LAKE SUPERIOR STATE UNIVERSITY

Academic Program Review

DUE DATE: November 21, 2018

The HLC Criteria for Accreditation, specifically Core Component 4.A, require institutions to maintain a "practice of regular program review[1]" as one component for ensuring the quality of our educational programs and evaluating our effectiveness in achieving our stated student learning outcomes. For academic units, "Program" means an academic School.

School:	**Mathematics and Computer Science**
Degree Programs of the School: (indicate which, if any, hold specialized programmatic accreditation)	***BACHELOR OF SCIENCE DEGREE PROGRAMS*** Computer Networking Computer Science Mathematics Mathematics, Elementary Teaching Mathematics, Secondary Teaching ***ASSOCIATE DEGREE PROGRAMS*** Computer Science Internet/Network Specialist
Academic Program Review Submission Date:	**November 21, 2018**
Dean:	**Dr. Kimberly Muller**
School Chair:	**Dr. Brian Snyder**
Names of Faculty Members Completing Program Review Report:	**Evan Schemm** **Chris Smith** **Rob Kipka** **Grace Ngunkeng** **Joni Lindsey** **Brian Snyder** **Daeshik Choi** **George Voutsadakis**

[1] https://www.hlcommission.org/Policies/criteria-and-core-components.html

Guidelines for Completing the Academic Program Review

Questions in Part 1 are focused at the School level, and should reflect School-level data, findings, etc.

Questions in Part 2 should be completed for each distinct academic degree program in the School. In the cases where an academic degree holds specialized programmatic accreditation, Schools can cite the page(s) which address the prompt question. In all cases, attach evidence where available using the appendix cover sheet to identify how the evidence supports the relevant criteria or prompt.

PART 1: School-Level Review

School Mission and Goals

1. Provide the School's mission statement and explain its connection to the University mission.

In 2009, the School of Mathematics and Computer Science formed an assessment committee which worked toward developing a Mission, Vision, Goals and Program Learning Outcomes and an assessment plan to measure all of the above. The mission was as follows:

> *The School of Mathematics and Computer Science offers baccalaureate degree programs in mathematics and computer science that are designed to develop students' full potential and to prepare graduates for professional careers, and also to provide them with the background needed to pursue further study in graduate school.*
>
> *The School also offers computer-related associate's degrees, designed to prepare graduates for employment in technologically challenging programs in business and industry.*
>
> *The School provides general education support in mathematics for all academic programs across the University.*
>
> *Finally, the School provides important foundational support in mathematics and computer science to the various academic programs offered within other units of the University.*

While all of the above is still applicable, in 2017 LSSU developed a new strategic plan, mission and vision. On August 24, 2018, the School of Mathematics and Computer Science voted to adopt a new mission that was more concise and better aligned with the University Mission. It is stated below.

Mission of the School of Mathematics and Computer Science

> ***We equip our graduates for success through emphasis on rigorous programs, hands-on experiences, and interaction with highly-qualified faculty members who are centered on student success.***

We feel this mission embodies what we value as a School and it is aligned with the University Mission in that our programs contain challenging coursework that provide students with the knowledge and practical skills necessary to succeed in jobs and in graduate studies.

2. List the School-level goals and explain how they support and connect to the CAFE Master Goals of the Strategic Plan.
https://www.lssu.edu/wp-content/uploads/2018/09/2018-2023-LSSU-Strategic-Plan.pdf

The School of Mathematics and Computer Science has adopted the following goals for the school, its students, its faculty, its staff, and its alumni.

I. We support an environment of collaboration and inclusion where students, faculty, and staff from all fields of study are valued.

II. We promote faculty-student interaction through high-quality classroom instruction, through hands-on research opportunities, and through student advising.

III. We adapt to changes in our disciplines to provide a timely and relevant educational programs to our students.

IV. We build transparent fiscal responsibility into all budgetary processes including the collection and allocation of course fees to meet the needs of our students and programs.

V. We develop outreach programs with K-12, community colleges, tribal partners, and other organizations to improve recruitment.

VI. We cultivate connections to our alumni, to graduate programs, and to employers to enhance the opportunities available to our students.

The alignment of these goals with Lake Superior State University's Strategic Plan, as approved on December 1, 2017 is as follows:

CAFE Master Goals for Culture:

1. We cultivate an environment of inclusion where all members treat others with dignity and respect.
   School goal I
2. We cultivate open communication, engagement, and behaviors that strengthen community, across campus and in the wider region.
   School goals I, IV, V, and VI
3. We cultivate continuous self-improvement through service, assessment, and accountability.
   School goal II, III, and V

CAFE Master Goals for Academics:

1. We will cultivate continuous academic and co-curricular improvement to provide relevant programs and support services.
   School goals II and III
2. We will cultivate student educational experiences that add value and allow students to reach their full potential.
   School goals II, III, and VI
3. We will cultivate programs that support individual growth within the curricular, co-curricular, and non-curricular realms culminating in degree completion and endorsement of lifelong learning.
   School goals I and VI

CAFE Master Goals for Finance:

1. We will cultivate a culture of continuous improvement through accountability and sustainability practices, regular financial reviews, and periodic reporting.
   School goal IV
2. We will cultivate data-informed budgetary processes that are open, transparent, and in alignment with institutional priorities.
   School goal IV
3. We will cultivate viable entrepreneurial efforts to efficiently support evolving institutional needs, and to support new financially-viable, mission-driven opportunities.
   School goals IV, V, and VI

CAFE Master Goals for Enrollment:

1. We will cultivate, maintain, and support an enrollment management strategic plan that will center on programs and activities that reach enrollment goals.
   School goals III and V
2. We will cultivate collaborations with external and internal groups to promote student development and success.

School goals I, V, and VI

3. We will cultivate continuous improvement of the student experience through data-informed decision making and student input.

School goals I, II, and III

Explain how the School works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Teaching and Learning Programs Evaluation and Improvement: (CC 4.A)

3. Explain how faculty determine program and course learning outcomes, course prerequisites, rigor of courses, expectations for student achievement, and student access to resources.

Many of the lower level Mathematics courses taught at LSSU are used as service courses by other areas on campus. Faculty that teach these courses meet with areas that use these courses in their degree programs from time to time in order to discuss potential changes to the courses, as well as the learning outcome needs from the courses in these other areas. Learning outcomes for these courses are produced in collaboration between the Mathematics faculty who regularly teach these courses and the faculty in other areas that make use of these courses.

In general, the prerequisites of these courses (at least within the Mathematics curriculum) do not change, and are the same as they are at almost any other institution in the country. The only recent change to them was about 13 years ago when the three classes that served as pre-calculus classes were dissolved down to two separate components (Pre Calculus without Trigonometry and a separate Trigonometry [and related topics] course). Faculty from Mathematics met with the different areas of campus that used the two classes (and the two follow on Calculus classes) to help them determine which set of courses would be best for their program (and to ensure that topics needed by those programs would be covered in the classes). The move to reduce the number of different classes offered was motivated by two things. The first was a cost savings, as it reduced the number of courses with overlapping material. The other was that Pre-Calculus was a five hour course and many students struggled to be successful. This gave students the option of taking both classes at once or spreading out the material over an entire year depending upon their skill level.

Student achievement in these classes is monitored by both a faculty review of success rates in the follow on classes, as well as a faculty review of these classes from a General Education perspective. The former efforts have resulted in the identification of areas of concern. For instance, the amount of material covered in MATH 102 and the relationship of that material to the follow on classes (primarily MATH 111 and MATH 131). These areas of concern and solutions for them are currently under discussion.

For upper level course objectives in Mathematics classes, faculty determined the course objectives themselves, and the entire package of upper level course objectives was approved as a school. While there are occasionally wording changes to these objectives, no substantial objective changes have occurred recently.

Program objectives for the Mathematics degrees were determined during a school meeting and voted on by the school.

The initial objectives for lower level Computer Science and Computer Networking classes were created by the Computer Science / Computer Networking faculty as part of a periodic curricular review. This set of CS / CN classes are those that are used as the pre-requisites for the upper level CS and CN classes. When we have changes to our curriculum, the objectives and goals for these classes are again reviewed by the Computer Science / Computer Networking faculty.

Course level objectives for upper level Computer Science and Computer Networking courses are determined by the faculty who teach those courses, but are kept within the framework of the program level objectives (and the purpose for that class in our curriculum). Recently, we have been trying to streamline the actual wording of those objectives to make them less content specific, and more purpose specific. These changes don't affect the placement of the course within the program, but may affect the specifics of how the course it taught. With (currently) only two Computer Science / Computer Networking faculty, each with a different set of upper-level-course expertise, this model seems to make the most sense.

The most recent set of program level objectives for the Computer Science and Computer Networking degrees were determined by the current Computer Science and Computer Networking faculty. The objectives were changed to focus on broader topics common to the degree as a whole, rather than a laundry list of content area topics (some of which were only covered by a class or two). This change will allow us to make changes to the specific implementations of the classes (and or swap out classes) without needing to constantly update the wording of the program objectives.

Students in all of our degree programs share access to the same set of resources. Some of these resources are currently maintained by the university as a whole, The Learning Center (tutoring) being an example of such. Our school maintains two classrooms where the school maintains the technological resources for instruction. This gives us control of the technologies used, as well as ensuring that those technologies match those that the students may be using for assignments as well. The school maintains two computer labs (and one study room), where we determine both the hardware and software available to the students. These match the hardware and software used in the classroom. All majors within our programs have access to these, not only for courses that specifically use them, but also during non-classroom hours for homework or general studying.

4. Explain how faculty ensure the equivalence of learning outcomes and achievement in all modes and locations where degrees are delivered. Provide examples of course syllabi from multiple delivery modes and locations of the same course(s).

Only three courses in Mathematics have been offered using other modes or locations in the last few years. All three were offered through concurrent enrollment with high school students. We will address the three locations individually.

(1) MATH 111 College Algebra was offered in 2014-2015 at the Advanced Technology Academy in Dearborn. It was taught by a high school teacher with an advanced degree. A syllabus is included in the related documents as well as a syllabus from an instructor on the main campus. A professor was designated as the liaison for the teacher and reviewed all quarterly exams. She also traveled to Dearborn to observe a class and complete an instructional observation form. The instructor's evaluation was positive. The students then took a departmental final that was written by faculty on the main campus. The students on the ATA campus scored considerably lower on the department final than those on the main campus. Through a joint decision with ATA, we chose to discontinue offering MATH 111 on the ATA campus.

(2) MATH 111 College Algebra, MATH 131 College Trigonometry and MATH 151 Calculus 1 were offered at Pickford High School in 2014-2015. It was taught by a high school teacher. The teacher had a master's degree, but she did not have 18 hours of graduate level mathematics. A professor was designated as the liaison for the teacher, reviewed the quarterly exams and watched many of the classes through ITV. At this time, changes and clarification about teaching qualifications were made clearer through our interactions with HLC. As discussions and review of teaching qualifications moved forward, the teacher was given a timeline for reaching the 18 hours, but she chose to stop teaching our courses instead of pursuing further studies.

(3) MATH 111 College Algebra, MATH 131 College Trigonometry and MATH 151 Calculus 1 were offered at Les Cheneaux Community Schools in Cedarville, MI. Examples of the most recent syllabi are attached. Like ATA and Pickford, a liaison reviews quarterly exams and performs an instructional evaluation. In 2015-2016, the students' success on the departmental final was poor, so the liaison provided lecture outlines in 2016-2017. There was improvement for MATH 151, but the performance in MATH 111 and MATH 131 was still poor. We discontinued these two courses in Cedarville in 2017-2018 and only offered MATH 151. Unfortunately, the performance in MATH 151 in 2017-2018 failed to meet expectations on the departmental final. We are not offering the course in Cedarville this year.

An attempt was made in the Fall of 2018 to offer MATH 151 remotely from the main campus. However, no high school students signed up for it. Therefore, for 2018-2019, no concurrently enrolled high school students are taking our courses off-campus.

In addition to the above mathematics courses, two courses in Computer Networking were offered in the Fall of 2018 online. This is not typical and was only done because the adjunct instructor took a full time job at the last minute that prevented him from coming to campus at the designated times. However, he is an experienced online instructor. He has taught courses with similar content online for another university. Syllabi for these courses are attached (CSCI 106 and CSCI 323). He is using Moodle, web development software and networking simulation software.

5. If applicable, attach the most recent report, findings and recommendations from specialized programmatic accreditations within the School.

There are no specialized programmatic reviews for the School.

6. Report data from the past two years to show what students are doing after graduation from the programs in your School. For example, statistical data should report the numbers of students in specific areas (*i.e.*, business, government, education, military, unemployed, pursuing advanced degrees, etc.). Attach representative data.

Of graduates in the last 2 years, 90% of graduates responded to the employment survey. Of those who responded, 75.7% are working in industry, 8.1% are in graduate school or are applying for graduate school, 13.5% are teachers, and 2.7% are unemployed. (This is one individual.) The list of graduates and their employers is included as an attachment.

Assessment (CC 4.B and CC 4.C)

Explain how the School uses assessment to promote ongoing growth and improvement. As evidence for each question, you may choose to include content from the 'Use of Results' column in the 4-Column Program Assessment Report, or provide broader assessment results from an alternative source.

7. School-level goals and their connections to the university's CAFE Master Goals Strategic Plan were listed in Question 2 of this report. Select 3-5 of those goals as a focus for the School's 4-Column School Assessment Report; add the selected goals to the 4-Column report document, and attach the document.

See attached.

8. Describe how results from assessment have been used to improve your School. Include specific examples.

Assessment of Assessment

In 2009, the School developed a course assessment template that included the student learning outcomes, a quantitative analysis, a grade summary, a general education analysis (when applicable), and an overall summary. In some cases it also included a student self-analysis of their own understanding of the student learning outcomes. When the campus as a whole moved to using an online platform for storing assessment data, some faculty continued to use the old template, some moved to the online platform and some did both. During the 2015 Program Review of Mathematics, it was noted that in many cases the online platform was more difficult than the old method and contained less reflection and use of results. After a review of the program review by the Provost

Council, our School was encouraged by the Associate Provost to return to using our template if we found that more useful. In the fall of 2015, the School voted to return to using the template. However, to be more in line with the online system, we added two sections on "Actions" and "Follow up on prior offerings". Two examples of course assessment are attached for your reference, one in computer science and one in mathematics

Academics

A national study showed that the success rate of college algebra was around 50%. At LSSU, we assessed our success rate in MATH 111 and found that it was at the national average. After studying national trends, we transformed out College Algebra course into an applied course with fewer topics and greater depth in those topics. This increased our success rate in MATH 111 to around 70%, depending on the year.

Shortly after the above change, we assessed our 5-credit precalculus course and found that it had a similar success rate. We also discovered through assessment that most of the unsuccessful students were struggling with trigonometry. When they failed a 5-credit course they often ended up on probation or suspension. We proposed a college trigonometry course where students who needed precalculus would take college algebra and trigonometry instead. This allowed students to spread the course out into a full year if they felt this would be helpful or take both courses at one time. This also allowed for a reduction of load when we deleted the precalculus course.

In another assessment of the prerequisite sequence in mathematics, in 2017, we found that 100% of students who were given overrides in College Algebra after making a C- or below in the prerequisite course were not successful in College Algebra. As a result, the Chair stopped making such overrides and encouraged other faculty to do the same. We instead encourage students to use the new math placement system ALEKS-PPL which has remediation abilities built into it.

After two years of data on the value of CSCI 103 for our Computer Science and Computer Networking majors, the school needed to determine what to do for a freshman seminar class for Mathematics majors. After evaluation of the assignments and topics in the course, the faculty of the school voted to make CSCI 103 be the freshman seminar class for Mathematics majors. A couple of the topics were changed slightly to have additional utility for Mathematics majors (including the invitation of a Mathematics faculty member to co-teach the course).

One ongoing process is the assessment and monitoring of CSCI 121 and CSCI 201. These courses are probably our most experimented on courses in the school. They are both foundational courses for our Computer Science major, but only CSCI 121 is taken in the other degrees in our school. Attempting to meet the needs of these different programs, as well as having a set of student learning outcomes that students accepted into those programs can achieve has proven more difficult than one might imagine. There are many issues with respect to student preparation, student engagement, student backgrounds (computer science, computer networking, mathematics, mathematics education) and mathematical knowhow. For the last 15 years, we have been trying out various sets of topics between the two classes (and at one point split them into three classes) in order to improve the student success rate.

Recently, though, we have started looking at the data in a different light. We have noted that students who are not successful in CSCI 121 or CSCI 201 almost universally fail to hand in over 75% of the assignments. Our focus the last two years has been on trying to identify the reasons for this. If we can identify those reasons, we hope to adjust the classes to improve the student success rate. We are currently looking at the inputs to CSCI 121 (CSCI 103 and CSCI 105) and how those classes can be improved to make a better incoming CSCI 121 student. Then we can apply those principles to CSCI 121 to make a better CSCI 201 student. Two of our newest improvements in that regard, is a change of programming language in CSCI 105 from C# to Python and a new text in CSCI 121.

Next is the assessment and monitoring of CSCI 281 and CSCI 412. As we looked at upper level Computer Networking students, we noticed a lack of skillset in the writing of scripts to solve System Administration tasks. As we first looked at adding CSCI 371 to the curriculum (as per latest ACM curriculum guidelines), this problem has been even more pronounced. Students need to have a greater amount of scripting experience, as well as experience with the tools required to do these tasks. To solve this problem, we moved much of the scripting material from CSCI 412 (Unix System Administration) to CSCI 281 (Introduction to UNIX). This solution has worked very well for students within our degree program. One side effect though, is that this has made transfer into our program from other institutions more difficult. Most two year colleges only offer a basic course in UNIX or Linux that does not include a heavy scripting component. We have had to remove transfer equivalence for these courses, as students who only have them lack the needed skills that were moved into our intro course. We have been working with a number of institutions that wish to have transfer agreements with us to help them improve their UNIX/Linux class to cover these topics. So far, results have been mixed. We are also looking into the possibility of remote delivery of this course so that we can ensure the critical topics are covered before a student transfers to LSSU.

Another example is MATH 087 and MATH 088. These classes are a consolidation of material found in six one-credit math classes (MATH 081 – MATH 086). The original idea had been to separate the material out into 6 different mini-classes. Students who had difficulty with one of the modules would only need to repeat course material for the module that they did not pass, rather than repeat the entire three module sequence (1 semester of class). Additionally, students who put additional effort into the class might be able to pass all six of the modules in one semester instead of being locked into a single three credit class. After 10 years of data, it was determined by the school that these benefits were offset by several negatives, and a decision was made to revert back to 2 classes. MATH 087 would cover the topics of the first three modules (081 – 083) and MATH 088 would cover the topics of the second three (084 - 086). This gave a more continuous format for students (14 weeks of continuous instruction instead of 3 groups of more intense 4 week instruction). Additionally, students were having issues with financial aid and/or athletic requirements which inhibited their ability to make use of the module groupings. Finally, with declining enrollments, students had significantly fewer opportunities to either 'get ahead' or 'make up' more or less than the 3 modules normally offered during a semester. In order to help offset the loss of advantages of the older system, arrangements were made for students to take online self-paced versions of this material which could then be tied in to the university math placement testing. Students who wished to progress faster than

one grouping per semester would be able to do so on their own time, and students who struggled with a part of the course would be able work on their own time to improve their deficient areas.
Another change we made due to assessment results is a group overview of all sophomore and senior projects. We found that some students were not successful on their senior projects because of improper alignment of the project to the individual or group. We developed a web address, were all project proposals were sent to the entire group and faculty met together to align students and projects. This has improved students success, especially when cross-disciplinary teams are helpful.

Finance

After assessment of the budget, course fees and computing needs, we decided to go to a five year cycle on computer replacement with a purchased warranty instead of a three year cycle. We have now completed two cycles for each lab and find that this has been a successful reduction in cost.
Based upon assessment and student feedback the tables and chairs were replaced in one of the computing labs. The new tables allow cords to be locked to prevent tampering. We have seen an improvement of upkeep in the lab.

Enrollment

Based upon a need to promote our programs, five years ago we began holding a Mathematics and Computer Science Field Day for area high school students. Based upon assessment and feedback of this endeavor we have added sections on careers in mathematics and computer science, requested help from area teachers with behavioral issues, and offered campus tours.

Based upon a decline in enrollment we terminated our degrees in (1) Computer Information Systems, (2) Computer Science Secondary Teaching and (3) Computer and Mathematical Sciences. We have also suspended our web development programs.

9. Describe how the School uses assessment results to inform and facilitate better planning and budgeting.

During the 2015, budgeting process for the 2015-2016 academic year the amount budgeted, approved, and actual values were monitored for a two-year period. Cuts were made based upon the findings and budgeted items were moved between instructional and administrative costs to better represent actual spending. As stated in question 8, after assessment of the budget, course fees and computing needs, we decided to go to a five year cycle on computer replacement with a purchased warranty instead of a three year cycle. We have now completed two cycles for each lab and find that this has been a successful reduction in cost.

In 2018, a similar three-year budget cycle was evaluated for trends and changes were made based upon past spending. With a new Dean, school chairs receive monthly budget updates and can adjust spending accordingly.

10. In addition to LSSU's campus-wide programs designed to support retention and degree completion, list any additional activities of the School specifically intended to increase retention and degree completion.

Our school was among the first to implement a freshman class that specifically targeted topics and practices designed to improve retention and academic completion for our degree programs. CSCI 103 is a class that is either explicitly required by all degree programs in our School, or for one of the math degrees was the most likely of two options students could take. As of 2018, and because of the success seen in the prior two years, the course is now required for non-education Mathematics majors as well.

When we overhauled this class three years ago, we were looking to accomplish two things. First, we recognized that there was (at the time) no other class that introduced students to the policies and procedures regarding academic life at LSSU. Why would a student use the academic catalog? Under what circumstances should they plan a visit to the library? What constitutes a scholarly journal in Computer Science or Mathematics, and what submission guidelines will they be required to use (ENGL 110 covers the various styles, but does not indicate which disciplines use specific styles). Even more, we found that freshmen are often misusing or unaware of common collegiate words (what is the difference between a major, minor, and concentration?). What is supposed to happen each semester in order to register for classes? What is an "Application for Graduation" (and can they safely ignore it until April)? We wanted to not only answer these questions, but explain to students how the answers affect both their time at LSSU, and their future employment. Since implementing this course, we have a much better response rate in students signing up for (and following through with) advising. Additionally, students are much better prepared for these advising meetings, and in most cases actually have a plan for what they need to do in order to graduate on time.

We specifically have one assignment that deals with all of these questions, as well as introduces them to all the players in their academic path to graduation. Most students prior to this point have no idea what a Dean actually is (or even that such exists). Students completing the assignment not only know who their (current) Dean is, but why they might be seeking her out down the road. They also meet their School chair, locate a copy of the course offering pattern and learn about prerequisite chains.

Another assignment asks students to find a number of useful, but otherwise not-explicitly pointed out areas of campus (and take pictures of them for proof). Where can they go if a vending machine refuses to give out product? Where is the section of the library that houses CS and Math journals? Who is the President (of the University)? What is the highest numbered door in our building? Where is the student section at the Ice Arena? Where is the Registrar's Office? Where is the counseling center, and why might they go there (and why that isn't a negative thing!). These things aren't as degree-important as the topics from the previously mentioned assignment, but they serve to show our majors the rest of campus, and perhaps some of the non-academic things that they might want to participate in. Some of this material is covered by the campus tour that they likely had when they first came here, but they have likely forgotten much of it, and/or did not realize its relevance to them personally. Furthermore, some of these resources are only seen as needed once the student is here and struggling. We are trying to help them realize that there is help for most student problems, as well as where to get that help (instead of waiting for the world to crash).

The net goal of these assignments is to familiarize students with the processes and life of being an LSSU student. One thing mentioned several times in retention discussions at the university level is that 'students did not know where to go', or 'students were confused about...'. These assignments, and their relevant classroom discussions (and yes, they were discussions, not lecture) gave students at least a foundational familiarity with the things most likely to be of concern to a struggling or confused student.

The second goal we had in CSCI 103 was to teach some foundational skills and knowledge that we had assumed students had, but that we found was never actually taught as part of introductory courses. The incoming population into Computer Science and Computer Networking is far broader than in many other majors. For instance, a student choosing to major in Mathematics, has very likely taken several math courses in high school (one would expect at least through Calculus I), and most likely has an aptitude for math of that level. Too often, though, students choose Computer Science or Computer Networking because they like playing with computers (games or just general computer use). Because many high schools do not offer formal Computer Science classes (and the few that do are almost always introductory web page setup, or elementary programming), even students that know what the subject is, have little formal background.

Several weeks of lecture and discussion, as well as two assignments seek to introduce students to the basics of computer hardware terminology, the importance and methodology of numerical representation (in other than base 10), and the beginnings of Boolean Algebra and Logic (and its relation to Decision and Repetition structures in Computer Science). As these students advance through our curriculum, that common foundation will serve them well. Even our math students will benefit from the earlier introduction to these topics, as they will see them in greater depth in upper level courses.

Our net goal with this is to smooth the transition between the vastly disparate knowledge and skill bases of incoming students and the expected knowledge and skill base for our classes. College is not High School. With this effort, we are trying to reduce the shock of that transition.
Lastly, we have also introduced a few lectures / discussions on some of what it means to live in a digital society. Most students believe that they already know this area of knowledge, but as we discuss what these things mean from a technical perspective and they come away with a new respect for their digital presence. We, for instance, talk about the background behind digital forensics (and what this means for all the digital droppings they leave on the internet). We talk about elements of computer security and how they work (and are exploited) in the real world. It's quite a bit different from what they are presented on the television, and it requires conscious effort to improve your computer security. Inclusion of these topics makes LSSU more of a life-altering experience for them, but also invites them to talk with us about these sorts of things in the future.

It also shows that life exists outside the classroom, and that the things they are learning in their classes have application outside the classroom and their future careers.

In the last year, the Mathematics faculty have started several new initiatives including 'Talk Math 2 Me', which is an opportunity for students and faculty to present short, interesting mathematical applications in a semi-formal setting. The goal is to give students an opportunity to learn and present mathematics outside of the classroom. They have also started a lecture series on Friday to have a forum for more formal coverage of mathematical research topics. The plan is that this will eventually include the senior project presentations given by Mathematics majors prior to their graduation. While these have only been going on for a couple months, attendance has been picking up.

Lastly, we have developed a means of reporting Early Alert warnings to the dean via a form and through her to Campus Life and Student Success. While this is in the early stages, we will track whether or not these reports are effective.

Resources (CC 5.A and CC 5.C).

11. Describe how the School allocates resources to adequately support the mission. Include explanations of faculty/staff, fiscal, and infrastructure allocations. For example, describe the process used to ensure that each faculty member or instructor in the program is qualified to teach the courses they are assigned, as consistent with HLC guidelines. (https://www.hlcommission.org/Publications/determining-qualified-faculty.html)

Staff

All full-time faculty in the School of Mathematics and Computer Science have terminal degrees in their fields. One of these has PhDs in both mathematics and computer science. All adjuncts have master's degrees in their field or a closely related field. In addition, the School has an administrative assistant who works half-time in the School of Mathematics and Computer Science and half-time in the School of Kinesiology. One of our faculty members also receives a small stipend in the summer to set up and maintain the computer labs (both hardware and software).

Infrastructure

The School's offices for faculty and staff are in CASET 206. There are also offices reserved for the supply of educational tools and for student testing (as needed for make-up tests). The educational tools are primarily used for the instruction of elementary education majors, but are at times used for other courses. The main office has a copier, two printers (color and black and white), file cabinets and supply cabinets.

The School has two classrooms and two labs that are reserved completely for their use. They also have a student research room that is also used for departmental meetings. The equipment in these classes and labs are paid with course fees and are maintained by a member of the faculty. One of the classrooms has boards on each wall for student presentations. They both have movable tables and chairs. One of two labs also has storage for computers reserved for computer networking projects and/or replacement, as needed. The research room houses a library of reference books in mathematics and computer science, as well as four computer workstations. Students can use both labs or the research room as long as classes are not being held at that time.

The School has two additional rooms where they have first refusal of classroom use. For one of the rooms, the tables and equipment were purchased by the department in a move to create a better active learning environment. For the other, the ITV equipment was purchased jointly by the School and two other Schools.

Fiscal

The budget is written by the chair with oversight by the dean. Software, computers and licenses are purchased on rotation, depending upon the relevant contracts. Items are also replaced as they break. Most other supplies are purchased annually with fairly steady expenditures. Course fees were developed and planned out by the School in order to ensure that students had the things that they needed. Most large purchases are planned at least one year in advance. For events that involve high school and charter school students, charter school funds are leveraged when possible.

Teaching Qualifications

The Mathematics department has minimum teaching qualification guidelines for each course offered, (see sample TQF) and courses are assigned to instructors based on these guidelines, which are in compliances with HLC requirements.

<u>Fulltime Faculties:</u>
All fulltime faculties in the department have earned a terminal degree (PhD) in Mathematics, Applied Mathematics, mathematics education, Statistics, Computer Science and Related fields. The department peer reviewed and approved the TQF of each faculty member (see meeting minutes).

<u>Adjunct Faculty:</u>
At the beginning of each academic year, the department peer reviews and approves all qualified adjuncts. These include faculty members from other departments who included Mathematics courses in the TQF. (see meeting minutes). These adjuncts teach mostly developmental mathematic courses such as MATH 087 –Pre Algebra and MATH 088 - Beginning Algebra.

<u>Dual Credit Faculty (High school)</u>
The department reviews and approves in compliance with HLC guidelines the credentials of high school teachers who are scheduled to teach mathematics dual credit courses.

12. Explain how the School ensures that the curriculum for each program is current. For example, evidence may include specialized program accreditation, advisory boards, input from industry, discipline standards, previous School reviews or reports, etc.

The School of Mathematics and Computer Science reviews discipline standards for their curriculum. For Computer Science and Computer Networking, they review the ACM Computer Science Curricula - Ironman Draft. It can be found at:
http://ai.stanford.edu/users/sahami/CS2013/ironman-draft/cs2013-ironman-v0.8.pdf

For the mathematics degrees, we review the Curriculum Guide to Majors in Mathematical Sciences, published by the Mathematical Association of America's Committee on Undergraduate Programs in Mathematics (CUPM). It can be found at:
https://docs.google.com/viewer?url=https%3A%2F%2Fwww.maa.org%2Fsites%2Fdefault%2Ffiles%2Fpdf%2FCUPM%2Fpdf%2FCUPMguide_print.pdf.

For the Mathematics Secondary Teaching degree we review the Michigan Department of Education Standards for the Preparation of Teachers of Mathematics–Secondary (EX) found at:
https://docs.google.com/viewer?url=http%3A%2F%2Fwww.michigan.gov%2Fdocuments%2Fmde%2FMath_Standards_554574_7.pdf

For the Mathematics Elementary Teaching degree we review the Michigan Department of Education Standards for the Preparation of Teachers of Mathematics–Elementary (EX) found at:
https://docs.google.com/viewer?url=http%3A%2F%2Fwww.michigan.gov%2Fdocuments%2Fmde%2FElem_Math_Standards_554575_7.pdf

Additionally, for the two education degrees we use The Mathematical Education of Teachers II, (METII) published by the Conference Board of Mathematical Sciences in 2012. It can be found at:
https://docs.google.com/viewer?url=https%3A%2F%2Fwww.cbmsweb.org%2Farchive%2FMET2%2Fmet2.pdf

You can find discussions related to all of the above in the past program review documents which are in related documents. These documents are:
Computer Science Program Review (2014); pg 6.
Computer Networking Program Review (2015); pgs 8-9.
Mathematics Program Review (2016); pgs 6-7.
Computer Science Monitoring Report (2016); pg 1.
Mathematics Elementary and Secondary Teaching Program Review (2016); pgs 9-11.

Appendix Cover Sheet

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	Mathematics and Computer Science
Document Title (if attached) or Filename (If emailed):	MATH 111 2014-2015 On Campus
This documentation is relevant to Question number:	4
Briefly summarize the content of the file and its value as evidence supporting program review:	Example of On Campus syllabus for comparison.

LAKE SUPERIOR
STATE UNIVERSITY

College of Natural and Mathematical Sciences **Spring, 2015**
MATH 111: College Algebra **3 Credits**

Prerequisites: ACT Score of 23 or higher, or a score of 66 or higher on either the Algebra A or Algebra B COMPASS exam, or MATH 102 with a grade of C or better.

Instructor(s): Tom Boger
206-A2 Center for Applied Science
906 635 2427
tboger@lssu.edu

Office Hours:
Monday: 9:00 – 9:50 AM, 11:00 - 11:50 AM
Tuesday, Thursday, and Friday – 9:00 – 9:50 AM
Other hours are available by appointment

Required Text(s): College Algebra in Context with applications for the managerial, life, & social sciences, 4th Edition (Harshbarger & Yocco)
Note: Electronic versions of the textbook are **NOT** allowed in the classroom.
Your textbooks are available at the campus bookstore. New, used, rental and digital are options for purchase depending on title. You may use cash, checks, debit and credit cards as forms of tender, including financial aid checks. In addition to in-store purchase, the bookstore also offers the convenience of ordering your textbooks 24/7 online through My.LSSU (Anchor Access) or at www.lssu.bncollege.com.

Course Description: This course is a study of families of functions through formulas, tables, graphs, and words, emphasizing applications in business, life science, and social science. The function families include linear, polynomial, rational, exponential, logarithmic, and power functions. Within these families, topics include problem solving, model creation, solving equations, systems of equation and inequalities, rates of change, graphing, analysis, and interpretation.

Course Objectives: At the conclusion of MATH 111, a student will be able to:

1. Solve problems presented in the context of real world situations, with emphasis on model creation, prediction and interpretation. This will be done using multiple perspectives, including formulas, tables, graphs, and words. (This includes determining if a given formula, table, graph or situation represents a function, as well as finding the domain and range.)
2. Calculate the average rate of change of a function using the slope formula or simplify the average rate of change using the difference quotient.
3. Define, evaluate, graph and analyze linear functions and solve linear equations and systems. (The analysis will include finding slopes, input/output values, intercepts, and intersections, as well as determining if data are linear.)
4. Define, evaluate, graph and analyze polynomial and piece-wise polynomial functions, and solve polynomial equations. (The analysis will include finding input/output values, finding zeros, and optimization.)
5. Define, evaluate, graph and analyze power functions, and solve power equations. (The analysis will include finding input/output values, and determining concavity.)
6. Define, evaluate, graph and analyze exponential functions, and solve exponential equations. (The analysis will include finding input/output values, using growth/decay rates, and determining if data are exponential.)

7. Define, evaluate, graph and analyze logarithmic functions, and solve logarithmic equations. (The analysis will include finding input/output values, comparing inputs/outputs of logarithmic scales using ratios, and using properties of logarithms to evaluate functions and solve equations.)
8. Perform operations on functions such as transformations, compositions and inversions.
9. Solve polynomial inequalities.

General Education Objectives:
This course is designed to meet the Mathematics General Education Outcome. Students will be able to analyze situations symbolically and quantitatively in order to make decisions and solve problems. All of the above ***Course Objectives*** will be used to satisfy the Mathematics General Education Outcome.

Grading Scale and Policies:
Grades: Grades will be assigned on the basis of total points earned this semester. There will be three hourly tests, worth 100 points each, a comprehensive final exam, worth 200 points, and an additional 200 points for in-class activities, quizzes, homework, and attendance. Final grades will be based on total points earned, in accordance with the following schedule:

640 - 700 Points: A	500 - 549 Points: C
630 - 639 Points: A-	490 - 499 Points: C-
620 - 629 Points: B+	480 - 489 Points: D+
570 - 619 Points: B	430 - 479 Points: D
560 - 569 Points: B-	420 - 429 Points: D-
550 - 559 Points: C+	0 - 419 Points: F

Absences and Make-ups:
- Students are expected to be in class each day at the time the class begins. If you miss class, or are late, it is up to you to track down anything you may have missed.
- Tests are to be taken at the scheduled times.
- In the event of a university-approved absence or a conflict with some event in your personal life, you should provide written notification (NOT e-mail or voice mail) at least one week in advance. If I approve, we will make arrangements for a make-up at that time.
- If you miss an exam due to an unexpected illness or family emergency, you should notify me as soon as possible (e-mail or telephone messages are permissible) of the reason for your absence; we can then discuss whether a make-up opportunity will be provided.
- If you simply miss an exam without providing proper notification, no make-up will be allowed - you will receive a grade of 0 for the exam.

Classroom Expectations:

- I expect you to be in class on time; late arrival is disruptive to both your instructor and your classmates. Refilling your backpack 5 minutes before class is scheduled to end is equally disruptive; please wait until class has ended.
- There is no need for you to be using <u>any</u> electronic devices in this class other than your calculator. I don't want to see any headphones, computers, tablets, or cell phones on the tables. Please make sure your cell phone is muted, and refrain from checking it during class.
- Show respect for your classmates at all times.

<u>Universitv and Departmental Policies</u>:

Please see the accompanying Class Policies handout from the School of Mathematics and Computer Science.
Additional policies, including those below, are posted on the Provost's website: www.lssu.edu/provost/forms.

- The Americans with Disabilities Act & Accommodations
- IPASS (Individual Plan for Academic Student Success)

Tentative Semester Schedule: To the extent possible, we will cover the specified sections on the dates shown in the following schedule. If for some reason we do not hold strictly to this schedule, exams will still be held on the dates shown.

Monday	Tuesday	Wednesday	Thursday	Friday
1/12	1/13 Section 1.1, 1.2	1/14	1/15 Section 1.2, 1.3	1/16
1/19	1/20 Section 1.3, 1.4	1/21	1/22 Section 2.1	1/23
1/26	1/27 Section 2.2	1/28	1/29 Section 2.3	1/30
2/02	2/03 Section 2.4	2/04	2/05 Review	2/06
2/09	2/10 Test #1	2/11	2/12 Section 3.1, 3.2	2/13
2/16	2/17 Section 3.2, 3.3	2/18	2/19 Section 3.3, 3.4	2/20
2/23	2/24 Section 4.1, 4.2	2/25	2/26 Section 4.2, 4.3	2/27
3/02	3/03 Spring Break	3/04	3/05 Spring Break	3/06
3/09	3/10 Section 4.3, 4.4	3/11	3/12 Review	3/13
3/16	3/17 Test #2	3/18	3/19 Section 5.1	3/20
3/23	3/24 Section 5.2	3/25	3/26 Section 5.3	3/27
3/30	3/31 Section 5.4	4/01	4/02 Section 6.1, 6.2	4/03
4/06	4/07 Section 6.2, 6.3	4/08	4/09 Section 6.6	4/10
4/13	4/14 Review	4/15	4/16 Test #3	4/17
4/20	4/21 Review	4/22	4/23 Review	4/24
4/27	4/28 Final Exam (10:00 AM)	4/29	4/30	5/01

Homework Practice:
The homework exercises for each section are below. You should spend a lot of your math study time doing homework. It is recommended that you buy or print graph paper for this course and use this paper when completing your homework. If you are struggling with your homework seek help from your instructor or the tutors in the Learning Center.

Underlined problems indicate pre-requisite skills.

	Skills Check	Exercises
Section 1.1; page 18	1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31	37, 43, 49, 51, 59, 65, 66, 69
Section 1.2; page 37	1, 5, 17, 21, 27	37, 47, 49, 51
Section 1.3; page 55	3, 7, 13, 15, 17, 21, 27, 29	35, 39, 43, 49, 53, 55, 59
Section 1.4; page 69	3, 5, 7, 8, 11, 15, 17, 19, 23, 25, 27, 29, 31	37, 39, 47, 49, 51, 59, 61
Section 2.1; page 99	3, 7, 9, 13, 17, 27, 33, 35, 41	45, 53, 63, 65, 67, 71, 79
Section 2.2; page 116	1, 3, 5, 7, 9, 11-14, 21	27, 31, 35, 41, 43
Section 2.3; page 134	1, 5, 9, 11, 13, 17, 21, 23	37, 39, 41, 49, 55, 57, 61, 67
Section 2.4; page 146	3, 7, 11, 13, 15, 17, 19, 25	29, 33, 43, 45, 49, 55
Section 3.1; page 178	1, 5, 7, 13, 23, 27, 29, 37	49, 53, 61, 65, 67
Section 3.2; page 195	1, 7, 23, 27, 31, 33, 37	53, 55, 59, 65, 73
Section 3.3; page 209	1, 5, 7, 9, 13, 17, 21, 23, 25, 27, 39, 41	43, 47, 49, 53, 59, 61
Section 3.4; page 223	1, 7, 11, 12, 13, 15, 17, 21	23, 27, 31, 37, 43, 47
Section 4.1; page 259	1, 3, 5, 7, 9, 11, 13, 15, 17, 21	51, 55, 59, 61
Section 4.2; page 271	3, 7, 11, 15, 21	27, 31, 37, 43, 45, 47
Section 4.3; page 283	1, 3, 5, 7, 9, 11, 15, 17, 19, 23, 25	37, 39, 43, 45, 49
Section 4.4; page 297	13, 15, 17, 19, 23, 35, 37	43, 45, 49, 51, 53
Section 5.1; page 321	1, 3, 5, 7, 9, 11, 13-18, 19, 23, 25, 27	29, 31,33, 35, 43, 45
Section 5.2; page 337	1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 23, 25, 27, 31, 35, 37	41, 45, 47, 51, 53, 55, 59, 63, 65, 69, 71
Section 5.3; page 350	1, 5, 7, 11, 15, 17, 19, 23, 25, 27, 29, 31, 33	43, 47, 53, 55, 61, 63, 67, 73
Section 5.4; page 366	1, 3, 7, 9, 13, 15	17, 19, 21, 25, 29, 33
Section 6.1; page 424	1, 5, 7, 9, 11-16, 17, 23, 27	37, 41, 43, 45
Section 6.2; page 437	1, 5, 11, 13, 14	17, 23
Section 6.3; page 451	1, 5, 11, 15, 19, 31	33, 35, 39, 47
Section 6.6; page 483	1, 3, 5, 15, 17	21, 23, 25

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**MATH 111 2014-2015 At ATA**
This documentation is relevant to Question number:	**4**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Example of Off Campus syllabus for comparison.**

LAKE SUPERIOR
STATE UNIVERSITY

College of Natural and Mathematical Sciences **2014-15 School year**
MATH 111: College Algebra **3 Credits**

Instructor(s): Stephanie Robinson
srobinson@atafordpas.org

Room: 243

Class Website: **www.mrsrobinsonsclasswebsite.weebly.com**

Office Hours:
Monday, Tuesday & Thursday – 3:20 – 3:50 PM

Required Text(s): College Algebra in Context with applications for the managerial, life, & social sciences," 4th edition, by Harshbarger and Yocco

Course Description: This course is a study of families of functions through formulas, tables, graphs, and words, emphasizing applications in business, life science, and social science. The function families include linear, polynomial, rational, exponential, logarithmic, and power functions. Within these families, topics include problem solving, model creation, solving equations, systems of equation and inequalities, rates of change, graphing, analysis, and interpretation.

Course Objectives: At the conclusion of MATH 111, a student will be able to:

1) Solve problems presented in the context of real world situations with emphasis on model creation, prediction, and interpretation. This will be done using multiple perspectives (formulas, tables, graphs, and words) and will include fitting an appropriate curve to a scatter plot.
2) Calculate the average rate of change of a function on a given interval and use it as an estimation tool.
3) Define, evaluate, and analyze linear functions and solve linear equations and systems. The analysis will include finding slopes, input/output values, intercepts, and intersections, and determining if data are linear.
4) Define, evaluate, and analyze exponential functions and solve exponential equations. The analysis will include finding input/output values and growth/decay factors or rates, and determining if data are exponential.
5) Define, evaluate, and analyze logarithmic functions and solve logarithmic equations. The analysis will include finding input/output values, comparing inputs/outputs of logarithmic scales using ratios, and using properties of logarithms to evaluate functions and solve equations.
6) Define, evaluate, and analyze power functions and solve power equations. The analysis will include finding input/output values, comparing inputs/outputs of power functions using ratios, and determining if data can be represented by a power function.
7) Define, evaluate, and analyze polynomial functions and solve polynomial equations. The analysis will include finding input/output values, finding zeroes, and optimization.

8) Perform operations on functions, including composition and inversion.
9) Solve polynomial inequalities.

<u>**General Education Objectives**</u>: This course is designed to meet the Mathematics General Education Outcome. Students will be able to analyze situations symbolically and quantitatively in order to make decisions and solve problems. Specifically, students will be able to:

- Solve problems presented in the context of real world situations with emphasis on model creation, prediction, and interpretation. This will be done using multiple perspectives – formulas, tables, graphs, and words – and will include fitting an appropriate curve to a scatter plot.

Course Outline:

Described is the tentative schedule of the MATH 111/College Algebra/Algebra III course. Items may be changed from one semester to another with or without notice but will be changed only for the benefit of the student. Also, after each semester will be a semester final.

Semester 1 *(tentative)*

1st Quarter

- Course and Classroom Expectations/Review — Sept. 2 - 17
- CH 1 – Functions, Graphs, and Models
  Linear Functions — Sept. 18-Oct. 7
- CH 2 – Linear Models, Equations, and Inequalities — Oct. 8 – 31

2nd Quarter

- CH 2 – Linear Models, Equations, and Inequalities — Nov. 3 - 5
- CH 3 – Quadratic, Piecewise-Defined, and
  Power Functions — Nov. 6 – Dec. 5
- CH 4 – Additional Topics with Functions — Dec. 8 – Jan. 13
- SEMESTER EXAM REVIEW — Jan. 14 - 16
- SEMESTER EXAMS — Jan. 20 - 22

Semester 2

3rd Quarter

- CH 5 – Exponential and Logarithmic Functions — TBD

4th Quarter

- CH 6 – Higher Degree Polynomial and Rational Functions — TBD
- Senior Final Exam Review — May 18-20, 26
- Senior FINAL EXAM — May 28
- FINAL EXAM REVIEW — June 4 - 9
- FINAL EXAMS — June 10 - 12

Grading: Each quarter grade includes assessments (tests, quizzes), bellwork, classroom assignments, homework assignments, and class participation. Please note: report cards will only be sent home at the semester end not at the end of each quarter. It is important to monitor grades by logging into PowerSchool. (https://ata.powerschool.com/public/home.html).

Assessments	70%
Assignments, HW, Participation, BW	30%

*On assessment days there **will be** absolute silence so that all students have the opportunity to complete their work in a positive atmosphere. Failure to adhere to this policy (finished or not) will result in a zero grade. In addition, cheating of any kind will also result in a zero.*

Grading Scale:

A = 93% -100%	C = 73% -76%
A- = 90% -92%	C- = 70% -72%
B+ = 87% -89%	D+ = 67% -69%
B = 83% -86%	D = 63% -66%
B- = 80% -82%	D- = 60% -62%
C+ = 77% -79%	F = 0% - 59%

Homework Practice:
The homework exercises for each section are below. You should spend a lot of your math study time doing homework. It is recommended that you buy or print graph paper for this course and use this paper when completing your homework. If you are struggling with your homework seek help from your instructor or the tutors in the Learning Center.

Underlined problems indicate pre-requisite skills.

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Section 6.3; page 451	1, 5, 11, 15, 19, 31	33, 35, 39, 47
Section 6.6; page 483	1, 3, 5, 15, 17	21, 23, 25

Expectations

- Students must be prepared for class. This means that you need to have your book, homework, ***pencil***, and/or anything else you may need for class. You will not be allowed to go back to your locker to retrieve them.
- Students are expected to be in class on time. If a student is tardy (meaning he/she is not in the class prior to the bell ringing), then the student will receive a tardy.
- Students must be in proper school uniform. This includes and is not limited to proper shoes, pants, and a tucked in shirt.
- No cell phones and electronic devices are permitted in the classroom. They must be kept in your lockers at all times.
    - If you are caught with any of these items, they will be confiscated and turned into the dean of discipline.
- Students are expected to act in a respectful manner at all times. This means no talking during instruction or when another student is talking.
- There will be absolutely **NO food, gum, or drink** allowed in the classroom.
- If you have trash to throw away, keep it until the **end of the hour** and throw it away.
- Backpacks and purses are to be kept in your locker. These items will not be allowed in the classroom.

  Note: Parents and students have both a right and a responsibility to know the contents of the ATA Handbook.

Consequences:

Students who do not adhere to the classroom policies will face disciplinary action as outlined in the student handbook.

Procedures:

- Although I would prefer you use mechanical pencils, regular pencils must be sharpened before class starts. Have at least 2 pencils sharpened in case one breaks so you do not have to get up and disrupt the class. You will not be allowed to get up in the middle of instruction, quiz/test, etc. to sharpen pencils; it is too disruptive and distracting.

- Bellwork is to be completed within the first 5 minutes of class. If you are tardy to class, you will not be able to make up the bellwork.

- Homework will be assigned on a regular basis. It is the student's responsibility to get homework done in a timely fashion.

- Each student will be given 3 hall passes to use as needed per quarter for emergency purposes. I will keep track of the dates in which you use your passes. Do not interrupt classroom instruction to use a pass, wait for an appropriate time.

- **Remind App**

  This school year I will be using an app called Remind. It is a text messaging service that allows me to send text updates to my students. I will register students on the website, which will then put them on my list of contacts. I will then be able to send messages either directly from the website, or from the mobile app. This is entirely voluntary, and no students will be required to register. Students will receive reminders on a wide range of topics. Everything from test reminders to study guides can be sent using this app. Please note that this is a one-way program, and students will not be able to respond to my texts. Lastly, I encourage all parents to register as well so they know exactly what's happening in class. See my website for more info.

- We will discuss other specific procedures together as a class.

Attendance Policies:

Tardy Policy

- Students are expected to be in class when the bell rings, otherwise they are considered tardy. When the bell rings, students should have all materials out and ready to work.

Absenteeism Policy

- **Students have one day for each absence to turn work in.** For example, if a student is absent on Tuesday and returns on Wednesday, Tuesday's work is due on Thursday. If a student misses Tuesday and Wednesday, then work for both of those days is due on the following Monday. There will be an absent file that you can go to and get any missed notes and/or worksheets.

- If a student is absent on the day the assignment or project is due, the assignment is due the **first** day the student returns. If the student is absent on test day, he/she is responsible for taking the test the day that he/she returns after school. **It is the student's responsibility to see me about taking the test.**

- **Not all work can be made up.** Sometimes we watch videos in class, conduct lab investigations, hold class discussions and students are given credit for these activities. If a student misses class, they may not be able to make up the assignment. It is imperative for students to be in class every day. **It is the responsibility of the student to collect all missed work.**

- LATE WORK POLICY - Any work not turned in when it is due will be considered LATE. You may turn in LATE work until the day before the test on that material. Point value for the late work will be determined by the Instructor.

- The instructor also reserves the right to assign an alternative assignment if the answers to the original assignment have already been reviewed in class.

- No additional assignments will be given to boost a grade.

~~~~~~

Mrs. Robinson's CLASSROOM AGREEMENT

I have read & reviewed the Course Syllabus/Classroom Agreement.

I understand and agree with the rules and expectations set forth in the contract provided. Please sign, date, and return form to your teacher.

Thank you and I look forward to working with you this semester.

Student Name (Please Print): ______________________________

Student Signature: ____________________ Hour: __________

Parent/Guardian Name (Please Print): ______________________

Parent/Guardian Signature: ____________________________

Relationship to Student: ______________________________

Best telephone number to be reached at: ____________________

E-Mail Address: ____________________________________

Date: ____________________
~~~~~~

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	Mathematics and Computer Science
Document Title (if attached) or Filename (If emailed):	CSCI 106 F17 On Campus
This documentation is relevant to Question number:	4
Briefly summarize the content of the file and its value as evidence supporting program review:	Example of On Campus syllabus for comparison.

LAKE SUPERIOR STATE UNIVERSITY

College of Arts and Sciences **Fall 2017**
CSCI106 (2, 2) Web Page Design and Development **3 Credits**

Prerequisites: No academic prerequisites; Basic computer literacy skills required.

Instructor: Dr. Katie Kalata, Assistant Professor
Office Location: CAS 206
Office Phone: (906) 635-2747
Text Messages: (906) 202-0314
Email Address: kkalata@lssu.edu

Office Hours: *Students may request appointments outside of these hours!*

Wednesdays:	2:00 – 4:00 pm
Thursdays:	9:00 – 11:00 and 3:00 – 4:00 pm

Required Texts:

The Definitive Guide to HTML5
Author: Adam Freeman
Publisher: Apress, December 2011
ISBN-13: 9781430239604 – 1st Ed.

The lab computers are configured with Adobe software. Students are required to have access to an external source to store their files. Download book examples & solutions: https://github.com/Apress/def-guide-to-html5/archive/master.zip

Course Description: Topics include planning a web site starting with domain name registration and selection of hosting service providers, creating web page using HTML/XHTML and cascading style sheets; validating web pages; using web authoring tools such as Dreamweaver, publishing web pages to a remote web server, introductory web site design, including best practices for inserting graphics, page layout, building the web site navigation and user interface, integration of third-party and Web 2.0 tools and software, implementing web and accessibility standards, ethical and legal issues such as copyright and trademarks.

Course Goals: *The students will be proficient developing and managing basic web sites.*

Course Objectives/Student Learning Outcomes: At the conclusion of CSCI106 students will:

1. Describe how to setup a web site including registering the domain name and selecting a hosting service provider, identifying a sitemap plan, locating graphic and multimedia resources.
2. Create web applications using a variety of tools such as HTML, CSS and content managed systems that are compliant with accessibility standards, aesthetically pleasing, with a common layout, navigation and themes.
3. Publish and maintain a web application to a live remote server.
4. Create and modify images and insert them into web pages.
5. Utilize new technologies such as social networking and mobile web applications to enhance the web applications.
6. Identify the web development, design and programming job skills and requirements, education and certifications that are in high demand.

Section Information

Dates:	08/29/2017 - 12/7/2017, Lecture and Lab
Lecture:	CAS Room 210, Tuesday and Thursday @ 2:00 pm - 2:50 pm
Lab:	CAS 303 (Upstairs Lab) @ 4:00 pm - 5:50 pm - Monday

Grading Scale and Policies:

Point Values:

Lab Assignments (14 * 3 points each)	42
Midterm Exam	28
Final Exam (cumulative)	30
The total number of points:	100 points

You cannot pass the course unless you complete the final exam successfully. Students who do not complete the final exam during the last week of class receive an automatic F. You must complete the cumulative final exam with a C (70%) or better to pass this course.

Grading Scale:

Letter	%	Letter	%	Letter	%	Letter	%
A+	98-100	B+	88-89	C+	78-79	D+	68-69
A	92-97	B	82-87	C	72-77	D	62-67
A-	90-91	B-	80-81	C-	70-71	D-	60-61
						F	<60.0

University Policies and Statements: **Refer to the School classroom policies handout!**

Please review the University policies at to the Provost's web page where the policies are provided. https://www.lssu.edu/provost/faculty-resources/. You are required to read all of these policies and statements:

1) Class Attendance and Excused Student Absences: Attendance at all lectures and lab is required. There are ***NO make-ups*** for the labs, midterm or final exam except for University approved absences.
2) Institutional Policy on Academic Integrity: http://www.lssu.edu/academics/pdfs/Academic%20Integrity%20Policy.pdf
3) The Americans with Disabilities Act & Accommodations
4) IPASS (Individual Plan for Academic Student Success)

Final Exam:

Wednesday 12/13 from 3:00 – 5:00 in CAS 210

The final exam is cumulative. All students are required to take the exam during finals week or receive a 0. No make-ups will be given unless you are in another exam at that time. Then, you will be allowed to reschedule the exam and take it in the Testing Center, during finals week.

Course Policies and Statements: See the Syllabus Addendum

Tentative Course Outline

#	Week	Readings	• Tentative Topics: Tuesday	Thursday	LAB	Notes
1	8/29	Online Readings	Syllabus and Course Overview **Intro - *Web Site Design & WordPress*** Evaluating Web Site Design and UX	...	Lab 1	
2	9/5	Online Readings	Setup & create content on social media (such as Facebook, Twitter, Flickr, YouTube) Setup & create managed web site (WordPress) History of the internet & WWW Registering domain names and hosting providers Creating graphics & locating resources Copyright & legal issues	...	Lab 2	
3	9/12	CH 1-5	Unit I - *Getting Started* Creating a web site with web page editors (such as Dreamweaver & Visual Studio) Overview of HTML, CSS and JS Publish web pages on a live server (SFTP, SSH) Website testing	...	Lab 3	
4	9/19	CH 6-15	Unit II - *The HTML Elements* Creating a web page with a fluid and responsive web page layout (mobile devices) using Bootstrap	...	Lab 4	
5	9/26	...	Multimedia, tables and image maps Accessibility standards	...	Lab 5	
6	10/3	...	Forms & HTML validation	**MIDTERM EXAM**	Lab 6	
7	10/9	...	***Holiday*** **No Classes or Lab on Tuesday**	Review Midterm	**No Lab**	Monday classes will meet on Tuesday
8	10/17	CH 16-24	Unit III - *Cascading Style Sheets* CSS selectors, CSS3, LESS/W3.CSS	...	Lab 7	
9	10/24	CH 25-31	Unit IV- *DOM and JavaScript* Functions, events & dynamic content using DOM objects with tables, image	...	Lab 8	

			maps, images & forms			
10	10/31	...	Processing registration and login forms securely OWASP and web security	...	Lab 9	
11	11/7	CH 34-40	<u>Unit V - *Advanced Features*</u> Using cookies, local storage and Geolocation	...	Lab 10	
12	11/14	...	Using the canvas for drawing	...	Lab 11	
13	11/21	...	Building user interactivity (i.e. drag and drop, games)	**Holiday No Classes**	Lab 12	No classes on Wed., Thursday or Friday
14	11/28	Online Readings	New tools & technologies such as mobile web application development, JQuery & Node.JS	...	Lab 13	
15	12/5	Online Readings	**Unit VI - *Careers in Web Development*** ***Final Exam Review***	...	Lab 14	
16	12/12	**Final Exam: Wednesday** 12/13 from 3:00 - 5:00 in CAS 210				

* The schedule may change for multiple reasons. If the schedule changes, an announcement will be made in class.

Course Policies and Statements: Syllabus Addendum

Communication Modes

Overview: Please visit my office if your question is about grades or personal information. Students, who need to meet with outside of the times posted on the syllabus, may make an appointment with me. Any changes will be posted on my office door. ***I will read my email only during the weekdays. I am in class all day. Therefore, I will likely not read my email until the end of the day, after classes. Put the course code in the subject line of any email or it will not be read.***

Student Email & Social Media: Students may text message me at any time to the number given out in class. However, I do not discuss grades via texting. I will not 'friend' students until they have graduated.

Course Policies

Lab Grades: Due to the amount of work involved in the lab activities, some lab assignments may span more than one week and would be graded as a multiple week lab assignment. Late assignments will not be accepted. You are responsible for keeping track of your own grades. Doing the minimum assignments is NOT enough to get an A in this course. A means excellence beyond requirements! Students will demonstrate their lab assignments to the instructor.

Midterm Grades: Midterm Grades will be calculated based on your performance through the midterm exam. Your midterm grade is only a *snapshot* of your grade at that time.

Final Exam: To prevent cheating, students may not be allowed to keep the exams. You may review the exams in my office during office hours.

Disability Testing Services for Exams: If the University has provided you classroom related services for disability, you are required to inform the instructor (privately by email or during office hours) at the first week of the class. To protect the integrity of the exam, you are required to schedule the exam to start at the same day as the other students even if you take the exam in the testing center.

Make-Ups: Makeups for exams will only be given for instructor pre-approved or university absences. Attendance at lab sessions is equally important and will impact your grade. There are no lab makeup assignments.

Late assignments: Late assignments will **not** be accepted except for legitimate pre-approved reasons as determined by the instructor. Do not go to the health center to get a 'note' if you are absent from class for illness. Remember, plan early and get started on your assignments early!

Due Dates: You are required to complete the assigned readings, learning activities and assessments each week according to the class schedule as announced in class. Students are required to submit graded homework with references and cite the references of resources (images, code). All 'written' assignments are required to follow APA format. Copying content or code without citation or quotations will result in an F grade for the assignment and be subject to the plagiarism and academic integrity policies.

FERPA: We maintain the confidentiality of *all student education records*. Students are never required to release their identification on the Internet without their consent.

Incomplete Policies: Generally, no incompletes are given. **All incomplete requests must be made to the Provost's Office and approved before the instructor will approve them.** Students must have completed ¾ of the course requirements, midterm exam as well as the final exam. No incomplete grade will be given to a student who did not complete the final exam. Exceptions may be made are for university approved absences or exceptions, military deployment or similar circumstances (as determined at the *sole discretion* of the instructor). The instructor will require verification and the instructor has sole discretion to approve the request and will identify the requirements, which the student will need to accomplish to complete the course, which you can read in the MyLSSU web site. Students, who are granted an incomplete, are required to complete the requirements and turn them into the instructor within 8 weeks of the course final examination. Students not completing the required activities by the due date will have an F replace the incomplete grade.

Study Time: Remember, standard homework and reading time assigned in higher education is 2 hours per 1 hour of lecture! So that's 6 hours per week for a 3-credit course! In order to accommodate a diverse range of learning preferences, you will have learning activities including readings, discussions, lecture, presentations, demonstrations and web resources.

Technology Policies

Backing Up Your Files: You are responsible for backing up your own files – however you choose!

Lab Usage: Comply with ALL University and math and computer science department policies and procedures, including information technology policies with respect to usage of the department computer software, computers and lab rooms. Failure to comply may result in failure of the course.

Use of Technology During Class: You may use your computer in class to take notes, or classroom – related learning activities. Using computer technology in class for anything other than class activities is prohibited.

Computer Lab Access: You will be using the department computer labs. These are not private computers. Do not change any of the settings on the local computer or the virtual machines, unless instructed to during class. All students are required to comply with department and university IT policies. You are not allowed to share the password to login with other students or anyone.

Software Access: For lab courses you will have exposure to different software applications and techniques and participate in learning activities using software applications in the weekly lecture and lab activities. All required software is available in the computer lab or free by download. The software in the lab, such as the Adobe software, may not be used for any commercial work, as that is a violation of the license.

Illegal Activity: Attempting unauthorized access instructor data or resources, web sites, servers, computers or any other instructor- or University-owned computer technologies is permitted. For example, deliberate destruction of computer equipment, computer hacking or attempting to circumvent computer security or authentication programs will not be tolerated and may be subject to criminal prosecution.

Flash Drives: Each student is required to have their own removable USB flash/portable hard drive, cloud access or other storage medium. You may not 'leave' your files on the desktop or on the computer. When you are finished using the computer, please copy your files to your storage medium or email them to yourself. Then remove your files from the computer and ***empty the trash***. Each student is responsible for backing up their own files. We do not provide technical support for individual student-owned computers.

Imagine/DreamSpark: The Microsoft Academic Alliance (MSDNAA) distributes software at for free. Do not provide your login password or activation codes to anyone. Violation of the license agreements is cause for failure in the course and potential legal consequences. This software too cannot be used for commercial purposes. Access may only permitted for a limited period of time at the beginning of the course.

After Hours Access: You can contact any computer science faculty during the day, or in the evenings, contact public safety to open the door. Please have your school ID with you. If you are the last student leaving the lab, you are **required** to turn off lights, close the window, and close/lock the door if you are the last to leave. Violation may result in revocation of after hour's lab privileges for you and/or all students!

Online Classroom Web Site: It is common knowledge that technology and software changes regularly. There may be online videos, tutorials or readings, which will be assigned during the course, which will be required but are always freely available to the public on the Internet or in the Moodle.lssu.edu online classroom.

Behavior and Expectations of Students:

Expectations for Student Learning

"Students attending Lake Superior State University can expect commitment by the University to document and enhance student learning. Through the assessment process, the University demonstrates its commitment to ***improving student learning*** *and ensures that when students graduate they have attained specific attributes and abilities. Lake Superior State University expects a commitment on the part of its students to* ***actively participate*** *in the learning process."* ***(Academic Catalog)***

What is Participation?

Active participation is important to meet the learning outcomes. Everyone should plan to become an ***active*** member of the learning community. Participation includes weekly attendance, active involvement in course functions, contribution to discussions, and support of other classmates. You are expected to be in lecture to listen to or watch the lectures and take notes. This hands-on lab is a major portion of your grade.

The nature of computer science results in continual changes in technologies and skills required. Your responsibility is to read the assignments before coming to class AND be prepared to discuss the readings. You are expected to be in lecture to listen to and watch the lectures and take notes. Participation means forming supportive and inquiring relationships with other students in the class through sharing points of view, and providing encouragement and constructive critique, reading the assigned readings before beginning your assignments, and applying readings to the discussions and coursework. Each student brings different life experiences, points of view, and ways of knowing to our classroom and our learning environment.

Use Netiquette. Be respectful in all forms of communications with all students and faculty.

Patience is a virtue. Help respect others by allowing them to share their point of view. If I can't answer your question in class, allow me time to respond to your question at the following class.

Behavioral Expectations: Simply put, you may not use the class/lab time to:

1. Do homework for other courses or homework that was due at the beginning of the class.
2. Do other non-course related activities (including sleep, listen to music, watch videos, browse the web, read your email, play online games, use your smart phone, chat, send text or instant messages, read or use social media
3. Make a mess. If you bring it into the classroom, you leave with it.

Any of these activities would be considered a disruption and at instructor's sole discretion the student may be asked to leave the classroom and this will count as an unexcused absence.

Disclaimer: In addition to ever-technology changing, from term to term other external situations as well as University events may affect the Course Schedule and other planned classroom learning activities and assessments. The instructor reserves the right to make any changes the instructor determines as necessary to the course syllabus and addendum, content of the course, schedule of topics, lectures, assessments in order to accommodate the class and University needs but they will be announced in class or in the online classroom.

Copyright and Live Recordings

Copyright: All course materials are copyright protected and may not be copied or duplicated outside of the Online Classroom or reprinted. You may not reproduce, publish, or distribute course handouts, computer programs/graphics, assessments/tests, classroom or online materials. No distributing or publishing lecture notes, quizzes or any information about the course on any web site, blog, or web page or other print or electronic format.

Instructor Materials: Likewise, without written permission of the instructor you may **not** publish or broadcast ***live*** or ***recorded*** audio or video recording(s) of the lecture or lab sessions.

Course Materials: Some material from the textbook publisher and other resources are also protected by copyright and is for classroom purposes only under "Fair Use" and are available in the Online Classroom.

Student Materials: Students may voluntarily sign a release form that their class work may be used by the instructor as examples of student work and for marketing the program.

Live Recordings: I will be using Swivl technology to record the lectures and lab sessions. Students will be asked to ***voluntarily*** sign a release form that they may be recorded on audio and/or video, which may be available on public media sites such as YouTube. Students who do not want to be recorded may be asked to sit in an area that will be out of the range of audio and video recording.

Violations: Violation in copyright law or this course policy may result in failure in the course. "*If, in the judgment of the faculty member, academic integrity has been violated, the faculty member will impose the appropriate sanction, either a failure for the assignment or exam, or failure for the course.*" If the course has already ended, the instructor will file an Academic Integrity Incident Report with the University. Please refer to the Academic Catalog for the University Integrity Policies.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**CSCI 106 F18 Online**
This documentation is relevant to Question number:	**4**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Example of Online syllabus for comparison.**

LAKE SUPERIOR STATE UNIVERSITY

College of Innovation and Solutions **Fall 2018**
CSCI106 (2, 2) Web Page Design and Development **3 Credits**

Prerequisites: No academic prerequisites; Basic computer literacy skills required.

Instructor: Duane Bedell, Ed.S., Adjunct Professor
Voice and Text: (906) 322-7765
Email Address: dbedell3@lssu.edu

Office Hours: *Please make an appointment to setup a virtual conference*

Required Texts:

The Definitive Guide to HTML5
Author: Adam Freeman
Publisher: Apress, December 2011
ISBN-13: 9781430239604 – 1st Ed.

The lab computers are configured with Adobe software. Students are required to have access to an external source to store their files. Download book examples & solutions: https://github.com/Apress/def-guide-to-html5/archive/master.zip

Course Description: Topics include planning a web site starting with domain name registration and selection of hosting service providers, creating web page using HTML/XHTML and cascading style sheets; validating web pages; using web authoring tools such as Dreamweaver; publishing web pages to a remote web server, introductory web site design, including best practices for inserting graphics, page layout, building the web site navigation and user interface, integration of third-party and Web 2.0 tools and software, implementing web and accessibility standards, ethical and legal issues such as copyright and trademarks.

Course Goals: *The students will be proficient developing and managing basic web sites.*

Course Objectives/Student Learning Outcomes: At the conclusion of CSCI106 students will:

1. Describe how to setup a web site including registering the domain name and selecting a hosting service provider, identifying a sitemap plan, locating graphic and multimedia resources.
2. Create web applications using a variety of tools such as HTML, CSS and content managed systems that are compliant with accessibility standards, aesthetically pleasing, with a common layout, navigation and themes.
3. Publish and maintain a web application to a live remote server.
4. Create and modify images and insert them into web pages.
5. Utilize new technologies such as social networking and mobile web applications to enhance the web applications.
6. Identify the web development, design and programming job skills and requirements, education and certifications that are in high demand.

Section Information

This course is delivered online using Lake Superior State University's Learning Management System, Moodle. Both lecture and lab work will conducted in Moodle.

Grading Scale and Policies:

Point Values:

Lab Assignments (14 * 3 points each)	42
Midterm Project	28
Final Project	30
The total number of points:	100 points

You cannot pass the course unless you complete the final exam successfully. Students who do not complete the final exam during the last week of class receive an automatic F. You must complete the cumulative final exam with a C (70%) or better to pass this course.

Grading Scale:

Letter	%	Letter	%	Letter	%	Letter	%
A+	98-100	B+	88-89	C+	78-79	D+	68-69
A	92-97	B	82-87	C	72-77	D	62-67
A-	90-91	B-	80-81	C-	70-71	D-	60-61
						F	<60.0

University Policies and Statements: **Refer to the School classroom policies handout!**

Please review the University policies at to the Provost's web page where the policies are provided. https://www.lssu.edu/provost/faculty-resources/. You are required to read all of these policies and statements:

1) Class Attendance and Excused Student Absences: Attendance at all lectures and lab is required. There are ***NO make-ups*** for the labs, midterm or final exam except for University approved absences.
2) Institutional Policy on Academic Integrity: http://www.lssu.edu/academics/pdfs/Academic%20Integrity%20Policy.pdf
3) The Americans with Disabilities Act & Accommodations
4) IPASS (Individual Plan for Academic Student Success)

Final Exam:

TBD

The final exam is cumulative. All students are required to take the exam during finals week or receive a 0. No make-ups will be given unless you are in another exam at that time. Then, you will be allowed to reschedule the exam and take it in the Testing Center, during finals week.

Course Policies and Statements: See the Syllabus Addendum in addition to the following:

1. **Absences:** All work assigned each week must be completed to be counted as present.
LSSU sanctioned travel related absences (athletics, conference presentations, conference attendance) are approved by the Provost. Instructors are expected to accommodate students in these situations. However, students are expected to make arrangements with the instructor before the travel occurs. Failure to do so may result in "F" grades being assigned for missed work.
2. **Participation:** In order to encourage discussion, students are expected to participate in weekly discussion.
3. **Cheating:** Students are expected to perform all assigned work themselves unless otherwise noted. Any form of cheating or plagiarism will be handled in accordance with the Honor Code Procedures. Violations of the Honor Code may result in an F for the course grade.
4. **Late Work:** Late work will not be accepted.

Tentative Course Outline

#	Date	Readings	Tentative Topics
1	8/27	Online Readings	• Syllabus and Course Overview • Intro - *Web Site Design & WordPress* o Evaluating Web Site Design and UX o Lab #1
2	9/3	Online Readings	o Setup & create content on social media (such as Facebook, Twitter, Flickr, YouTube) o Setup & create managed web site (WordPress) o History of the internet & WWW o Registering domain names and hosting providers o Creating graphics & locating resources o Copyright & legal issues o Lab #2
3	9/10	CH 1-5	• Unit I - *Getting Started* o Creating a web site with web page editors (such as Dreamweaver & Visual Studio) o Overview of HTML, CSS and JS o Publish web pages on a live server (SFTP, SSH) o Website testing o Lab #3
4	9/17	CH 6-15	• Unit II - *The HTML Elements* o Creating a web page with a fluid and responsive web page layout (mobile devices) using Bootstrap o Lab #4
5	9/24	...	o Multimedia, tables and image maps o Accessibility standards o Lab 5
6	10/2	...	o Forms & HTML validation o Mid-Term Project Plans
7	10/8		o Mid-Term Project Due
8	10/15	CH 16-24	• Unit III - *Cascading Style Sheets* o CSS selectors, CSS3, LESS/W3.CSS o Lab #7
9	10/22	CH 25-31	• Unit IV- *DOM and JavaScript* o Functions, events & dynamic content using DOM objects with tables, image maps, images & forms o Lab #8
10	10/29	--	o Processing registration and login forms securely o OWASP and web security o Lab #9

11	11/5	CH 34-40	○ <u>Unit V - ***Advanced Features***</u> Using cookies, local storage and Geolocation ○ <u>**Lab #10**</u>
12	11/12	...	○ Using the canvas for drawing ○ Lab #11
13	11/19	--	○ Building user interactivity (i.e. drag and drop, games) ○ Lab #12
14	11/26	Online Readings	○ New tools & technologies such as mobile web application development, JQuery & Node.JS ○ Lab #13
15	12/3	Online Readings	• **Final Project**
16	12/12		

• The schedule may change for multiple reasons. If the schedule changes, an announcement will be made in class.

Course Policies and Statements: Syllabus Addendum

Communication Modes

Overview: Since this is an online course, please email me at dbedell3@lssu.edu with any questions you may have. I answer all emails within a 24-hour period after your email is received. Often times, I will answer your emails as soon as I receive them if I am not in a meeting.

Student Email & Social Media: Students may text message me at any time to the number given out in class. However, I do not discuss grades via texting. I will not 'friend' students until they have graduated.

Course Policies

Lab Grades: Due to the amount of work involved in the lab activities, some lab assignments may span more than one week and would be graded as a multiple week lab assignment. Late assignments will not be accepted. You are responsible for keeping track of your own grades Doing the minimum assignments is NOT enough to get an A in this course. A means excellence beyond requirements! Students will demonstrate their lab assignments to the instructor.

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Due Dates: You are required to complete the assigned readings, learning activities and assessments each week according to the class schedule as announced in class. Students are required to submit graded homework with references and cite the references of resources (images, code). All 'written' assignments are required to follow APA format. Copying content or code without citation or quotations will result in an F grade for the assignment and be subject to the plagiarism and academic integrity policies.

FERPA: We maintain the confidentiality of *all student education records*. Students are never required to release their identification on the Internet without their consent.

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Study Time: Remember, standard homework and reading time assigned in higher education is 2 hours per 1 hour of lecture! So that's 6 hours per week for a 3-credit course! In order to accommodate a diverse range of learning preferences, you will have learning activities including readings, discussions, lecture, presentations, demonstrations and web resources.

Technology Policies

Backing Up Your Files: You are responsible for backing up your own files – however you choose!

Lab Usage: Comply with ALL University and math and computer science department policies and procedures, including information technology policies with respect to usage of the department computer software, computers and lab rooms. Failure to comply may result in failure of the course.

Use of Technology During Class: You may use your computer in class to take notes, or classroom – related learning activities. Using computer technology in class for anything other than class activities is prohibited.

Computer Lab Access: You will be using the department computer labs. These are not private computers. Do not change any of the settings on the local computer or the virtual machines, unless instructed to during class. All students are required to comply with department and university IT policies. You are not allowed to share the password to login with other students or anyone.

Software Access: For lab courses you will have exposure to different software applications and techniques and participate in learning activities using software applications in the weekly lecture and lab activities. All required software is available in the computer lab or free by download. The software in the lab, such as the Adobe software, may not be used for any commercial work, as that is a violation of the license.

Illegal Activity: Attempting unauthorized access instructor data or resources, web sites, servers, computers or any other instructor- or University-owned computer technologies is permitted. For example, deliberate destruction of computer equipment, computer hacking or attempting to circumvent computer security or authentication programs will not be tolerated and may be subject to criminal prosecution.

Flash Drives: Each student is required to have their own removable USB flash/portable hard drive, cloud access or other storage medium. You may not 'leave' your files on the desktop or on the computer. When you are finished using the computer, please copy your files to your storage medium or email them to yourself. Then remove your files from the computer and ***empty the trash***. Each student is responsible for backing up their own files. We do not provide technical support for individual student-owned computers.

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Behavior and Expectations of Students:

Expectations for Student Learning

"Students attending Lake Superior State University can expect commitment by the University to document and enhance student learning. Through the assessment process, the University demonstrates its commitment to **improving student learning** *and ensures that when students graduate they have attained specific attributes and abilities. Lake Superior State University expects a commitment on the part of its students to* **actively participate** *in the learning process."* ***(Academic Catalog)***

What is Participation?

Active participation is important to meet the learning outcomes. Everyone should plan to become an ***active*** member of the learning community. Participation includes weekly attendance, active involvement in course functions, contribution to discussions, and support of other classmates. You are expected to be in lecture to listen to or watch the lectures and take notes. This hands-on lab is a major portion of your grade.

The nature of computer science results in continual changes in technologies and skills required. Your responsibility is to read the assignments before coming to class AND be prepared to discuss the readings. You are expected to be in lecture to listen to and watch the lectures and take notes. Participation means forming supportive and inquiring relationships with other students in the class through sharing points of view, and providing encouragement and constructive critique, reading the assigned readings before beginning your assignments, and applying readings to the discussions and coursework. Each student brings different life experiences, points of view, and ways of knowing to our classroom and our learning environment.

Use Netiquette. Be respectful in all forms of communications with all students and faculty.

Patience is a virtue. Help respect others by allowing them to share their point of view. If I can't answer your question in class, allow me time to respond to your question at the following class.

Behavioral Expectations: Simply put, you may not use the class/lab time to:

1. Do homework for other courses or homework that was due at the beginning of the class.
2. Do other non-course related activities (including sleep, listen to music, watch videos, browse the web, read your email, play online games, use your smart phone, chat, send text or instant messages, read or use social media
3. Make a mess. If you bring it into the classroom, you leave with it.

Any of these activities would be considered a disruption and at instructor's sole discretion the student may be asked to leave the classroom and this will count as an unexcused absence.

Disclaimer: In addition to ever-technology changing, from term to term other external situations as well as University events may affect the Course Schedule and other planned classroom learning activities and assessments. The instructor reserves the right to make any changes the instructor determines as necessary to the course syllabus and addendum, content of the course, schedule of topics, lectures, assessments in order to accommodate the class and University needs but they will be announced in class or in the online classroom.

Copyright and Live Recordings

Copyright: All course materials are copyright protected and may not be copied or duplicated outside of the Online Classroom or reprinted. You may not reproduce, publish, or distribute course handouts, computer programs/graphics, assessments/tests, classroom or online materials. No distributing or publishing lecture notes, quizzes or any information about the course on any web site, blog, or web page or other print or electronic format.

Instructor Materials: Likewise, without written permission of the instructor you may **not** publish or broadcast ***live*** or ***recorded*** audio or video recording(s) of the lecture or lab sessions.

Course Materials: Some material from the textbook publisher and other resources are also protected by copyright and is for classroom purposes only under "Fair Use" and are available in the Online Classroom.

Student Materials: Students may voluntarily sign a release form that their class work may be used by the instructor as examples of student work and for marketing the program.

Live Recordings: I will be using Swivl technology to record the lectures and lab sessions. Students will be asked to ***voluntarily*** sign a release form that they may be recorded on audio and/or video, which may be available on public media sites such as YouTube. Students who do not want to be recorded may be asked to sit in an area that will be out of the range of audio and video recording.

Violations: Violation in copyright law or this course policy may result in failure in the course. "*If, in the judgment of the faculty member, academic integrity has been violated, the faculty member will impose the appropriate sanction, either a failure for the assignment or exam, or failure for the course.*" If the course has already ended, the instructor will file an Academic Integrity Incident Report with the University. Please refer to the Academic Catalog for the University Integrity Policies.

Appendix Cover Sheet

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	Mathematics and Computer Science
Document Title (if attached) or Filename (if emailed):	CSCI 323 F18 Online
This documentation is relevant to Question number:	4
Briefly summarize the content of the file and its value as evidence supporting program review:	Example of Online syllabus for comparison.

LAKE SUPERIOR STATE UNIVERSITY

College of Innovation and Solutions **Fall 2018**
CSCI323 Routers and Switches (3,0) **3 Credits**
Course delivered online through Moodle

Prerequisites: CSCI221 with a grad of C (2.0) or better.

Instructor: Duane Bedell, Ed.S., Adjunct Instructor
Text and Voice: (906) 322-7765
Email Address: dbedell3@lssu.edu

Office Hours: *Please make an appointment to setup a virtual conference*

Required Texts: CCNA Routing and Switching Complete Deluxe Study Guide, ISBN 978-1-119-28831-2

Course Description: Principles of Wide Area Networks, IP and TCP, routers, routing protocols and configurations, virtual LANs, network management, subnetting, design of LANs and WANs, and security issues. Students completing this course will be prepared to take the CCENT and CCNA certification exams.

Course Goals: *Students will be proficient at designing complex networks utilizing Cisco routers and switches.*

Course Objectives/Student Learning Outcomes: After successfully completing this course, the student should be able to:

1. Install, configure, and troubleshoot basic configuration of routers and switches.
2. Analyze and evaluate the needs and configuration of a subnet, including IP range, gateway, and broadcast.
3. Identify, evaluate and mitigate security threats to a network through the router/switch.
4. Configure, verify, and troubleshoot a switch with VLANs and interswitch communication.

Grading Scale and Policies:

20% of your final grade will be from exams, 20% of the grade will be from hands-on exams, 20% of the grade will be from hands-on labs, 20% of the grade will be from weekly discussion, and 20% of the grade will be from written labs. There will be three hands-on exams, three written exams, and a comprehensive final exam. The hands-on exams are weighted equally, and the written exams are weighted equally.

Point Values:

Weekly Discussions (15 points x 15 discussions)	150 points
Written Labs (15 points x 10 labs)	150 points
Hands-on Labs (20 points x 10 labs)	200 points
Hands-on Exams (30 points x 3 exams)	90 points
Written Exams (30 points x 3 exams)	90 points
Final Hands-on Exam	60 points
Final Exam	60 points
	Total 800 points

Grading Scale:

Letter	%	Letter	%	Letter	%	Letter	%
A+	98-100	B+	88-89	C+	78-79	D+	68-69
A	92-97	B	82-87	C	72-77	D	62-67
A-	90-91	B-	80-81	C-	70-71	D-	60-61
						F	<60.0

Course Policies:

1. **Absences:** All work assigned each week must be completed to be counted as present.
   LSSU sanctioned travel related absences (athletics, conference presentations, conference attendance) are approved by the Provost. Instructors are expected to accommodate students in these situations. However, students are expected to make arrangements with the instructor before the travel occurs. Failure to do so may result in "F" grades being assigned for missed work.
2. **Participation:** In order to encourage discussion, students are expected to participate in weekly discussion.
3. **Cheating:** Students are expected to perform all assigned work themselves unless otherwise noted. Any form of cheating or plagiarism will be handled in accordance with the Honor Code Procedures. Violations of the Honor Code may result in an F for the course grade.
4. **Late Work:** Late work will not be accepted.

University Policies and Statements:

Online and Blended Course Attendance Policy

Students in online or blended classes are required to log in to the Course Management System (Blackboard, Wimba, TaskStream, etc.) and complete at least one "Academic Related Activity" within the Add/Drop period.

The Americans with Disabilities Act & Accommodations

In compliance with Lake Superior State University policies and equal access laws, disability-related accommodations or services are available to students with documented disabilities.

If you are a student with a disability and you think you may require accommodations you must register with Disability Services (DS), which is located in the KJS Library, Room 130, (906) 635-2355 or x2355 on campus. DS will provide you with a letter of confirmation of your verified disability and authorize recommended accommodations. This authorization must be presented to your instructor before any accommodations can be made.

Students who desire such services should meet with instructors in a timely manner, preferably during the first week of class, to discuss individual disability related needs. Any student who feels that an accommodation is needed – based on the impact of a disability – should meet with instructors privately to discuss specific needs.

The university will make reasonable accommodations for persons with documented disabilities. Students should notify the Director of Disability Services (located in LBR 149 just down the hall from the Learning Center) and their instructors of any accommodation needs as soon as possible.

IPASS (Individual Plan for Academic Student Success)

If at mid-term your grades reflect that you are at risk for failing some or all of your classes, you will be contacted by a representative of IPASS. The IPASS program is designed to help you gain control over your learning through pro-active communication and goal-setting, the development of intentional learning skills and study habits, and personal accountability. You may contact 635-2887 or email ipass@lssu.edu if you would like to sign up early in the semester or if you have any questions or concerns.

Final Exam:

TBD

The final exam is cumulative. All students are required to take the exam during finals week or receive a 0. No make-ups will be given unless you are in another exam at that time. Then, you will be allowed to reschedule the exam and take it in the Testing Center, during finals week.

Tentative Course Outline

Week	Date	Reading	Topic
1	8/27	Ch.3	Introduction to TCP/IP Lab #1: TCP/IP
2	9/3	Ch.4	Easy Subnetting Lab #2: Subnetting
3	9/10	Ch. 5	Variable Length Subnet Mask (VLSM) Summarization Lab #3: VLSM Lab
4	9/17	Exam	Written Exam: Chapters 3-5
5	9/24	Ch. 6	Cisco's Internetworking Operating System Lab #4: User, Privileged, and Configuration Modes
6	10/2	Ch. 7	Managing Cisco Internetwork Lab #5: Backing up configurations with Telnet
7	10/8	Ch. 8	Managing Cisco Devices Lab #6: IP Routing (RIP)
8	10/15	Exam	Written Exam: Chapters 6-8 Hands-on Exam: (Routing Packets)
9	10/22	Ch. 9	Open Shortest Path First (OSPF) Lab #7: OSPF
10	10/29	Ch. 10	Layer 2 Switching Lab #8 Configuring Layer 2 Switches
11	11/5	Ch. 11	VLANs and Inter VLAN Routing Lab #9: Creating VLANs
12	11/12	Exam	Written Exam: Chapters 9-11 Hands-on Exam: (VLANs)
13	11/19	Ch. 12	Security Lab #10: Standard IP Access Lists (ACLs)
14	11/26	Ch. 12	Security Continued Lab #10 (Part Two): Extended IP Access Lists
15	12/3	Ch.13	Network Address Translation Final Hands-on Exam
16	12/12		

- The schedule may change for multiple reasons. If the schedule changes, an announcement will be made in class.

Course Policies and Statements: Syllabus Addendum

Communication Modes

Overview: Since this is an online course, please email me at dbedell3@lssu.edu with any questions you may have. I answer all emails within a 24-hour period after your email is received. Often times, I will answer your emails as soon as I receive them if I am not in a meeting.

Student Email & Social Media: Students may text message me at any time to the number given out in class. However, I do not discuss grades via texting. I will not 'friend' students until they have graduated.

Course Policies

Lab Grades: Due to the amount of work involved in the lab activities, some lab assignments may span more than one week and would be graded as a multiple week lab assignment. Late assignments will not be accepted. You are responsible for keeping track of your own grades. Doing the minimum assignments is NOT enough to get an A in this course. A means excellence beyond requirements! Students will demonstrate their lab assignments to the instructor.

Midterm Grades: Midterm Grades will be calculated based on your performance through the midterm exam. Your midterm grade is only a *snapshot* of your grade at that time.

Final Exam: To prevent cheating, students may not be allowed to keep the exams.

Disability Testing Services for Exams: If the University has provided you classroom related services for disability, you are required to inform the instructor (privately by email or during office hours) at the first week of the class. To protect the integrity of the exam, you are required to schedule the exam to start at the same day as the other students even if you take the exam in the testing center.

Make-Ups: Makeups for exams will only be given for instructor pre-approved or university absences. Attendance at lab sessions is equally important and will impact your grade. There are no lab makeup assignments.

Late assignments: Late assignments will <u>**not**</u> be accepted except for legitimate pre-approved reasons as determined by the instructor. Do not go to the health center to get a 'note' if you are absent from class for illness. Remember, plan early and get started on your assignments early!

Due Dates: You are required to complete the assigned readings, learning activities and assessments each week according to the class schedule as announced in class. Students are required to submit graded homework with references and cite the references of resources (images, code). All 'written' assignments are required to follow APA format. Copying content or code without citation or quotations will result in an F grade for the assignment and be subject to the plagiarism and academic integrity policies.

FERPA: We maintain the confidentiality of ***all student education records***. Students are never required to release their identification on the Internet without their consent.

Incomplete Policies: Generally, no incompletes are given. **All incomplete requests must be made to the Provost's Office and approved before the instructor will approve them.** Students must have completed ¾ of the course requirements, midterm exam as well as the final exam. No incomplete grade will be given to a student who did not complete the final exam. Exceptions may be made are for university approved absences or exceptions, military deployment or similar circumstances (as determined at the ***sole discretion*** of the instructor). The instructor will require verification and the instructor has sole discretion to approve the request and will identify the requirements, which the student will need to accomplish to complete the course, which you can read in the MyLSSU web site. Students, who are granted an incomplete, are required to complete the requirements and turn them into the instructor within 8 weeks of the course final examination. Students not completing the required activities by the due date will have an F replace the incomplete grade.

Study Time: Remember, standard homework and reading time assigned in higher education is 2 hours per 1 hour of lecture! So that's 6 hours per week for a 3-credit course! In order to accommodate a diverse range of learning preferences, you will have learning activities including readings, discussions, lecture, presentations, demonstrations and web resources.

Technology Policies

Backing Up Your Files: You are responsible for backing up your own files – however you choose!

Lab Usage: Comply with ALL University and math and computer science department policies and procedures, including information technology policies with respect to usage of the department computer software, computers and lab rooms. Failure to comply may result in failure of the course.

Use of Technology During Class: You may use your computer in class to take notes, or classroom – related learning activities. Using computer technology in class for anything other than class activities is prohibited.

Computer Lab Access: You will be using the department computer labs. These are not private computers. Do not change any of the settings on the local computer or the virtual machines, unless instructed to during class. All students are required to comply with department and university IT policies. You are not allowed to share the password to login with other students or anyone.

Software Access: For lab courses you will have exposure to different software applications and techniques and participate in learning activities using software applications in the weekly lecture and lab activities. All required software is available in the computer lab or free by download. The software in the lab, such as the Adobe software, may not be used for any commercial work, as that is a violation of the license.

Illegal Activity: Attempting unauthorized access instructor data or resources, web sites, servers, computers or any other instructor- or University-owned computer technologies is permitted. For example, deliberate destruction of computer equipment, computer hacking or attempting to circumvent computer security or authentication programs will not be tolerated and may be subject to criminal prosecution.

Flash Drives: Each student is required to have their own removable USB flash/portable hard drive, cloud access or other storage medium. You may not 'leave' your files on the desktop or on the computer. When you are finished using the computer, please copy your files to your storage medium or email them to yourself. Then remove your files from the computer and ***empty the trash***. Each student is responsible for backing up their own files. We do not provide technical support for individual student-owned computers.

Imagine/DreamSpark: The Microsoft Academic Alliance (MSDNAA) distributes software at for free. Do not provide your login password or activation codes to anyone. Violation of the license agreements is cause for failure in the course and potential legal consequences. This software too cannot be used for commercial purposes. Access may only permitted for a limited period of time at the beginning of the course.

After Hours Access: You can contact any computer science faculty during the day, or in the evenings, contact public safety to open the door. Please have your school ID with you. If you are the last student leaving the lab, you are **required** to turn off lights, close the window, and close/lock the door if you are the last to leave. Violation may result in revocation of after hour's lab privileges for you and/or all students!

Online Classroom Web Site: It is common knowledge that technology and software changes regularly. There may be online videos, tutorials or readings, which will be assigned during the course, which will be required but are always freely available to the public on the Internet or in the Moodle.lssu.edu online classroom.

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	Mathematics and Computer Science
Document Title (if attached) or Filename (if emailed):	CSCI 323 F16 On campus
This documentation is relevant to Question number:	4
Briefly summarize the content of the file and its value as evidence supporting program review:	Example of on campus syllabus for comparison.

LAKE SUPERIOR
STATE UNIVERSITY

School of Mathematics and Computer Science — **Fall Semester, 2016**
CSCI323 Routers and Switches (3,0) — **3 Credits**
Tuesday, 5:00 p.m. - 7:00 p.m. — **CAS 211**
Thursday, 5:00 p.m. – 7:00 p.m. — **CAS 303**

Prerequisites: CSCI221 with a grade of C (2.0) or better.

Instructor:

Duane Bedell
dbedell3@lssu.edu
231-224-6085 (call or text)

Office Hours:

Available by appointment

Required Texts: CCNA Routing and Switching Study Guide, ISBN 978-1-118-74961-6

Course Description: Principles of Wide Area Networks, IP and TCP, routers, routing protocols and configurations, virtual LANs, network management, subnetting, design of LANs and WANs, and security issues. Students completing this course will be prepared to take the CCENT and CCNA certification exams.

Course Objectives: After successfully completing this course, the student should be able to:

1. Install, configure, and troubleshoot basic configuration of routers and switches.
2. Analyze and evaluate the needs and configuration of a subnet, including IP range, gateway, and broadcast.
3. Identify, evaluate and mitigate security threats to a network through the router/switch.
4. Configure, verify, and troubleshoot a switch with VLANs and interswitch communication.

Grading Scale and Policies:

40% of your final grade will be from exams, 40% of the grade will be from hands-on exams, and 20% of the grade will be from hands-on labs. There will be three hands-on exams, three written exams, and a comprehensive final exam. The hands-on exams are weighted equally, and the written exams are weighted equally.

School of Mathematics and Computer Science — **Fall Semester, 2016**
CSCI323 Routers and Switches (3,0) — **3 Credits**
Tuesday, 5:00 p.m. - 7:00 p.m. — **CAS 211**
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Point Values:

Lab Activities (20 points x 10 labs)	200 points
Hands-on Exams (30 points x 3 exams)	90 points
Written Exams (30 points x 3 exams)	90 points
Final Hands-on Exam	60 points
Final Exam	60 points
	Total 500 points

Grading Scale:

97-100	A+	73-76	C
93-96	A	70-72	C-
90-92	A-	67-69	D+
87-89	B+	63-66	D
83-86	B	60-62	D-
80-82	B-	0-59	F
77-79	C+		

***Course Policies*:**

1. **Absences**: Students will be allowed to make up missed work for excused absences only if the student notifies the instructor **in advance** of the absence and the instructor has determined the excuse to be valid.

   LSSU sanctioned travel related absences (athletics, conference presentations, conference attendance) are approved by the Provost. Instructors are expected to accommodate students in these situations. However, students are expected to make arrangements with the instructor before the travel occurs. Failure to do so may result in "F" grades being assigned for the missed work.

2. **Participation**: Classroom participation is encouraged. If you have questions or comments about topics being discussed in class, please raise your hand.

3. **Cheating**: Students are expected to perform all assigned work themselves unless otherwise noted. Any form of cheating or plagiarism will be handled in accordance with the Honor Code Procedures. Violations of the Honor Code may result in an F for the course grade.

4. **Late work**: Any assignments that are turned in late will lose 20% of the point value for being one day late, 40% for two days late, and will be worth zero (0) points after two days late. The weekend counts as one "day" late. An assignment is considered "late" any time after the assignments are picked up on the day they are due.

5. **Electronic devices**: All electronic devices, including computers, tablets, and cell phones, must be turned off for all class lecture sessions.

University Policies and Statements:

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School of Mathematics and Computer Science | **Fall Semester, 2016**
CSCI323 Routers and Switches (3,0) | **3 Credits**
Tuesday, 5:00 p.m. - 7:00 p.m. | **CAS 211**
Thursday, 5:00 p.m. – 7:00 p.m. | **CAS 303**

Tentative Course Outline

Week	Date	Reading	Tuesday	Thursday
1	29-Aug	Ch. 3	Introduction to TCP/IP	Lab #1: TCP/IP Lab
2	5-Sep	Ch 4	Easy Subnetting	Lab #2: Subnetting Lab
3	12-Sep	Ch. 5	VLSM, Summarization	Lab #3: VLSM Lab
4	19-Sep		Written Exam Chapters 3-5	Hands-on Exam (Network Design)
5	26-Sep	Ch. 6	Cisco's Internetworking Operating	Lab #4: User, Privileged, and Configuration Modes
6	3-Oct	Ch. 7	Managing Cisco Internetwork	Lab #5: Backing up configurations with Telnet
7	10-Oct	Ch. 8	**No Class**	Lab #6: IP Routing (RIP)
8	17-Oct		Written Exam Chapters 6-8	Hands-on Exam (Routing Packets)
9	24-Oct	Ch. 9	Open Shortest Path First	Lab #7: OSPF
10	31-Oct	Ch. 10	Layer 2 Switching	Lab #8: Configuring Layer 2 Switches
11	7-Nov	Ch. 11	VLANs and Inter VLAN Routing	Lab #9: Creating VLANS
12	14-Nov		Written exam Chapters 9-11	Hands-on Exam (VLANS)
13	21-Nov	Ch. 12	Security	**Thanksgiving No Class**
14	28-Nov	Ch. 12	Security Continued	Lab #10 (ACLs)
15	5-Dec	Ch. 13	Network Address Translation	Final Hands-on Exam
Finals	12-Dec		**FINAL EXAM: Tuesday, December 13, 5-7pm**	

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School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**MATH 151 Syllabi for Main Campus**
This documentation is relevant to Question number:	**4**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Provides Examples for Comparison.**

College of Arts and Science **Fall 2017**
MATH151.001 and 151.002 Calculus I (4,0) **4 Credits**

Class Meetings: Math151.001: 9:00 MTRF in CAS 205. Math 151.002: 12:00 MTRF in CAS 205.

Prerequisites: High school mathematics that includes two years of algebra, one year of plane geometry and one-half year of trigonometry and equivalent/satisfactory score on ACT or Placement Exam, or MATH 111 and MATH 131 with grades of C or better.

Instructor: Kimberly Muller
CASET Hall, Room 206-A-2
906-635-2170
kmuller@lssu.edu

Office Hours:

Monday	Tuesday	Wednesday	Thursday	Friday
1:00-1:50 p.m.	10:00-10:50 a.m.	09:00-09:50 a.m.	10:00-10:50 a.m.	1:00-1:50 p.m.

If you are unable to see me during the above times, feel free to make an appointment.

Required Texts: Calculus: Early Transcendentals, by Jon Rogawski, Freeman, 2nd Edition, ISBN: 9781429282574, 2011.

Optional Text: Student Solution Manual to Accompany Jon Rogawski's Calculus Single Variable, 2nd Edition, by Brian Bradie and Roger Lipset, ISBN: 97814292550055, 2012.

Course Description: Limits, continuity and inverse functions. Logarithmic and exponential functions. Differentiation and applications of the derivative. L'Hopital's rule. Inverse trigonometric functions. Integration and the definite integral.

Course Goals: Provide students with an introduction to differential and integral calculus and prepare students to go on to Calculus II.

Course Objectives: At the conclusion of MATH151 successful students will be able to:

1. Describe the concept of limit intuitively; find **limits** graphically, algebraically, analytically, and using L'Hôpital's rule; apply limits to the concepts of continuity, derivative, and definite integrals and then interpret the results.
2. Describe intuitively the concept of **continuity** and state rigorously the definition using limits; identify intervals of continuity and points of discontinuity in particular functions; and state, interpret, and apply the Intermediate Value Theorem.
3. Describe intuitively the concept of **derivative** and state rigorously the definition using limits; find and interpret derivatives using the definition, the various rules available, implicit differentiation and related rates; apply to the analysis of functions (increasing, decreasing, optima); and state, interpret, and apply the Mean Value Theorem.
4. Use area and average value to describe intuitively the concept of **integration**; define integration rigorously using limits; find anti-derivatives using integration rules and substitution; state and interpret the Fundamental Theorem of Calculus and use this theorem to evaluate definite integrals; and apply integration techniques to problems involving rates.
5. Solve **application** problems by drawing sketches, where applicable, and using English statements to name variables, find equations, define parameters, and create models; then apply algebra, trigonometry, and calculus methods to solve for the unknown values, and report the solution.

College of Arts and Science **Fall 2017**
MATH151 001 and 002 Calculus I (4,0) **4 Credits**

General Education Objectives:

This course is designed to meet the Mathematics General Education Outcome. *Students will be able to analyze situations symbolically and quantitatively in order to make decisions and solve problems.*

Grading Scale and Policies:

Percentage Values:

Quizzes/Homework/Attendance	20%
Exams (4 at 15% each)	60%
Final Exam	20%
	Total 100%

Grading Scale:

98-100	A+	88-89	B+	78-79	C+	68-69	D+
93-97	A	83-87	B	73-77	C	60-67	D
90-92	A-	80-82	B-	70-72	C-	0-59	F

You will be graded on correct methodology. This means that if you provide an answer but show no work or your work is incorrect, you will not receive credit. Here are some general guidelines, but this list is not meant to be exhaustive:

- You must follow directions. If you tackle a problem using a method different than the outlined directions, you may fail to demonstrate the skill that the problem was designed to measure.
- Your solutions must be written in a connected, step-by-step logical fashion and all variables should be clearly defined. If your solution is not written clearly, you will not receive full credit.
- In many cases, setting up the correct mathematical model and using this model to solve a problem will be just as important as computing a numeric answer.
- When you use technology (where allowed) to provide an answer, you must state your method. If your method is graphical, you must also include the graph.
- Where possible, you must include units of measurement for your answers.
- One of your goals should always be to clearly communicate mathematical ideas. You should consider your work to be targeted toward a non-mathematical reader. For instance, not using the equals sign when things are equal or incorrectly using an equals sign when things are not equal should be avoided at all times.
- You should always give functions names that clarify their roles in the problem. You should use correct mathematical notation.

Ground Rules:

1. Homework Assignments and Class Preparation: It is recommended that you spend at least two hours outside of class doing mathematics for every hour spent in class. If you do not have a strong foundation in prerequisite skills, you should expect to work much more than that to be successful. The majority of this time should be spent doing the practice problems from the homework. However, rewriting your notes, reading your textbook and seeking help, if needed, are also worthwhile uses of your study time. Lectures are an opportunity for students to ask questions and seek clarification on material. Lecture is also an opportunity for the instructor to coordinate coverage of the material and present material that is historically or potentially difficult. This implies student preparation has been accomplished prior to class. A common phrase to go by is "math is not a spectator sport." Think of your practice time as training.

> ***When to practice:*** Please do homework exercises every day, rather than letting them build up. Trying to succeed in math by practicing only during 8-hour sessions on the weekends or right before the tests is just as futile as trying to succeed at any sport that way.

How to practice: *"Doing homework exercises"* means actually writing each exercise on paper, writing out its solution completely, in a logical, step-by-step fashion, and then reconciling your answer with the one given in the back of the book. If you have a *Student Solution Manual*, that is fine. However, you should refer to it only after first making your best attempt at the problem. Copying the solution from the manual is only a useful learning tool if you then do another similar problem afterwards. Just reading the solution in the manual is even less useful. That is like expecting to master the high jump by only watching a high jumper.

Where to practice: Good places to work on math homework: The CAS lobby has round tables that are great for working on your homework either alone or in a group. You will find other students working on math and engineering there, so you will feel quite at home. Also, you can easily get help from either another student or a professor. The Math Drop-in Lab is also a good place to go for the same reasons. When studying together, working at the whiteboard in the library could be useful, but remember that ultimately the work should be your own. There is a big difference between helping and copying. (See academic integrity below.)

2. Calculator: You will need a graphing calculator. The TI-83/84 Plus is the recommended calculator for this course. This is the one your instructor will be using, and your instructor may not be able to provide assistance with other models (See *School of Mathematics and Computer Science Policy Sheet.*) As a trial for this semester, I am allowing the app "GraphLock". This app allows me to verify via my ipad that your phone is locked down where you cannot access other apps or the internet. If you are going to use that instead of the TI 83/84 please let me know within the first week of school. You may only have your phone visible during exams if it is clearly locked.

3. Technology: ~~All other electronic devices, including computers, PDAs, and cell phones, must be silenced and put away for all class lecture sessions. All exceptions to this rule must have prior instructor approval or be a mandated accommodation from Accessibility Services.~~ On a trial basis, you are allowed to use electronic devices during class lectures as long as you are using them to enhance your mathematical understanding. This trial will largely be used to determine my policies for **all students** in the future. Your devices should be turned to silent. Some **examples** of acceptable uses of such devices are: graphing a function, verifying a solution, determining an alternative method of solution, finding a definition, viewing an electronic version of the course textbook, or taking a picture of the board. (If you do take pictures of the chalkboard, please send copies to the instructor to share with the class.) Some **examples** of unacceptable uses of technology are: texting, cheating, talking on the phone, viewing social media, checking email, violating privacy (such as taking photos of others), or bullying. The instructor reserves the right to change this policy at any time.

4. Classroom Atmosphere: The primary function of the classroom is the dissemination and application of knowledge. In order to meet that goal, the classroom atmosphere must be conducive to learning. It is expected that you will arrive to class on time. If you are late because of a situation that is beyond your control, you should enter the classroom quietly. If you must leave early, you should notify your instructor before class begins, sit by the door and exit quietly.

5. Equity: It is important that all students are provided with a classroom atmosphere that fosters learning without fear of prejudice or bias. It is expected that you will treat yourself and your classmates with dignity and respect.

6. Make-up Quizzes/Homework: In most cases, make-up quizzes will not be given. Instead, at least one quiz grade will be dropped. If there is a valid verifiable excuse, such as hospitalization, automobile accident, death in the family or a university excused absence, make-up quizzes will be administered/accepted under the following conditions

- For an in-class quiz, you are required to take such quizzes before you leave campus (preferable) or before the next class period. You should make such arrangements promptly.
- For a take-home quiz, a late quiz will be accepted as long as an attempt was made to deliver the quiz promptly (as soon as the emergency has passed). This can be done electronically, if necessary.

If you miss the class period that a take-home quiz is distributed, it is your responsibility to obtain the take-home quiz and turn it in <u>on time</u> at the beginning of the next class period. In most cases, late homework will not be accepted. Instead, each student is allowed three "grace days". A grace day entitles you to turn in one assignment up to one class period late, no questions asked. There is no penalty for using a grace day, no reward for not. At the top of the paper, you should write "grace day #j."

7. Make-up Exams: Each exam should be taken at the designated time. In the event of a university excused absence, an exam should be taken prior to the scheduled date. The student must provide a written request at least one week prior to the date of the exam. In all other cases, if a test is missed, the student must contact the instructor within 48 hours of the scheduled test time. The student may leave a message by voice-mail or e-mail if necessary. It is the sole discretion of the instructor to give (or not) make-up exams if an absence is unexcused. Examples of excused absences include illness, hospitalization, an automobile accident, death in the family or a university sponsored trip. Make-up exams and exams which are taken early may or may not be the same exam as the in-class exam.

8. Academic Integrity: Students are expected to perform all assigned work themselves. Working on homework assignments with one or more classmates is a great way to learn. However, you should always write up your own solution without the aid of another person or another person's solution. Any form of cheating or plagiarism will be handled in accordance with the Academic Integrity Procedures. Violations of the *University Academic Integrity Policy* may result in an F for the course grade.

9. Testing: Use of head phones, internet or ball caps during exams are prohibited. Please bring your student ID to exams.

10. E-mail: When e-mailing your instructor you must include your course title (MATH151) and your class time in the subject line. It is also recommended that your subject line include the topic of the message. If you do not make a request or ask a question it will be assumed that your e-mail was for informational purposes only and you will not receive a response.

11. Extra Credit: No extra credit will be given. Course grades assess student mastery of the course objectives as defined by the department syllabus. Artificially inflating those grades not only weakens such assessment, but it could allow you to move on to another course for which you are not prepared, thus perpetuating a growing problem. You can earn up to three additional dropped quiz/homework grades by doing the following: visiting my office to get help with the material, asking relevant math questions in class, answering math questions in class, or attending the Math Drop-in Lab on at least 5 separate occasions. (No test grades will be dropped.)

12. Grades of "I" (Incomplete): According to university policy, students will need to be enrolled and have completed the majority of the work required for a course during the semester to be eligible to request an "I" (incomplete grade). An "I" grade is only to be given if extenuating circumstances beyond your control prevents the completion of the course requirements by the end of the semester.

<u>*University Policies*</u>

Online and Blended Course Attendance Policy

Students in online or blended classes are required to log in to the Course Management System (Blackboard, Wimba, TaskStream, etc.) and complete at least one "Academic Related Activity" within the Add/Drop period.

The Americans with Disabilities Act & Accommodations

In compliance with Lake Superior State University policies and equal access laws, disability-related accommodations or services are available to students with documented disabilities. If you are a student with a disability and you think you may require accommodations you must register with Accessibility Services, which is located in the KJS Library, Room 233 (906) 635-2355 or x2355 on campus. Accessibility Services will provide you with a letter of confirmation of your verified disability and authorize recommended accommodations. This authorization must be presented to your instructor before any accommodations can be made. Students who desire such services should meet with instructors in a timely manner, preferably during the first week of class, to discuss individual disability related needs. Any student who feels that an accommodation is needed – based on the impact of a disability – should meet with instructors privately to discuss specific needs. The university will make reasonable accommodations for persons with documented disabilities. Students should notify the Coordinator of Accessibility Services (located in LBR 233), and their instructors, of any accommodation needs as soon as possible.

IPASS (Individual Plan for Academic Student Success)

If at mid-term your grades reflect that you are at risk for failing some or all of your classes, you will be contacted by a representative of IPASS. The IPASS program is designed to help you gain control over your learning through pro-active communication and goal-setting, the development of intentional learning skills and study habits, and personal accountability. You may contact 635-2887 or email ipass@lssu.edu if you would like to sign up early in the semester or if you have any questions or concerns.

College of Arts and Science **Fall 2017**
MATH151 001 and 002 Calculus I (4,0) **4 Credits**
Calendar (**Tentative**):

Week	*Week of*	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*
1	08/28	Syllabus, Review Pre-Calculus	2.1 Limits, rates of change, tangent lines		2.2 Limits: A numerical and graphical approach	Quiz 2.3 Basic Limit Laws
2	09/04	**Labor Day Holiday**	2.4 Limits and continuity		2.4 Limits and continuity	Quiz 2.5 Evaluating limits algebraically
3	09/11	2.5 Evaluating limits algebraically	2.6 Trigonometric limits		2.7 Limits at infinity	2.7 Limits at infinity *Review if time allows*
4	09/18	**Test 1**	2.8 Intermediate Value Theorem		3.1 Definition of the derivative	3.1 Definition of the derivative
5	09/25	3.2 The derivative as a function	3.3 The Product rule and the Quotient rule		3.4 Rates of change	Quiz 3.5 Higher derivatives
6	10/02	3.6 Trigonometric functions	3.7 The Chain Rule		3.8 Derivatives of inverse functions	Quiz 3.9 Derivatives of exp. & log. functions
7	10/9	**Canadian Thanksgiving Holiday**	3.9 Derivatives of exp. & log. functions		3.9 Derivatives of exp. & log. functions *Review if time allows*	**Test 2**
8	10/16	3.10 Implicit Differentiation	3.11 Related Rates		3.11 Related Rates	Quiz 4.1 Linear approximations and applications
9	10/23	4.2 Extreme Values	4.2 Extreme Values		4.3 The Mean Value Theorem and monotonicity	Quiz 4.4 The Shape of a Graph
10	10/30	4.5 L'Hopital's Rule	4.5 L'Hopital's Rule		4.6 Graph Sketching and Asymptotes	4.7 Applied Optimization
11	11/06	4.7 Applied Optimization	4.7 Applied Optimization *Review if time allows*		**Test 3**	4.8 Newton's Method
12	11/13	4.9 Antiderivatives	5.1 Approximating and computing area		5.2 The definite integral	Quiz 5.3 The Fundamental Theorem of Calc, Pt I
13	11/20	5.4 The Fund. Thm. of Calc, Part II	5.5 Net Change as an Integral of Rate	**U.S. Thanksgiving Holiday**		
14	11/27	5.6 Substitution Method	5.6 Substitution Method		5.7 Further Transcendental Functions *Review if time allows*	**Test 4**
15	12/04	5.7 Further Transcendental Functions	5.8 Exponential growth and decay		*Review if time allows /assessment*	*Review*
16	12/11		**Final Exam 10:00-12:00**			

College of Arts and Science **Fall 2017**
MATH151 001 and 002 Calculus I (4,0) **4 Credits**
Homework Exercises:
Section 2.1: 1, 5, 6, 7, 11, 17, 19, 25.
Section 2.2: 1, 3, 6, 7, 17, 25, 27, 35, 39, 47, 53.
Section 2.3: 1, 2, 5, 7, 9, 13, 17, 21, 24, 27, 30, 31.
Section 2.4: 2,3,4,5, 9, 13, 17, 23 29, 37, 47, 51, 57, 65, 67, 69, 73, 75, 77, 79
Section 2.5: 1, 7, 9, 11, 17, 21, 23, 27, 31, 47, 49, 51.
Section 2.6: 1, 2, 7, 17, 33
Section 2.7: 1, 2, 3, 4, 7, 9, 11, 13, 19, 25
Section 2.8: 1, 3, 6, 17

Section 3.1: 3, 7, 11, 12, 13, 19, 27, 33, 39, 51, 55.
Section 3.2: 3, 9, 13, 15, 21, 25, 27, 33, 37, 41, 43, 46
Section 3.3: 1, 5, 7, 9, 11, 15, 19, 21, 27, 37, 39, 51
Section 3.4: 1 (assume s is measured in inches), 5 (assume radius is measured in meters), 7 (assume height and radius are measured in feet), 9, 11, 15, 17, 23, 25, 27, 31, 35, 41, 43
Section 3.5: 3, 7, 9, 13, 21, 25, 39, 41.
Section 3.6: 1, 3, 5, 7, 9, 11, 13, 15, 19, 23, 25, 29.
Section 3.7: 1, 5, 9, 11, 17, 23, 29, 33, 35, 39, 43, 49, 55, 61, 93.
Section 3.8: 3, 5, 8, 11, 13, 15, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39.
Section 3.9: 1, 3, 5, 9, 11, 17, 23, 27, 31, 37, 41, 45, 49, 53, 59, 65, 73, 75.
Section 3.10: 3, 5, 7, 9, 11, 15, 19, 23, 31, 44, 48.
Section 3.11: 1, 5, 7, 9, 15, 17, 19, 23, 37.

Section 4.1: 1, 5, 9, 13, 17, 23, 31, 35, 39, 45, 59
Section 4.2: 1, 3, 11, 17, 29, 35, 39, 47, 55, 65, 75, 77, 79.
Section 4.3: 1, 3, 5, 9, 15, 19, 21, 25, 31, 33, 47.
Section 4.4: 1, 5, 9, 15, 23, 27, 35, 42. For each problem except #1, in addition to the requested tasks, please sketch the function, its derivative function, and its second derivative function, one above the next, with the same x scale.
Section 4.5: 3, 5, 9, 11, 13, 17, 21, 25, 27, 35, 43, 46, 47, 48, 49.
Section 4.6: 55, 57.
Section 4.7: 1, 5, 9, 13, 17, 21, 25, 29, 35, 43, 57.
Section 4.8: 1, 3, 7, 11, 13, 14, 21.
Section 4.9: 1, 3, 5, 7, 15, 17, 21, 23, 29, 33, 37, 41, 45, 49, 51.

Section 5.1: 13, 15, 17.
Section 5.2: 1, 3, 5, 7, 9, 13, 15, 23, 25, 27.
Section 5.3: 1, 3, 5, 7, 11, 17, 23, 25, 27, 29, 33, 35, 37, 43.
Section 5.4: 1, 3, 7, 9, 11, 13, 17, 21, 23, 25, 29, 31.
Section 5.5: 1, 3, 5, 7, 9, 17, 21.
Section 5.6: 1-71 (every other odd), 79, 83, 87, 89.
Section 5.7: 1-69 (every other odd).
Section 5.8: 1, 3, 7, 13, 17, 35.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**MATH 151 Syllabi for Concurrently Enrolled Students in Pickford and Cedarville**
This documentation is relevant to Question number:	**4**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Provides Examples for Comparison.**

LAKE SUPERIOR STATE UNIVERSITY

College of Natural, Mathematical and Health Sciences **Fall 2014**
MATH151 001 Calculus I (4,0) **4 Credits**

Class Meetings: 8:20 – 9:12 MTWRF

Prerequisites: High school mathematics that includes two years of algebra, one year of plane geometry and one-half year of trigonometry and equivalent/satisfactory score on ACT or Placement Exam, or MATH 140 with a grade of C or better or MATH 111 and MATH 131 with grades of C or better.

Instructor: Heather Salmi, Pickford High School, 906-647-6285, heathers@eup.k12.mi.us

Office Hours: Prep Hour 10:12 – 11:04

Required Texts: Calculus: Early Transcendentals, by Jon Rogawski, Freeman, 2nd Edition, ISBN: 9781429282574, 2011.

Recommended: Student Solution Manual to Accompany Jon Rogawski's Calculus Single Variable, 2nd Edition, by Brian Bradie and Roger Lipset, ISBN: 97814292550055, 2012. On reserve in the library.

Course Description: Limits, continuity and inverse functions. Logarithmic and exponential functions. Differentiation and applications of the derivative. L'Hopital's rule. Inverse trigonometric functions. Integration and the definite integral.

Course Goals: Provide students with an introduction to differential and integral calculus and prepare students to go on to Calculus II.

Course Objectives: At the conclusion of MATH151 students will be able to:

1. Describe the concept of limit intuitively; find **limits** graphically, algebraically, analytically, and using L'Hôpital's rule; apply limits to the concepts of continuity, derivative, and definite integrals and then interpret the results.
2. Describe intuitively the concept of **continuity** and state rigorously the definition using limits; identify intervals of continuity and points of discontinuity in particular functions; and state, interpret, and apply the Intermediate Value Theorem.
3. Describe intuitively the concept of **derivative** and state rigorously the definition using limits; find and interpret derivatives using the definition, the various rules available, implicit differentiation and related rates; apply to the analysis of functions (increasing, decreasing, optima); and state, interpret, and apply the Mean Value Theorem.
4. Use area and average value to describe intuitively the concept of **integration**; define integration rigorously using limits; find anti-derivatives using integration rules and substitution; state and interpret the Fundamental Theorem of Calculus and use this theorem to evaluate definite integrals; and apply integration techniques to problems involving rates.
5. Solve **application** problems by drawing sketches, where applicable, and using English statements to name variables, find equations, define parameters, and create models; then apply algebra, trigonometry, and calculus methods to solve for the unknown values, and report the solution.

LAKE SUPERIOR
STATE UNIVERSITY

College of Natural, Mathematical and Health Sciences **Fall 2014**
MATH151 001 Calculus I (4,0) **4 Credits**

General Education Objectives:
This course is designed to meet the Mathematics General Education Outcome. Students will be able to analyze situations symbolically and quantitatively in order to make decisions and solve problems. Specifically, students will be able to:

1. Solve problems presented in the context of real world situations with emphasis on model creation, prediction and interpretation. This will be done using multiple perspectives (formulas, tables, graphs, and words) and will include fitting an appropriate curve to a scatter plot.

Grading Scale and Policies:
Point Values:

Quizzes (at least 2 per chapter)	100 points
Exams (4 worth 100 points each)	400 points
Class activities/attendance	50 points
Final Exam	150 points
Total	**700 points**

Test Dates (Tentative)***:*** Chapter 2 October 3 Chapter 3 October 31
Chapter 4 November 25 Chapter 5 December 19

Grading Scale:

98-100	A+	88-89	B+	78-79	C+	68-69	D+
93-97	A	83-87	B	73-77	C	60-67	D
90-92	A-	80-82	B-	70-72	C-	0-59	F

***Ground Rules*:**

1. **Homework Assignments:** You are expected to read each section of the text, and daily homework exercises will be assigned in class. You should spend a lot of your math study time doing homework exercises, typically 2 hours per class period. Please think of Calculus as a sport that you want to master. To do so, we all need to practice.

***When to practice*:** Please do math exercises every day, rather than letting them build up. Trying to succeed in math by practicing only during 8-hour sessions on the weekends or right before the tests is just as futile as trying to succeed at any sport that way.

How to practice: *"Doing homework exercises"* means actually writing each exercise on paper, writing out its solution completely, in a logical, step-by-step fashion, and then reconciling your answer with the one given in the back of the book. If you have a *Student Solution Manual*, that is great. However, you should refer to it only after first making your best attempt at the problem. Copying the solution from the manual is only a useful learning tool if you then do another similar problem afterwards. Just reading the solution in the manual is even less useful. That is like expecting to master the high jump by only watching a high jumper.

LAKE SUPERIOR
STATE UNIVERSITY

College of Natural, Mathematical and Health Sciences **Fall 2014**
MATH151 001 Calculus I (4,0) **4 Credits**

2. Calculator: You will need a graphing calculator. The TI-83/84 Plus is the recommended calculator for this course. This is the one your instructor will be using, and your instructor may not be able to provide assistance with other models. (See *School of Mathematics and Computer Science Policy Sheet.*) All other electronic devices, including computers, PDAs and cell phones, must be turned off for all class sessions.

3. Purpose of Lecture: Class sessions are an opportunity for you to ask questions and seek clarification on material and for the instructor to present new material. You should prepare for class by doing the assigned homework from the previous meeting and reading the next section (See the Time Utilization section of the *School of Mathematics and Computer Science Policy Sheet.*).

4. Attendance Policy: Attendance is expected and will be recorded. If you miss a class, or are late, you are still responsible for class notes and assignments. Attendance and class activities will affect your final grade. If you arrive late, after I've taken attendance, then let me know after class, and I will record your presence. If you are habitually late, then this privilege will end for you.

5. Make-up Policy: Each exam should be taken at the designated time. In the event of a schedule conflict with a university function, dental/physician's appointment, wedding, etc., the student must tell the instructor one week in advance and arrange to take the test early. In case of an emergency that results in missing a test, the student must contact the instructor within 24 hours of scheduled test time. The student may leave a message by voice-mail or e-mail if necessary. It is the sole discretion of the instructor to give (or not) make-up exams if an absence is unexcused. Hospitalization of the student, death of a close relative and orders of a doctor would be considered valid excuses. Most other things would not. Make-up exams may be different from the in-class exam. In most cases make-up quizzes will not be given.

6. Academic Integrity: Students are expected to perform all assigned work themselves. Working on homework assignments with one or more classmates is a great way to learn. However, you should always write up your own solution, without the aid of another person or another person's solution. Any form of cheating or plagiarism will be handled in accordance with the Academic Integrity Procedures. Violations of the *University Academic Integrity Policy* may result in an F for the course grade.

7. Testing: Use of head phones, cell phones, internet and hats during exams is prohibited.

Calculus (MATH 151)

Instructor: Hank McClure

Room: 312 (Cedarville High School)

Phone Number: Work: 484 - 2256

E-mail address: hmcclure@eupschools.org

Prerequisites: Completed Math 140 or equivalent with a grade of a C or better.

Text: *Calculus, 2nd Edition;* Early Transcendentals, Jon Rogawski

ISBN: 978-1-4292-0838-3

Course Objectives: Limits, continuity, and inverse functions. Logarithmic and exponential functions. Differentiation and applications of the derivative. L'Hopital's Rule. Inverse trigonometric functions.

1. ***Limit:*** describe intuitively and state rigorously the definition; compute; understand their fundamental roll within the concepts of continuity, derivative, and definite integral

2. ***Continuity:*** describe intuitively and state rigorously the definition using limits, identify intervals of continuity and points of discontinuity in particular functions; state, interpret, and apply the intermediate value theorem

3. ***Derivative:*** describe intuitively and state rigorously the definition using limits; compute; apply to problems involving rates; apply to analysis of functions (increasing, decreasing, optima); state, interpret, and apply Rolle's Theorem and the Mean Value Theorem

4. ***Integral:*** describe intuitively (area, average value); define rigorously (using limits); compute; state and interpret the Fundamental Theorem of Calculus; apply to problems involving rates.

5. ***Modeling:*** translate from an English statement to a model involving a sketch, name variables, and find equations and parameters; identify which unknowns in the model correspond to unknowns in the English statement; apply algebra, trigonometry, and calculus methods to solve for the unknown values; report the solution in terms of the English statement.

Grading Policy: There will be six exams, the last of which will be a comprehensive final exam. The final exam is worth 200 points. The first 5 exams are each worth 100 points.

First five exams: 500 points (total)

Final exam: 200 points

After dividing your total points earned by 700 points and multiplying by 100 to get the percent, the following scale will be used to determine final letter grades:

A	93 - 100	C	73 - 77
A-	90 - 92	C-	70 - 72
B+	88 - 89	D+	68 - 69
B	83 - 87	D	60 -67
B-	80 - 82	E	59 and below
C+	78 - 79		

Make-up Policy: Each exam should be taken at the designated time. In some circumstances an exam may be taken prior to the scheduled date provided that the student provides a written request at least one week prior to the date in which he or she chooses to take a test. In the event of a schedule conflict with a university function, dental/physician's appointment, wedding, etc., the student must take the test early**.** If a test is missed for any other reason, the student must contact the instructor within 48 hours of the scheduled test time. You may leave a message by voice-mail or e-mail if necessary. Without a valid, verifiable excuse the highest possible score on a make-up test will be a 60. Hospitalization of the student, death of a close relative and orders of a doctor would be considered valid excuses. Most other things would not. Make-up exams and exams which are taken early may or may not be the same exam as the in-class exam. Homework, when collected, is due at a scheduled time. It is your responsibility to know when an assignment is due. Late homework will not be accepted and make-up quizzes will not be given. Instead, at least two homework/quiz grades will be dropped.

Testing Policy: You must use a calculator for this course and follow the School of Mathematics and Computer Science *Calculator Policy*. Students are not permitted to use notes of any kind during an exam. Students should be extremely careful to keep their eyes on their own work. Hats and caps that obscure the face are not allowed on test days. (For further information on cheating, see the Cheating section of the School of Mathematics and Computer Science *Class Policies* handout.) Exams are designed to be self-explanatory. Clarification and help with interpretation will be provided to the extent possible. However, requests that address the knowledge or skill that the question was designed to measure cannot be honored. You may be tested over problems that are generalizations of material covered during class and/or in the text. The problems may not look exactly like the ones from the book and/or from class.

Appendix Cover Sheet

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Graduate Employment Information**
This documentation is relevant to Question number:	**6**
Briefly summarize the content of the file and its value as evidence supporting program review:	**A list of graduates and their employees. It also lists graduate schools.**

Basmair	Ahmed	Computer Networking	Just a Flash
Behling	Porter	Computer Networking	Alden State Bank
Butler	Matthew	Computer Networking	Employed by Chamberlains Old Forest Inn
Eitrem	Jeremy	Computer Networking	War Memorial Hospital
Frazier	Lucas	Computer Networking	Bulldog IT
Gallagher	Sean	Computer Networking	Sault Tribe of Chippewa Indians
Gough	Kody	Computer Networking	Taco Bell
Holbrook	Cordell	Computer Networking	
Hollowell	Robert	Computer Networking	Graduate Student at Central Michigan University
Hotlen	Kyler	Computer Networking	Consulate Health Care
Ison	Max	Computer Networking	Kent Record Management
Minaker	Eric	Computer Networking	906 Technologies
Northrop	Everett	Computer Networking	EUP ISD
Postma	Tyler	Computer Networking	Bay Mills Community College
Reeves	Alaric	Computer Networking	NuAxis Innovations
Sullivan	Joseph	Computer Networking	Google
Barnum	Taylor	Computer Science	International Forwarders
Bartz	Leah	Computer Science	
Blumenthal	Joel	Computer Science	General Mills
Bosley	Josh	Computer Science	Aerotek/TARDEC
Dotski	Elizabeth	Computer Science	LSSU
Gerberding	James	Computer Science	Unemployed
Graziani	Philip	Computer Science	Aerotek/TARDEC
McBain	Robert	Computer Science	Platform Staffing Group
Novic	Tamara	Computer Science	
Qian	Wei	Computer Science	Applying to Graduate Program
Rain	Adam	Computer Science	UC Synergetic
Roberts	Laura	Computer Science	Optimation
Wiley	Joshua	Computer Science	KPIT
Wilson	Cody	Computer Science	NEMCMH
Barrett	Michael	Mathematics	Teacher/Tutor, Bay Mills Community College
Canduro	Anna	Mathematics	High School Math specialist at Coast Tsimshian Academy in Lax Kw'alaams, Northern British Columbia
Carte	Olivia	Mathematics	Teacher, Pickford Area Schools
Dotski	Elizabeth	Mathematics	I.T. System Specialist and Adjunct Lab Instructor, Lake Superior State University
Keilholtz	Jessica	Mathematics	Teacher, Les Cheneaux Public Schools
McNamara	Kiegan	Mathematics	Industrial Air Technology in Alpena
Nicholson	Michael	Mathematics	
Povey	Adam	Mathematics	Bay Mills Indian Community Payroll Accountant
Rogers	Ryan	Mathematics	Young Cabinetry
Sloat	Dillon	Mathematics	Teacher, Lake City Area Schools
Suehr	Sean	Mathematics	Graduate Student, North Carolina Agricultural and Technical State University

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Four-Column Report School of Mathematics and Computer Science Goals**
This documentation is relevant to Question number:	**7**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Demonstrates the level of completion of School goal assessment as of November 21, 2018**

Assessment: Planning Unit Four Column

School: Planning - Computer Science and Mathematics

Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
I. Collaboration and Inclusion - We support an environment of collaboration and inclusion where students, faculty, and staff from all fields of study are valued. **Goal Status:** Active **Strategic Plan Outcome(s) addressed:** C1. We cultivate an environment of inclusion where all members treat others with dignity and respect. , C2. We cultivate open communication, engagement, and behaviors that strengthen community, across campus and in the wider region. , A3. We will cultivate programs that support individual growth within the curricular, co-curricular, and non-curricular realms culminating in degree completion and endorsement of lifelong learning., E2. We will cultivate collaborations with external and internal groups to promote student development and success., E3. We will cultivate continuous improvement of the student experience through data-informed decision making and student input.	The School will maintain and attend speaking series involving students, faculty, and staff.	**Finding Reporting Year:** 2018-2019 **Goal met:** Yes The School has begun a Mathematics Seminar that meets on a biweekly basis. (11/20/2018)	
		Finding Reporting Year: 2018-2019 **Goal met:** Yes The School has created an informal seminar called Talk Math to Me that meets on a weekly basis in the Center of Teaching and Engaged Learning for students to present mathematics in a supportive and non-threatening environment. Average attendance has been 11 students and 3 faculty & staff members per week. (11/19/2018)	
		Finding Reporting Year: 2018-2019 **Goal met:** Yes The School has started a University wide Colloquium series and contributed the initial talk, along with several others. The Colloquium has had speakers from other Schools across campus. (11/19/2018)	
		Finding Reporting Year: 2016-2017 **Goal met:** Yes LSSU hosted the Upper Peninsula Regional Meeting of the Mathematical Association of America - Michigan Section in October 2016. (11/19/2018)	**Use of Result:** LSSU is scheduled to host the Upper Peninsula Regional Meeting of the Mathematical Association of America - Michigan Section in October 2020 (11/20/2018)
	The School will maintain and attend social events.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Interested faculty continue to meet socially every week and	

Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
		once a month during the summer. (11/21/2018)	
	The School will maintain active clubs in mathematics and computing.	**Finding Reporting Year:** 2018-2019 **Goal met:** Yes The School currently has a chapter of the Association for Computing Machinery (ACM). Every year the chapter participates in the ACM Programming contest, which we hosted in November 2018. The School has begun a mathematics club. (11/19/2018)	**Use of Result:** The School is beginning the process of establishing a chapter of the undergraduate mathematics honor society Pi Mu Epsilon. A requirement is that the University has a math club for a minimum of 1 year. (11/20/2018)
	Our classes are accessible, and have utility and value to students outside our degree programs.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes For years 2013-2018, 120 non school majors took CSCI 105, or 24 per year on average. (11/20/2018)	
		Finding Reporting Year: 2017-2018 **Goal met:** Yes For 2013-2018, CSCI 201 had 59 students from outside our school, an average of 12 per year. (11/20/2018)	
		Finding Reporting Year: 2017-2018 **Goal met:** Yes For years 2013 - 2018, CSCI 201 had 22 students from outside our majors, and average of 4 per year. (11/20/2018)	
		Finding Reporting Year: 2017-2018 **Goal met:** Yes For years 2013-2018, CSCI 221 had 23 students who were not in our majors, an average of 4.6 per year. (11/20/2018)	
		Finding Reporting Year: 2017-2018 **Goal met:** Yes For years 2013-2018, CSCI 341 had 28 students that were not our majors. The class was only offered 3 times in that range, so the average was 9. (11/20/2018)	
		Finding Reporting Year: 2017-2018 **Goal met:** Yes For the 2016-2017 academic year the total enrollment in math courses was 707 for Fall, 549 for Spring and 26 for summer. (11/20/2018)	**Use of Result:** We recently moved to ALEKS-PPL as math placement. In 2019, we will assess the success of students who place into courses using ALEKS-PPL scores to ensure that this new method is properly preparing them for

Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
			success. (11/21/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes For the 2017-2018 academic year the total enrollment in math courses was 774 for Fall, 587 for Spring and 26 for summer. (11/20/2018)	
II. High Quality Instruction - We promote faculty-student interaction through high-quality classroom instruction, through hands-on research opportunities, and through student advising. **Goal Status:** Active **Strategic Plan Outcome(s) addressed:** C3. We cultivate continuous self-improvement through service, assessment, and accountability., A1. We will cultivate continuous academic and co-curricular improvement to provide relevant programs and support services., A2. We will cultivate student educational experiences that add value and allow students to reach their full potential. , E3. We will cultivate continuous improvement of the student experience through data-informed decision making and student input.	The School will engage with the broader campus community for continuous improvement of instruction.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes A list of activities of instruction that represent engagement by faculty and students is attached. (11/21/2018) **Related Documents:** SchoolEngagement.docx	
	Students will complete sophomore and senior projects in computing and senior projects in mathematics.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes During the Spring 2018 semester 8 students completed a sophomore project in computing and 14 students completed a senior level project in computer science (11/19/2018)	
		Finding Reporting Year: 2017-2018 **Goal met:** Yes During the 2017-2018 academic year, 4 students completed a senior project in mathematics. (11/19/2018)	**Use of Result:** While assessing student mathematics projects last year, a question was raised about whether or not our assessment methods were properly assessing the ILO on Professionalism. That will be reviewed and improved in the Spring of 2019. (11/21/2018)
III Currency - We adapt to changes in our disciplines to provide a timely and relevant educational programs to our students. **Goal Status:** Active **Strategic Plan Outcome(s) addressed:** C3. We cultivate continuous self-improvement	Topics in sophomore and senior projects are chosen to be of current interest – either directly addressing skills that will be used in the workforce or exploring topics that will be of use in a graduate program.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes A list which includes sophomore and senior projects is attached. Many of these projects are directed toward helping the community or on current interests and innovation. (11/21/2018) **Related Documents:** SchoolEngagement.docx	**Use of Result:** We will continue to encourage projects that pertain to current interests and help the community. (11/21/2018)

Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
through service, assessment, and accountability., A1. We will cultivate continuous academic and co-curricular improvement to provide relevant programs and support services., A2. We will cultivate student educational experiences that add value and allow students to reach their full potential. , E3. We will cultivate continuous improvement of the student experience through data-informed decision making and student input.	Faculty will attend and participate in conferences.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes A list of faculty presentations and attendance at conferences and workshops are attached. (11/21/2018) **Related Documents:** FacultyProfessionalDev.docx	**Use of Result:** Faculty will be encouraged and supported (to the extent possible) to continue to present at and attend conferences and workshops. (11/21/2018)
	Faculty will maintain scholarly activities in their fields.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes A list of faculty scholarly activities for the last five years is attached. (11/21/2018) **Related Documents:** FacultyProfessionalDev.docx	**Use of Result:** Faculty will be encouraged and supported (to the extent possible) to continue scholarly activities. (11/21/2018)
IV Budgetary Transparency - We build transparent fiscal responsibility into all budgetary processes including the collection and allocation of course fees to meet the needs of our students and programs. **Goal Status:** Active **Strategic Plan Outcome(s) addressed:** C2. We cultivate open communication, engagement, and behaviors that strengthen community, across campus and in the wider region. , F1. We will cultivate a culture of continuous improvement through accountability and sustainability practices, regular financial reviews, and periodic reporting., F2. We will cultivate data-informed budgetary processes that are open, transparent, and in alignment with institutional priorities., F3. We will cultivate viable entrepreneurial efforts to efficiently support evolving institutional needs, and to support new financially-viable, mission-	The dean will meet with the chair monthly to discuss the budget.	**Finding Reporting Year:** 2018-2019 **Goal met:** Yes In a move for greater transparency in budgeting, the dean met with the chairs in the college on September 28, 2018 to discuss the differences between the submitted budget and the approved budget. She also gave the chairs year-to-date totals. It was decided by the dean and chairs that these should be monthly discussions. The dean met with the chairs again on November 5, 2018 with year-to-date totals. (11/19/2018)	**Use of Result:** The dean will continue these meetings. The feedback to greater transparency has been positive. Our last School review/justification of program and course fees was in 2016. The School will meet in the Spring of 2019 and review program and course fees with the goal of submitting new proposals in the Fall of 2019, if necessary. (11/19/2018)
	Students are informed yearly about access to student copies of software from organizations that we purchase software licenses from.	**Finding Reporting Year:** 2018-2019 **Goal met:** Yes For 2018 - 2019, the students were sent an email on 11 October 2018. Students who contacted Dr. Schemm independently before that date were manually set up. (11/20/2018)	**Use of Result:** For 2019-2020 Academic Year a list of all majors and students in classes explicitly requiring a software package will receive an email no later than the second week of the semester informing them of software packages and options for individual use. (10/11/2018)

Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
driven opportunities.			
V. Outreach - We develop outreach programs with K-12, community colleges, tribal partners, and other organizations to improve recruitment. **Goal Status:** Active **Strategic Plan Outcome(s) addressed:** C2. We cultivate open communication, engagement, and behaviors that strengthen community, across campus and in the wider region. , C3. We cultivate continuous self-improvement through service, assessment, and accountability., F3. We will cultivate viable entrepreneurial efforts to efficiently support evolving institutional needs, and to support new financially-viable, mission-driven opportunities. , E1. We will cultivate, maintain, and support an enrollment management strategic plan that will center on programs and activities that reach enrollment goals., E2. We will cultivate collaborations with external and internal groups to promote student development and success.	The School will maintain a relationship with regional partners such as the EUP ISD and LSSU Charter Schools.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes The School collaborates with the School of Education and the EUPISD to hold it's annual Pi Day event. There were 85 students in attendance in 2018. (11/20/2018)	**Use of Result:** Following last year's action plan, the award ceremony was held together as planned and the chaperones were assigned. It is recommended that if the scavenger hunt is held next year, that clearer directions are given to the volunteers at each site. (11/20/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes The School collaborates with the School of Education and the EUPISD to hold it's annual Pi Day event. There were 80 students in attendance in 2017. (11/20/2018)	**Use of Result:** As a follow up from last year, there was more collaboration between the ISD and LSSU. Instead of students taking turns in competing, more activity was planned throughout the day. This worked well and should be continued. Following a feedback survey from this year, it is recommended that next year the awards ceremony is held with the middle school students and the high school students in the same room. It is also recommended that at least one chaperone stay with the students at all times. (11/20/2018)
		Finding Reporting Year: 2018-2019 **Goal met:** Yes The School has a presence on the MiSTEM Advisory Board with the EUP ISD. (11/19/2018)	
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Existing articulation agreements with community colleges hosting LSSU Regional Centers (Bay de Noc CC - Escanaba and North Central Michigan College - Petoskey) (11/19/2018)	**Use of Result:** Review existing articulation agreements in Computer Science & Computer Networking (11/19/2018)

Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	The school will create and update articulation and transfer agreements with community colleges and other similar organizations to facilitate student enrollment.	**Finding Reporting Year:** 2018-2019 **Goal met:** Yes In 2018-2019, we have worked on updating two articulation / transfer agreements. One with Bay Mills, and the other with Bay College. (11/20/2018)	**Use of Result:** The articulation with Bay is a work in progress, but our Dean has met with people from Bay College and we are currently working to improve accessibility for students for both Computer Science and Computer Networking (formerly, we had only considered Computer Networking). (11/20/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes In 2017-2018, we worked on updating 1 articulation / transfer agreement(s). Kirtland CC (11/20/2018)	
VI. Connections - We cultivate connections to our alumni, to graduate programs, and to employers to enhance the opportunities available to our students. **Goal Status:** Active **Strategic Plan Outcome(s) addressed:** C2. We cultivate open communication, engagement, and behaviors that strengthen community, across campus and in the wider region. , A2. We will cultivate student educational experiences that add value and allow students to reach their full potential. , A3. We will cultivate programs that support individual growth within the curricular, co-curricular, and non-curricular realms culminating in degree completion and endorsement of lifelong learning., F3. We will cultivate viable entrepreneurial efforts to efficiently support evolving institutional needs,	We will maintain a record of alumni employment and graduate schools.	**Finding Reporting Year:** 2018-2019 **Goal met:** Yes Graduating student lists have been complied for the 2017 and 2018 graduating classes. We have identified the current employment status or post-secondary institution for 90% of those alumni. (11/19/2018)	**Use of Result:** Exit interviews will be conducted by the School chair during finals week for students completing graduation requirements. (11/20/2018) **Use of Result:** Electronic surveys will be conducted every summer targeting alumni with less than 2 years after graduation. (11/20/2018)
		Finding Reporting Year: 2018-2019 **Goal met:** Yes The School of Mathematics and Computer Science maintains a public page on Facebook. (11/19/2018)	

Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
and to support new financially-viable, mission-driven opportunities. , E2. We will cultivate collaborations with external and internal groups to promote student development and success.			

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School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Example of Course Assessment Template- CSCI 342**
This documentation is relevant to Question number:	**8**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Provides an example of our assessment Template**

LAKE SUPERIOR STATE UNIVERSITY

Course Assessment
School of Mathematics and Computer Science

Course: CSCI 342 Semester Offered: Fall 2017
Instructor: Christopher E. Smith Course Credits: 4

Quantitative Course Assessment Matrix Mapping Objectives and Assessment Instruments

Instructor Assessment												
Activity	Possible Points	Average Score	Objective 1		Objective 2		Objective 3		Objective 4		Objective 5	
			% of students above 70% of available pts		% of students above 70% of available pts		% of students above 70% of available pts		% of students above 70% of available pts		% of students above 70% of available pts	
			# Q	%	#	%	#	%	#	%	#	%
Final Exam	200	153.3	8	77%	4	81%	3	67%	2	71%	1	47%
Outcome			Meets		Meets		Fails to Meet		Meets		Fails to Meet	

Explanation of above table: *On the Final, the targeted questions for Objective 1 are used to calculate the number of the students that received at least 35.5 of the 50 (70%) points possible. The standard of 70% (at least 6 out of 9) of the students must earn at least 70% of the available points (at least 35.5 out of the possible 50) is applied.*

Course Objectives

CSCI 342 Objectives:
Upon completion of this course, students should be able to:

1. Apply the basic types of algorithms, and identify each.
2. Apply brute force, divide and conquer, dynamic programming and greedy algorithms.
3. Analyze the complexity of algorithms
4. Apply the principles of testing and design test plans based upon these principles.
5. Describe the concept of a memory leak and demonstrate the ability to discover them.

Course Success Rate

The following table shows the distribution of grades that reflect the success rate of the students in the above named course.

CSCI 342 Advanced Programming Techniques				
Class Size	A to C	C- to D-	F/W/N	I
17	15	2	0	0

Summary

Objective 5 again failed to meet expectations, as it did during the last offering two years ago. This topic is introduced in CSCI 121, reinforced in CSCI 201, and is expected to be mastered in CSCI 342. For this offering, Objective 3 was slightly below standards, but is a topic that is covered in at least two prior courses and, if the student takes CSCI 341 first, is covered there as well.

Actions

Strengthen the emphasis on memory leaks in CSCI 121/201 as well as a stronger reinforcement in CSCI 341/342.

Follow-up from Prior Offerings

Objective 5 was to be looked at more closely. That has been done and found that changes need to be implemented.

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School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Example of Course Assessment Template- MATH 111**
This documentation is relevant to Question number:	**8**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Provides an example of our assessment Template**

LAKE SUPERIOR STATE UNIVERSITY

Course Assessment
School of Mathematics and Computer Science

Course: MATH 111.003 College Algebra Semester Offered: Fall 2017_
Instructor: Muller. K. Course Credits: 3

Course Assessment Matrix Mapping Objectives and Assessment Instruments
The following table has the averages on the course objectives from students in MATH 111.003 only.

MATH 111.003		Skills and Objectives																	
Activity	Possible Points	1		2		3		4		5		6		7		8		9	
Test 1	100	26.2	32.0	15.9	23.0	33.8	45.0												
Test 2	50											5.9	7.0	11.6	15.0	17.2	21.0	6.2	7.0
Test 3	50							10.7	12.0	14.3	18.0			12.3	14.0			5.0	6.0
Final Exam	100	8.7	10.0	8.5	10.0	5.2	8.0	8.2	10.0	11.7	16.0	6.9	8.0	10.0	12.0	13.5	16.0	7.5	10.0
	% Quantitative	83.1%		73.9%		73.6%		85.9%		76.5%		85.3%		82.7%		83.0%		81.3%	
	Goal Met	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	

Explanation of above table: On Test 1, for example, of the 100 points possible, 32 of the points measure mastery of Objective 1 and the average number of points earned was 26.2, etc.

The above data was from my section. The following table is from the Departmental final in all sections.

Departmental Final		Skills and Objectives																	
Activity	Possible Points	1		2		3		4		5		6		7		8		9	
Final Exam	100	8.6	10.0	8.4	10.0	4.8	8.0	7.7	10.0	11.5	16.0	7.0	8.0	9.8	12.0	13.0	16.0	6.5	10.0
	% Quantitative	86.0%		84.0%		60.0%		77.0%		71.9%		87.5%		81.7%		81.3%		65.0%	

As you can see the students in my section scored higher on all objectives except objective 6 on power functions, but the difference was slight.

Course Objectives At the conclusion of MATH111 successful students will be able to:

1. Solve problems presented in the context of real world situations, with emphasis on model creation, prediction and interpretation. This will be done using multiple perspectives, including formulas, tables, graphs, and words. (This includes determining if a given formula, table, graph or situation represents a function, as well as finding the domain and range.)
2. Calculate the average rate of change of a function using the slope formula or simplify the average rate of change using the difference quotient.
3. Define, evaluate, graph and analyze linear functions and solve linear equations and systems. (The analysis will include finding slopes, input/output values, intercepts, and intersections, as well as determining if data are linear.)
4. Define, evaluate, graph and analyze exponential functions, and solve exponential equations. (The analysis will include finding input/output values, using growth/decay rates, and determining if data are exponential.)

5. Define, evaluate, graph and analyze logarithmic functions, and solve logarithmic equations. (The analysis will include finding input/output values, comparing inputs/outputs of logarithmic scales using ratios, and using properties of logarithms to evaluate functions and solve equations.)
6. Define, evaluate, graph and analyze power functions, and solve power equations. (The analysis will include finding input/output values, and determining concavity.)
7. Define, evaluate, graph and analyze polynomial and piece-wise polynomial functions, and solve polynomial equations. (The analysis will include finding input/output values, finding zeros, and optimization.)
8. Perform operations on functions such as transformations, compositions and inversions.
9. Solve polynomial inequalities.

General Education Mathematics Outcome and Assessment Results

Analyze situations symbolically and quantitatively in order to make decisions and solve problems

All of the course objectives that meet the General Education Mathematics Outcome. As the final exam contains at least one problem from each objective I have used the final to assess the general education mathematics outcome.

The General Education Mathematics Outcome assessment result is as follows: The **average** on the final exam from this section was **80.4%** as compared to 77.4% in all sections of MATH 111.

The score on the General Education Quiz out of all MATH 111 courses was 1.54 out of 3 which is between Moderate and Proficient. (The data I have available does not separate out the 111 course I taught from others.)

Student Self-Assessment Matrix

The students were asked to rank their comprehension of each of the objectives on a 4 point scale, both before and after the class. These students ranked themselves quite high coming into the course.

Self Assessment	1	2	3	4	5	6	7	8	9
Before	2.6	2.6	3.3	2.7	1.8	2.5	2.8	2.6	2.4
After	3.6	3.5	3.8	3.7	3.3	3.6	3.7	3.4	3.6

Course Success Rate

The following table shows the distribution of grades that reflect the success rate of the students in the above named course.

MATH 111.003 College Algebra				
Number of students	**A to C**	**C- to D-**	**F/W/N**	**I**
35	30 (85.7%)	2 (5.7%)	3 (8.6%)	

Summary: All objectives were met.

Action: No new action.

Follow-up to prior offerings: My last offering of this course was in the Spring of 2016. My action was to have several quizzes and activities over logarithms before the exam. I made this change and the success on that objective was very good.

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School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Example minutes including TQF discussion**
This documentation is relevant to Question number:	**11**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Provides examples of School discussions regarding TQFs**

Mathematics and Computer Science
Wednesday, April 25, 2018
Minutes

Present: Kimberly Muller, Robert Kipka, Collette Coullard, Christopher Smith, Evan Schemm, George Voutsadakis, Grace Ngunkeng, Brian Snyder, and Colleen Barr

Absent: Lorraine Gregory (teaching) and Kathleen Kalata

Dr. Myton informed Kimberly that his teaching certificate he submitted as evidence of his teaching qualification for MATH 088 is a secondary mathematics certification not an elementary mathematics certification. With this new information, a motion was made by Chris Smith to accept Dr. Myton's TQF to include MATH 088, second by Rob Kipka. YES-6, NO-0, ABSENT-2, ABSTAIN-2.

Kimberly shared Dr. Myton's view that the mathematics qualification table could be changed now if the mathematics and computer science faculty wished. George will develop the changes and submit to faculty for fall implementation.

Dr. Myton summer tasks for MATH/CS.

1. Look at the programs and their objectives. These should be student centered – what the student will learn.
2. Kimberly is to identify a contact person for each program. This was completed as:
    a. AS in Internet Network Specialist — Evan Schemm
    b. BS in Mathematics — Robert Kipka
    c. BS in Elementary Education-Mathematics — Brian Snyder
    d. BS in Secondary Education –Mathematics — Brian Snyder
    e. BS in Computer Networking — Evan Schemm
    f. BS in Computer Networking/Web Develop — Evan Schemm
    g. BS in Computer Science — Chris Smith
    h. AS in Computer Science — Chris Smith
    i. AS in Web Development — Evan Schemm

Discussion on Lorraine Gregory's concern regarding CAEP with course SLO review. The mathematics education objectives need to match the CAEP objectives.

Course student learning outcomes will be reviewed by faculty who teach those courses with collaboration amongst faculty who teach the same course. Faculty will submit the list of all courses whose SLO's are acceptable to Colleen. Faculty will submit a list of courses to Kimberly whose SLO's have issues. A collection of these emails will be noted in the minutes.

Mathematics program learning outcomes were reviewed. Kimberly will develop a PLO for Professional Responsibility. George will develop a PLO for Analysis/Synthesis and also Evidence. Collette will develop a PLO for Communication. Course objectives should be able to be mapped to program learning outcomes.

Adjourned at 12:50pm
Submitted by Colleen Barr

Mathematics and Computer Science
Minutes
April 11, 2018

Present: Kimberly Muller, Evan Schemm, Robert Kipka, George Voutsadakis, Collette Coullard, Brian Snyder, Christopher Smith, Grace Ngunkeng, Colleen Barr

Absent: Lorraine Gregory (teaching), Kathleen Kalata

Motion by Brian Snyder to approve the minutes from March 28, 2018 and April 4, 2018 as presented, second by Grace Ngunkeng. Unanimous approval.

Motion by Evan Schemm to award a Franklin and Wanda Otis Scholarship to Sierra Jaqua in the amount of $600 and the Faculty of Mathematics and Computer Science Scholarship to Scott R. Smith (A00066416) in the amount of $1000. George Voutsadakis moved to amend Evan's motion to award a Franklin and Wanda Otis Scholarship to Scott R. Smith ($600) and the Faculty of Mathematics and Computer Science Scholarship to Lydia Harman ($1000), second by Christopher Smith.
Vote: YES-7, NO-0, ABSTAIN-1.

Motion by George Voutsadakis to award the two $1500 Gerald Samson Mathematics Scholarships to Daniel Foix and Connor Kintz, second by Evan Schemm. Vote: YES-8, NO-0, ABSTAIN-0.

Teaching Qualifications were reviewed.

- Motion by George Voutsadakis to approve three hours from Lorraine Gregory's dissertation to graduate hours of Mathematics and accept her teaching qualifications, second by Collette Coullard. YES-8, NO-0, ABSTAIN-0.
- Motion by Kimberly Muller to ask Steve Johnson for clearer justification of tested experience in his listing of qualifications to teach MATH 087, MATH 088, and MATH 102, second by Christopher Smith. YES-7, NO-0, ABSTAIN-1.
- Motion by Evan Schemm to approve Kathleen Kalata's qualifications to teach computer science courses as listed, second by Christopher Smith. YES-8, NO-0, ABSTAIN-0.
- Motion by George Voutsadakis to decline Paul Kelso's qualifications to teach Mathematics courses listed. George withdrew his motion. Christopher Smith moved to request more information and clarification from Paul Kelso of his qualifications to teach Mathematics courses listed, second by George Voutsadakis. YES-7, NO-0, ABSTAIN-1.
- Motion by Kimberly Muller to accept Robert Kipka's teaching qualifications as listed, second by Collette Coullard. YES-7, NO-0, ABSTAIN-1.
- Motion by Collette Coullard to accept Kimberly Muller's teaching qualifications as listed, second by Robert Kipka. YES-8, NO-0, ABSTAIN-0.
- Motion by George Voutsadakis to accept Grace Ngunkeng's teaching qualifications as listed, second by Collette Coullard. YES-8, NO-0, ABSTAIN-0.
- Motion by Robert Kipka to accept Mary O'Connor's qualifications to teach MATH 087, MATH 088, and MATH 102 as tested experience with possession of a teaching certification, second by Collette Coullard. YES-7, NO-0, ABSTAIN-1.
- Motion by Kimberly Muller to accept Evan Schemm's teaching qualifications as listed, second by Collette Coullard. YES-8, NO-0, ABSTAIN-0

Adjourned at 12:50
Submitted by Colleen Barr

Mathematics and Computer Science
Minutes
April 4, 2018

Present: Kimberly Muller, Evan Schemm, Robert Kipka, George Voutsadakis, Collette Coullard, Brian Snyder, Christopher Smith, Grace Ngunkeng, Colleen Barr

Absent: Lorraine Gregory (teaching), Kathleen Kalata

Motion by George Voutsadakis to award one of the Franklin and Wanda Otis scholarships for $600 to Brooke Leverton, second by Christopher Smith. Motion passed unanimously.

Motion by Evan Schemm to postpone awarding the remaining scholarships until donors have been contacted by Foundation to see if these awards can be amended to include computer networking majors, second by Kimberly. Vote: Yes-7, No-0, Abstain-1

Guidelines in determining teaching qualifications were discussed.

Adjourned at 12:50pm
Submitted by Colleen Barr

Mathematics and Computer Science
Minutes
March 28, 2018

Present: Kimberly Muller, Evan Schemm, Robert Kipka, George Voutsadakis, Collette Coullard, Brian Snyder, Christopher Smith, Grace Ngunkeng, Colleen Barr

Absent: Lorraine Gregory, Kathleen Kalata

Motion by Evan Schemm to approve the minutes from March 21, 2018, second by Christopher Smith. Unanimous approval.

Drop Anchor is on April 14th. Fall admits are invited to campus. The department showcase will be staffed by Chris, Rob, and Kimberly.

The Arts Center has inquired about using the glass display case in the CASET lobby. Faculty agreed that they would share the case with the Arts Center.

Summer tutor suggestions for the Learning Center are Jacob Cedolia, Mary Sonnabend, and Matt Zahara.

A science faculty member has asked to use one of the Mathematica licenses. Since there are only eight licenses, this appears to not be an option. Rob suggested they download SAGE which is free. Rob volunteered to give instructions on its use.

Motion by Evan Schemm to approve the addition of EDUC 101 to the Math Elementary and Secondary degrees, second by Collette Coullard. Unanimous approval.

Motion by George Voutsadakis to add CSCI 103 to the Mathematics and Mathematics Actuarial/Business degree, second by Collette Coullard. Unanimous approval.

Teaching Qualifications were reviewed.

- Motion by Evan Schemm, second by Rob Kipka to approve Collette Coullard's TQF as presented. YES 7, NO 0, ABSTAIN 1.
- Motion by Evan Schemm, second by Chris Smith to not approve Paige Gordier's qualifications to teach MATH 207 because it isn't clear that there are 18 hours of Mathematics course content. YES 5, NO 0, ABSTAIN 3.

Faculty will review the remaining TQFs and continue the approval process at the next meeting.

Math Search Update: Brian stated that all telephone interviews have been completed. The search committee will meet either on Friday, March 30th or Monday, April 2nd to determine which candidates will be invited to campus.

DFW grades discussion moved to next meeting.

Mini semester discussion moved to next meeting.

Adjourned at 12:50pm
Submitted by Colleen Barr

Mathematics and Computer Science
Minutes
Wednesday, February 28, 2018

Present: Evan Schemm, Katie Kalata, Collette Coullard, George Voutsadakis, Christopher Smith, Kimberly Muller, Brian Snyder, Robert Kipka, Grace Ngunkeng, Colleen Barr.

Absent: Lorraine Gregory (teaching)

Outstanding graduate awards as follows:

A motion to not award the Outstanding Associates in Computer Science Graduate award was made by Evan Schemm, second by Christopher Smith:
In Favor – 7
Oppose – 0
Abstain – 2

A motion by Evan Schemm nominating Joseph Sullivan as the Outstanding Computer Networking Graduate, second by Chris Smith.
Vote for Joseph Sullivan as Outstanding Computer Networking Graduate:
In Favor – 6
Oppose – 0
Abstain – 3

Motion by Evan Schemm nominating Wei Qian as the Outstanding Computer Science Graduate,second by Christopher Smith:
In Favor – 7
Oppose – 0
Abstain – 2

Motion by Brian Snyder nominating Michael Nicholson as the Outstanding Mathematics Graduate, second by Collette Coullard:
In Favor – 6
Oppose – 0
Abstain – 3

Motion by Collette Coullard to not award an Outstanding Mathematics Education Graduate award, second by Evan Schemm:
In Favor – 6
Oppose – 0
Abstain – 3

Completion of the Teaching Qualifications forms was discussed.

Kimberly is producing Alumni and Student Spotlights for the school webpage and to be used in email, text messages to admitted and current students. She asked those faculty who have information on current and past students to submit the information with pictures to her.

Kathleen Kalata will not be participating in the online teaching committee.

Motion to adjourn by Brian, second by Grace.
Adjourned at 12:50
Submitted by Colleen Barr

Mathematics and Computer Science
January 31, 2018

Present: Kimberly Muller, Evan Schemm, Brian Snyder, Collette Coulalrd, Robert Kipka, George Voutsadakis, Kathleen Kalata, Colleen Barr, Grace Ngunkeng (arrived at 12:10pm)
Guest: David Myton, Dean
Absent: Lorraine Gregory (teaching)

Motion by E Schemm to approve the minutes from 11/15/17 and 11/29/17. Seconded by C Smith. Unanimous approval.

F18 course schedules have been sent to Dr. Myton using E Schemm's scheduling program. Dr. Myton was given permission by E Schemm to use this scheduling program in other areas of the College.

K Muller is working on the S18 course schedules. Engineering has asked that Calculus I be taught this summer. They will poll their students for interest. Math faculty were asked to poll their MATH 102 and MATH 111 students to find interest in a MATH 131 offering this summer. C Collette will poll MATH 131 students to see if there's interest in Calculus I for summer.

Task group interest from Math/CS faculty:

- distance delivery – K Kalata
- graduate discussion – C Smith and G Ngunkeng
- room security and safety – K Muller (E Schemm will advise if needed)
- space utilization – G Ngunkeng
- budget – C Smith

Discussion about security and safety with passcards for labs

CS + X program – curriculum options working group will consist of C Smith, K Kalata, E Schemm, Greg Zimmerman (biology), Stephen Kolomyjec (biology), and possibly Steven Johnson (chemistry).

In the past, K Muller, as chair, has already mailed letters to admitted students and advisors have made personal contact with them. Currently, the schools have not been given admitted student lists so contact has not been made. Dr. Myton informed the group that this discussion has been had at the Provost Council. Dr. Finley will contact Admissions to find out the contact process and expectations for contact by schools. Dr. Myton will inform the group of the process.

Orientation will be held within a short period in June. K Muller said there will be a lot of work in developing student schedules within this short period of time. Also, there will not be any school chairs for summer questioning who will be overseeing orientation in the school.

K. Muller stated there needs to be a better list of math adjuncts so if faculty have names of anyone who could teach MATH 087 and 088, to pass them on to her.

K Muller will be writing two advertisements for adjuncts, one for developmental math and one for more advanced math to be posted on the Human Resources employment site.

E Schemm wanted to know who to send information to if a student is not attending classes. He was informed if it is an academic issue, to send the information to Bobbie Kyle in the FCT, and if it's anything other than academics, to send the information to Sharmay Wood in Student Life.

Faculty transcripts are in the Provost Office. C Barr was instructed to pick these up and distribute to faculty to help with their completion of the teaching qualifications form.

K Muller asked Dr. Myton for a copy of the older TQF that had been completed. Dr Myton said older TQFs are in ARGOS and a report can be run to produce this information.

G Voutsadakis stated that school faculty had given teaching qualification information to Donna Fiebelkorn last semester. Dr. Myton will ask D Fiebelkorn for this matrix.

Dr. Myton – things that are coming are program goals development and program reviews at the college level.

E Schemm motion to adjourn, second by B Snyder.

Adjourned at 12:50pm

Submitted by C Barr

School of Mathematics and Computer Science
Meeting, Wednesday, September 13, 2017

Minutes:

Present: Kimberly Muller, Evan Schemm, Christopher Smith, Lorraine Gregory, Robert Kipka, Kathleen Kalata, George Voutsadakis, Grace Ngunkeng, Brian Snyder, Colleen Barr

Absent: Collette Coullard

1. Approval of Minutes – Motion was made by Brian to approve the minutes from September 6th with the addition of attendees, seconded by Lorraine. The vote was unanimous.
2. Kimberly stated there is not an approved school budget yet. She was asked by Dean Fiebelkorn to encourage all to be frugal with making copies.
3. Minors – The Math minor currently requires 22 credit hours of mathematics. Engineering students need 18 hours of mathematics for their degree. George moved to lower the Mathematics minor credit hours to 21, seconded by Lorraine. Discussion. The vote was unanimous. Kimberly will submit the necessary curriculum paperwork.
4. PAW Weights – Rob and Grace will be completing their PAW evaluations this year.
    a. Rob requested his weights be set at: 65% Teaching, 5% Advising, 10% Service, 20% Scholarly and Creative Activity. Evan moved to approve, Chris seconded. Unanimous approval
    b. Grace requested her weights be set at: 65% Teaching, 10% Advising, 10% Service, 15% Scholarly and Creative Activity. Evan moved to approve, seconded by Chris. Unanimous approval.
5. Early Alert – Faculty were asked to pass along the names of students who are not attending classes to Bobbie Kyle in the Academic Success Center and the names of those students who are having issues with student life to Sharmay Wood. Bobbie and Sharmay will be coordinating student contact.
6. Field Day – Most of the abstracts have been received by faculty. Charter schools in the UP and Northern Lower Peninsula have been invited. Chris volunteered to create a form for the students to choose the presentations they would like to attend.
7. Faculty Qualifications – Kimberly will meet with Dean Fiebelkorn to clarify how this will be completed.
8. Other Business – Grace shared a confrontation between two students in her class. Grace was advised to contact Bobbie Kyle and cc Kimberly.
   Kimberly put a rough draft of the spring 2018 schedule in faculty mailboxes. She asked faculty to review for errors and/or conflicts.
   George stated that the General Education committee will be asking for a plan from the schools to assess the university learning outcomes.

School of Mathematics and Computer Science

Meeting, September 6, 2017

Present: Kimberly Muller, Evan Schemm, Christopher Smith, Lorraine Gregory, Robert Kipka, Kathleen Kalata, George Voutsadakis, Grace Ngunkeng, Brian Snyder, Collette Coullard

Minutes

1. Approval of Minutes—Two corrections were made to the minutes. Evan made a motion to approve the minutes with those corrections, Chris seconded. The vote was unanimous.
2. Kimberly reminded faculty to set PAW weights before the next meeting. She was asked to find out who was undergoing evaluation and when last year's evaluations would be complete.
3. Early Alert—Kimberly asked that all faculty continue to send names of students who may be in danger of failing due to non-attendance or other concerns. She also informed faculty that a procedure for following through with these names was in development.
4. Math General Education Outcome—The results of last year's general education outcome were discussed. Faculty decided to leave all of the data, including developmental classes, in the report but to remove section numbers. As an action, faculty chose to collect more data in upcoming semesters before acting further. George said he would write up the results with a comparison between pre-general education courses, pre-calculus courses and calculus courses and send them to the General Education Committee.
5. Field Day—Evan and Brian said they still had abstracts to submit. Behavior of students at last year's event was discussed. Kimberly said she would speak with Kevin about possible solutions.
6. Faculty Qualifications—Kimberly informed the faculty that Donna would be sending a document of course qualifications for faculty to complete. Kimberly was asked to determine if the document would contain all subjects or just those in our schools.
7. Program/Course Objectives—Kimberly asked faculty to review the document of course objectives that was sent via email from Colleen. The objectives should all be student focused and measurable.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Mathematics Elementary and Secondary Teaching 2016 Program Review**
This documentation is relevant to Question number:	**12**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Provides information about these programs using a prior program review format.**

Bachelor of Science in Mathematics Secondary Teaching and Bachelor of Science in Mathematics Elementary Teaching Program Reviews

Submitted By: Dr. Kimberly Muller, Chair, School of Mathematics and Computer Science

Date Submitted: August 9, 2016

1. **Mission/Vision**

The Bachelor of Science in Mathematics Secondary Teaching and the Bachelor of Science in Mathematics Elementary Teaching are programs of the School of Mathematics and Computer Science. Throughout this document we will refer to the Bachelor of Science in Mathematics Secondary Teaching degree as M-ST and the Bachelor of Science in Mathematics Elementary Teaching degree as M-ET. The M-ST and M-ET programs have been in place since 1994. Historically, LSSU had a similar program to the M-ST program from 1971 to 1981. You can find a partial history of the program up to 2004 (with some additional narrative and revisions made in 2006) at http://math.lssu.edu/prpe. In addition, this webpage has information on the content standards, pass rates of the accreditation examination up until 2004 and a detailed program philosophy.

An attempt was made initially to create two separate program reviews for these two programs, but after writing several pages of each, it was found that programs were so similar that the two documents were in many sections nearly identical. After the Chair's consultations with Associate Provost Myton and Dean Fiebelkorn on June 20, 2016, it was decided to create one document. Where there are large differences, these will be noted. If a difference is minor a subscript of ST or ET will be used.

The current program objectives for the two programs were developed in 2009 under the leadership of Professor Sherry Duesing. The objectives for the two programs are identical.

Program Objectives

Upon completion of a Bachelor of Science degree in mathematics: secondary teaching (or elementary teaching), from Lake Superior State University, students will be able to:

1. Demonstrate a fundamental and foundational knowledge of mathematics by developing quantitative and abstract reasoning skills in order to build a conceptual understanding of logical structures and axiomatic systems.
2. Demonstrate technical mathematical skills in the areas of algebra, geometry, calculus, and statistics for solving problems.
3. Use their knowledge of the historical background of mathematics in enriching their own lives and the lives of their future students.
4. Use software and other technology to solve problems.
5. Use their acquired skills in the pursuit of a job and/or graduate school.
6. Create mathematical models and use their mathematical and analytical skills to solve real-world problems.
7. Continue to acquire new knowledge for life-long learning in pursuit of their professional and personal goals.
8. Communicate mathematically in their profession and the broader community.
9. Make connections of mathematical ideas to other ideas both inside of and outside of mathematics.

The similarity between the two degrees is largely due to the similarity to the "Content Guidelines/Standards" matrices for the two certification programs that were instituted by the Michigan State Board of Education in 2000. The State of Michigan guidelines can be found at http://www.michigan.gov/mde/0,4615,7-140-5683_6368-24835--,00.html while our specific program matrices can be found on the website http://math.lssu.edu/prpe. The course mappings in the matrices were created by professors, Sherry Duesing, Lorraine Gregory and Brian Snyder in 2006. There are very few differences between the K-8 and 7-12 Mathematics subject areas and both lead to the Mathematics (EX) endorsement. The test objectives for the certification exams (Michigan Test for Teacher Certification – MTTC) can be found at http://www.mttc.nesinc.com/MI_viewFW_opener.asp. There are some specific content differences due to the grade level of the students.

LSSU Mission Statement

Our mission at Lake Superior State University is to help students develop their full potential. We launch students on paths to rewarding careers and productive, satisfying lives. We serve the regional, state, national and global communities by contributing to the growth, dissemination, and application of knowledge.

Our mathematics programs for future elementary and secondary teachers introduce students to a broad range of both pure and applied mathematics, as well as both continuous and discrete, throughout their four years of study. The M-ET degree

also provides those students with the foundational knowledge required of all elementary education majors. The topics are aligned with the Michigan State Board of Education content guidelines as illustrated by the Program Review done in 2006. In the M-ST degree we've had a 100% placement rate for students in this program over the last five years. In the last two years we've had students who graduated in December obtain mid-year full-time employment in the field. For the M-ET, degree we've had very few students over the last five years, but those who graduated had immediate career placement. (For more information see sections 3 and 4 on "Demand" and "Quality".) Because of our emphasis very early in MATH 103_{ET}, MATH 104_{ET}, MATH 215 and MATH 216_{ST} on inquiry-based, student-centered learning and our requirement of passing the licensure exam (MTTC) and student teaching before graduation, our graduates exit LSSU with the ability to both think independently and communicate their ideas effectively. As teachers, our graduates join a workforce that has dissemination as its primary goal.

LSSU Vision Statement

Our programs grow and evolve in ways that keep our graduates at the cutting edge of technological and societal advances. As such, we will be viewed by our constituents as:

- The preferred regional choice for students who seek a quality education which provides a competitive edge in an evolving job market.
- An institution where relevant concepts are taught by quality faculty, and are paired with practical real-world experience to provide a well-rounded education.
- An institution which capitalizes on its location to instill graduates with an understanding of environmental issues and an overarching desire to be responsible stewards of the environment.
- A University that is highly student centered and empowers all students to realize their highest individual potential.

Our program also supports the University Vision in several different ways. One of our program outcomes is that graduates should be able to "use software and other technology to solve problems". Several of our classes support this outcome including Elementary Statistics, Linear Algebra, College Geometry, Mathematical Modeling and Principles of Programming. As for quality faculty, except in rare cases, all of our program courses are taught by faculty who hold a doctorate in a field of pure or applied mathematics, statistics or mathematics education. The rare exceptions include courses where there is a co-teacher with a terminal degree in a related field, such as engineering. All of these faculty members have publications in their respective fields, one had a previous successful career at a tier one university, one has had prior K-12 experience, one has had more than 50 publications since coming to LSSU, two have received teaching awards, and one has co-authored a textbook in his field. Another program outcome is for successful graduates to "create mathematical models and use their mathematical and analytical skills to solve real-world problems." Many of our courses have course objectives tied to this program outcome, including MATH 103_{ET}, 104_{ET}, 151, 152, 207, 251_{ST}, 310_{ST}, and 401_{ST}. In particular, in the M-ST program, MATH 401 has a class project where the students work together to solve a current problem. In 2016 their class project was to design a mathematical model that would specifically help LSSU. One of our greatest areas of strength is the individual attention that our students receive. All of our classes are small with 30 or fewer students. When one compares this with larger state universities, which have large lecture classes for first year students, we are able to provide a uniquely student-centered atmosphere in the classroom. Our introductory proof sequence has 15 or fewer students and is typically taught using inquiry based learning. This is a very student-centered approach where students present the material to each other. In MATH 325, the students work in groups though activities both in the classroom and in the computer lab to form conjectures and build their own axiomatic system. For the elementary education students, MATH103 and 104 are taught using problem-based learning rather than direct instruction. Our program was the preferred regional choice in M-ST for many years. In fact, a large percentage of the area middle school and high school mathematics teachers are LSSU graduates. In 2011-2012, the teacher education programs at LSSU were placed on probation by the Michigan Department of Education. At the time our M-ST and M-ET pass rates had been between 89% (due to one student) and 100% for many years, but our programs took a large hit in enrollment that year and saw continued declines. While we don't think we can claim the status of preferred regional choice currently, our students have had an outstanding record on the certification exam and in job placement for many years. This would be an excellent area to promote as a program of distinction.

Several areas of the Strategic Plan are supported by our program. Some of these are emerging and others are more established.

2.1 LSSU will increase enrollment. For the last two years we have offered a Field Day experience for area high school students where we introduced students to topics in mathematics and computer science using hands-on activities. We also contacted admitted students after they were accepted, made new brochures and power point slides for our programs, increased the visibility of our Pi Day activities and saw a large increase in admitted students for this program. Last year there were 10 admits to these programs compared to 0 the year before and one the previous year. Sadly, this year we have seen a reversal of that trend.

2.5 LSSU will graduate students who have had an exceptionally good university experience. The one-on-one attention that our graduates receive gives them a chance to exceed beyond expectations. Students learn from instructors with a variety of experiences, including K-12 teaching experience and others involved in teacher professional development. They become involved in the content using inquiry based learning and problem solving, not just listening to lectures. Students are prepared for the classroom by extensive field experience and student teaching opportunities.
4.1 LSSU will increase high-impact educational experiences in BS/BA degree programs. Our students learn using inquiry-based learning and problem solving. Our students complete projects in MATH 207, MATH 321, MATH 325, MATH 341_{ST}. They have several hands-on classroom experiences, as well as student teaching.
4.3 LSSU will improve the tracking process of graduate success. We have been tracking our graduates' placements three months after graduation since 2012 and have increased efforts to track them later.
4.5 LSSU will prepare graduates who are ready for professional certifications or licensure. Our students are prepared to take MTTC certification exam since the course work required in the programs correlates to the objectives for the licensure exams (MTTC). The current pass-rate for the secondary and elementary exam in 100% for those majoring (not minoring) in these areas.
4.6 LSSU will increase the number of students participating in professional conferences and workshops. Several of our students have attended Math Teachers' Circle meetings. Three students attended the Michigan Council of Teachers of Mathematics conference July 2015.
6.1 LSSU will define assessment and engage in meaningful, institutionalized assessment activities. Our school has been doing course assessment with well-established objectives for many years. Our program assessment has improved greatly over the last four years.
6.2 LSSU will utilize appropriate and developing technology to facilitate effective and enriched learning experiences across the campus community. This is an area in which we excel. In fact we purchased and used many technologies such as i-Pads, tablets and document cameras before they were more widely available across campus. We also use many educational and commercial software packages in our courses to enhance student understanding of difficult mathematical concepts.

There are several areas that distinguish these programs from our main competitors in the state. One is the small class size, especially at the calculus level. A second is the number of courses that have opportunities for the students to present the material that they are learning to their peers, giving them ample opportunities to practice communicating mathematics before they begin their student teaching. Also, the fact that our program is housed in the mathematics department (as opposed to education) provides a level of mathematical rigor that facilitates a deeper understanding of the core content areas.

2. Productivity

The faculty and adjuncts in mathematics teach a large percentage of classes that are not required by our majors. Because all of the faculty teach courses that are both in the program and out of the program, gauging productivity can be difficult. Because of this we have tried to use several different measures. First, we will take a look at instructional load for courses with the MATH prefix. This includes developmental courses (MATH 087, MATH 088, MATH 102) and general education courses (MATH 110, MATH 111, MATH 131, MATH 207). Of these general education courses only MATH 207 is required in these programs. There is also a course that is taught as service to business and science (MATH 112), courses only required by the Elementary Education and M-ET programs (MATH 103 and MATH 104) and courses that are filled by a variety of majors including Mathematics, M-ET, M-ST, Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering and Physical Science (MATH 151, MATH 152, MATH 251_{ST}, MATH 310_{ST}). The only courses in these programs under review that are not included in other non-teaching programs are MATH 321 and MATH 325. Using data from two consecutive academic years (2014-2015 and 2015-2016) the mathematics faculty load can be broken down as follows:

- Developmental—25.7%
- General Education—36.1%
- Service to business and science—7.3%
- Courses only required for all Elementary Education majors and **M-ET**—3.0%
- **M-ST and M-ET Only**—1.4%
- **M-ST and M-ET** with Heavy Service—18.6%
- B.S. in Mathematics and **M-ST** Only—2.7%
- B.S. in Mathematics, **M-ET and M-ST**—2.1%
- B.S. in Mathematics Only—3.2%

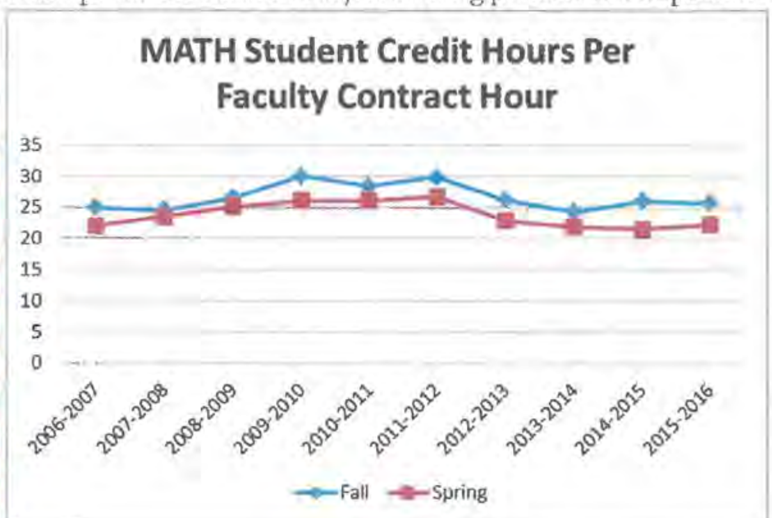
Only 1.4% of our mathematics faculty instructional load is used exclusively for these two programs. That is approximately 3.2 load hours per year. Additionally, only 4.8% of the load is used by this program without also being required for general education or engineering which significantly increases the student credit hour/load hour ratio for those courses. This represents 10.5 load hours per year for these programs, along with the B.S in Mathematics. (This file is in tracdat.) Note

that none of the courses used for the M-ET program are exclusive to that program. In correspondence with Dean Fiebelkorn about whether or not this program should be deleted for low enrollment, one of the reasons she gave for keeping this program was, "Provided we keep the elementary math minor, the elementary education program period, and the secondary math major, then there are no unique courses that are offered only for the elementary math major."

A second measure of productivity is from Professor Collette Coullard's Spring 2015-2016 Cost-Revenue Analysis. In her analysis, based on classroom discussions with Associate Provost David Myton and Interim Vice President of Finance Morrie Walworth, she took into consideration tuition, state funding, the tuition plateau, discounted tuition, State of Michigan Contributions, auxiliary funds, faculty salary, faculty benefits and 50% overhead. The Cost-Revenue analysis for those instructors who predominantly teach mathematics courses was a net revenue of $951,887 and for the department as a whole was $1,111,013. In the discussions during Professor Coullard's presentation of her class's research, President Pleger mentioned that one measure of cost effectiveness would be whether or not each faculty member's revenue from student credit hours to instructional load (taking into consideration all of the above variables) made a profit. Each mathematics faculty member does so according to this analysis.

Along those same lines, a third measure of productivity would be the ratio of student credit hours to faculty contract hour. The following table tracks data from 2006-2016. The numbers in blue represent the ratio of student credit hours to faculty contract hours in the Fall and the numbers highlighted in red are from Spring. The average of the Fall ratios is 26.6 with a standard deviation of 2.0 and the average of the Spring ratios is 23.9 with a standard deviation of 1.9. Even though there has been some fluctuation, an attempt has been made to adjust offering patterns to compensate for enrollment declines.

Term	Student Credit Hours	Faculty Contract Hours	Student Credit Hours Per Faculty Contract Hour
Fall 2006	2881	115.66	24.91
Spring 2007	2091	94.66	22.09
Fall 2007	2893	117.66	24.59
Spring 2008	2294	97.66	23.49
Fall 2008	3173	119.66	26.52
Spring 2009	2612	103.66	25.20
Fall 2009	3202	106.70	30.01
Spring 2010	2406	91.96	26.16
Fall 2010	3263	114.96	28.38
Spring 2011	2671	101.96	26.20
Fall 2011	3301	110.66	29.83
Spring 2012	2691	100.63	26.74
Fall 2012	2974	113.63	26.17
Spring 2013	2324	101.23	22.96
Fall 2013	2845	117.26	24.26
Spring 2014	2143	97.63	21.95
Fall 2014	2747	105.63	26.01
Spring 2015	2182	101.13	21.58
Fall 2015	2659	103.33	25.73
Spring 2016	1997	89.63	22.28



Divisions (As Defined in the Load Report Summary)	Instructional Load	Total Contract Hours	Student Credit Hours	Student Credit Hours per Instructional Load	Rank of SCH per ILH	Student Credit Hour per Contract Hour	Rank of SCH per CH
Business Fall	158.36	163.364	2870				
Business Spring	149.09	155.091	2951	18.933	4	18.279	4
CJFS Fall	108.844	109.8439	2459				
CJFS Spring	111.426	108.844	2718.59	23.506	2	23.676	2
Education Fall	60.197	72.1967	635				
Education Spring	64.906	72.6561	532	9.3283	11	8.0565	11
Engineering Fall	128.455	136.475	**1413.55**				
Engineering Spring	152.003	154.39	1306.44	9.6984	10	9.3514	9
EMS Fall	20.488	20.488	290				
EMS Spring	26	26	205	10.648	8	10.648	8
A & L Fall	233.676	251.671	4181				
A & L Spring	201.95	218.952	3135	16.794	5	15.545	5
Lib Arts Fall	5.333	12.0033	56				
Career Develop Spring	3.6667	11.9967	20	8.4447	12	3.1667	12
MathCS Fall	155.67	159.333	3532				
MathCS Spring	141.9	144.9	2638	20.735	3	20.281	3
Nursing Fall	210.1	228.067	1913.61				
Nursing Spring	126.23	144.227	1454.6	10.015	9	9.0472	10
PS_CBS Fall	163.7	166.704	4672.9				
PS_CBS Spring	184.45	187.445	5291	28.62	1	28.135	1
RSES Fall	97.1627	106.1597	1150				
RSES Spring	99.198	108.198	1146	11.693	7	10.711	7
Sciences Fall	309.11	338.109	3870				
Sciences Spring	327.38	354.38	5217.66	14.278	6	13.123	6

A fourth measure is the next comparison, to the left, with other academic areas (as separated by the load report summary on the O:\ drive). It was made using the summary for 2015-2016. Because of our heavy service load our ratio of student credit hours per faculty instructional load hours is the 3rd highest division on campus and our ratio of student credit hour per faculty contract hour is also the 3rd highest division on campus. (Instructional load does not include release time and Faculty Contract Hours do. Some areas receive a larger percentage of release time than others.) This data deals with instructional load.

A shortcoming of the above measures is that they show that the faculty members who teach courses in these programs are productive, but they don't show specifically what is happening in the program courses. The next table is an attempt to track course enrollment numbers for the program courses. The courses with bold yellow font have undergone changes to their course offering pattern in the last few years in order to either save money or make the course load easier on students taking multiple mathematics courses.

			Total Enrollment in Courses						
M-ET or M-ST	COURSE	TITLE	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
M-ET	MATH103	Number Sys/Prob Solv Elem Teac	32	20	12	12	24		9
M-ET	MATH104	Geometry/Measurement Elem Teac	32	29	18	18	12	8	8
M-ET, M-ST	MATH151	Calculus I	83	92	97	103	89	59	69
M-ET, M-ST	MATH152	Calculus II	46	54	57	57	67	59	61
M-ET, M-ST	MATH207	Prin of Statistical Methods	220	253	295	268	243	197	192
M-ET, M-ST	MATH215	Fund Concepts of Mathematics	18	25	19	20	19	6	7
M-ST	MATH216	Discrete Math/Problem Solving	14	8	11	11	6	5	5
M-ST	MATH251	Calculus III	39	31	42	24	24	44	47
M-ET, M-ST	MATH305	Linear Algebra	22		9		7		12
M-ST	MATH310	Differential Equations	37	35	38	23	30	39	30
M-ET, M-ST	**MATH321**	**History of Mathematics**	**13**	**20**	**13**	**5**	**9**	**5**	
M-ET, M-ST	**MATH325**	**College Geometry**	**9**		**7**		**5**	**7**	
M-ST	MATH341	Abstract Algebra I		15		8		10	
M-ST	**MATH401**	**Mathematical Modeling**		**16**		**14**	**8**		**8**
M-ET, M-ST	EDSE301	Intro to Special Education				5	9	4	8
M-ET, M-ST (Prior to Fall 2012)	EDUC150	Reflections Learning Teaching	55	64	48				
M-ET, M-ST	EDUC250	Student Diversity and Schools	50	61	43	17	21	17	15
M-ET, M-ST	EDUC301	Educ Psych & Learning Theory	40	42	20	22	15	11	10
M-ET	EDUC330	Reading Elementary Classroom	27	19	13	9	10	4	8
M-ET, M-ST	EDUC350	Int Tech 21st Century Lrn Env					0	11	9
M-ET	EDUC410	Corrective Reading Classroom	28	23	13	6	11	3	7
M-ET	EDUC411	Elem Lang Arts/Literacy Skills	21	26	13	11	14	4	5
M-ST	EDUC415	General Instructional Methods						11	8
M-ET	EDUC420	Math Methods Elem Teachers	27	24	17	6	12	3	7
M-ET	EDUC421	Science Methods Elem Teachers	26	26	15	7	9		8
M-ET	EDUC422	Soc Studies Meth Elem Teachers	27	28	12	9	5	2	5
M-ET	EDUC423	Art Methods-Classroom Teachers				13	15	11	13
M-ET	EDUC424	Hlth/Phy Ed Meth Cl Room Teach				9	12	5	10
M-ST	EDUC431	The Secondary Learner	18	15	20	7			
M-ST	EDUC440	Reading in the Content Area	19	21	22	7	8	6	3
M-ST	**EDUC442**	**Math Methods Secondary Teache**	**10**	**0**	**11**				
M-ST	**EDUC452**	**Dir St Math Meth Sec Teachers**					**1**	**4**	**1**
M-ST	EDUC460	Classroom Management						6	8
M-ET, M-ST	EDUC480	Directed Teaching Seminar	37	28	35	34	17	15	6
M-ET, M-ST	EDUC492	Directed Teaching	37	28	35	34	17	15	6

M-ET and B.S. in Elementary Education	64	49	30	30	36	8	17
M-ET, M-ST, Service and General Education	220	253	295	268	243	197	192
M-ET and M-ST Only	32	20	31	5	15	16	1
M-ET and/or MST with Large Service Component	205	212	234	207	210	201	207
M-ST and/or M-ET, with B.S. in Mathematics	54	64	39	53	40	21	32
M-ST and/or M-ET, with other Education Degree	412	405	306	196	175	128	136

The other enrollment numbers come from the following general education or program requirements. The following courses are specifically required by other majors (than M-ET or M-ST).

MATH 103 & MATH 104—Elementary Education

MATH 207—General Education, Athletic Training, Biochemistry, Computer Networking, Computer Science, Criminal Justice (Corrections, Criminalistics, Generalist, Homeland Security, Law Enforcement, Loss Control, Public Safety), Electrical Engineering Technology, Environmental Science, Exercise Science, Fire Science, Forensic Chemistry, Geology, Industrial Technology, Manufacturing Engineering Technology, Medical Laboratory Science, Nursing, Parks and Recreation, Physical Science

MATH 151 & MATH 152—Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mathematics, Mechanical Engineering, Physical Science

MATH 251, MATH 310—Computer Engineering, Electrical Engineering, Mathematics, Mechanical Engineering

Other than the courses in dark green, all other courses serve students in multiple majors. For those courses in dark green, two of them are alternate year offerings. This is only 6.3333 load hours over a two year period. Students have a choice between EDUC 442 and EDUC 452, but only EDUC 452 has been offered in recent years because it can be prorated. Our programs have very few expenses that are program specific. The needed software licenses, computers, instructional technologies and paper usage are more than covered by our course fees. It would seem the costs to the university are minimal, especially considering our large service role.

The following table shows the 10-year enrollment data for these two programs. Also included are the enrollments in the Bachelor of Science in Mathematics degree because 10 of the required courses for that program are also in the M-ST program.) We have included the minors because these students contribute to the enrollment in the courses.

	Bachelor of Science in Mathematics Elementary Teaching	Bachelor of Science in Mathematics Secondary Teaching	Bachelor of Science in Mathematics	Minor in Mathematics Elementary Teaching	Minor in Mathematics Secondary Teaching	Minors in Mathematics
Fall 2006	1	13	10	25	3	13
Fall 2007	0	13	8	17	2	11
Fall 2008	3	14	8	15	4	6
Fall 2009	3	12	9	13	3	7
Fall 2010	3	16	13	17	2	5
Fall 2011	0	19	11	14	2	4
Fall 2012	2	12	14	23	6	8
Fall 2013	0	9	12	12	8	14
Fall 2014	1	9	11	9	4	8
Fall 2015	2	10	11	2	3	15

As you can see by looking at the "Fall 2012" line, the fact that the education programs at LSSU were put on probation in 2012 impacted the enrollment in our programs and we have yet to recover. It is concerning that the majors dropped precipitously, but it is equally concerning that the Minor in Mathematics Elementary Teaching did as well. Since most of the courses overlap, our course enrollment and course offering patterns have been impacted. As noted earlier, prior to that year, these were regional programs of choice. We should consider ways that we can return the numbers to their prior levels. We believe that one of the best ways would be to advertise our high pass rates on the MTTC exam.

To be consistent with last year's B.S. in Mathematics program review an attempt was made to use the Ipeds database from the National Center for Educational Statistics to compare our enrollment with the 15 public universities in Michigan but in Ipeds, the data for all education majors was combined in one total and we were unable to separate by discipline.

The table to the right shows degree conferral. The table contains M-ET, M-ST and the B.S. in Mathematics because before 2009, the institutional data was combined for some of these programs. We've separated out the data in those years using Anchor Access and commencement programs, but if you do your own report in Argos, it will combine some of the data.

Academic Year	Bachelor of Science in Mathematics Elementary Teaching	Bachelor of Science in Mathematics Secondary Teaching	Bachelor of Science in Mathematics	Total
2006-2007		2	4	6
2007-2008		3	3	6
2008-2009	1	3	3	7
2009-2010		1	1	2
2010-2011	1	1	4	6
2011-2012		5	2	7
2012-2013		3	3	6
2013-2014			2	2
2014-2015		2	3	5
2015-2016		2	1	3

On a national level, data is collected every decade. According to the Conference Board of Mathematical Sciences 2010 survey at http://www.ams.org/profession/data/cbms-survey/cbms2010, there were a total of 3,614 degrees in mathematics education awarded in 2009-2010. (This is the last year that data is available.) There were 2774 four-year institutions in that

year, giving an **average of 1.3 related mathematics education degrees per four year institution.** (One commercial website seems to indicate that only around 1700 of these have programs in mathematics education bringing the ratio to 2.1, but we were not able to verify this number on a more dependable public site.) Our total degrees awarded for those programs is typically around 2, making us only slightly higher (or lower) than average.

Using Argos to estimate the terms to graduation for these two programs, the average was 9.09 terms for majors in this program over the period from 2009-2014 and 8.30 for LSSU graduates as a whole (more recent data appears to be unavailable in Argos). Since these students need student teaching in order to graduate, this difference is not surprising. In a 2014 report from Al Case in Admissions, the overall FTIC retention rate from Fall 2010-2014 at LSSU was 70.40% and for the M-ST degree it was 83.30%. (No number was provided for M-ET and this report is not available in Argos. We made an attempt to obtain more recent numbers from Annette Hackbarth-Onson in Admissions who referred us to Vice President Morrie Walworth. At the time of this writing, no new data has been made available.)

3. Internal and External Program Demand

External Demand:

Mathematics is a high need area for high school and middle school math teachers. According to the Occupational Outlook Handbook of the Bureau of Labor Statistics there will be a growth of 6% in the demand for high school and middle school teachers from 2014-2024.

According to the National Center for Educational Statistics, 15% of secondary level teachers are Mathematics teachers. Just less than 2% of elementary teachers focus on mathematics while 62% teach several subjects, including mathematics. (Source: https://nces.ed.gov/programs/digest/d13/tables/dt13_209.10.asp, accessed June 28, 2016). The Occupational Outlook Handbook (OOH), issued by the Bureau of Labor and Statistics, projects the job outlook for teachers in all disciplines to "grow about as fast as the average" between 2008 and 2018, an estimated 13% in ten years. Across the country, public interest in the school system is on the rise and the federal government has increased spending for education. The need for highly qualified teachers continues to expand.

A table published by the National Center for Educational Statistics provided information regarding the percentage distribution of public elementary and secondary schools with a teaching vacancy in selected teaching fields, by the school's reported level of difficulty in filling the vacancy, teaching field, and locale: 2011-12. The information regarding mathematics teachers was that the percentage of schools with vacancies was 20% nationwide of which 1.1% could not be filled 2012-13. This was the fourth highest vacancy rate listed. Source: http://nces.ed.gov/surveys/ruraled/tables/c.1.c.-1.asp

Both programs are approved by Michigan Department of Education (MDE) and are two of four possible majors available at LSSU for prospective teachers. In addition, the success of the mathematical education students has consistently remained good. We feel that the decline in enrollment has more to do with the problems caused by probation in 2011-2012 and less to do with demand. The students who have graduated in recent years have all either been employed immediately or had employment offers, but chose to pursue other opportunities.

Internal Demand:

Refer back to page 5 for programs that require the M-ST or M-ET program courses. The largest constituents outside of mathematics are:

- MATH 151 & MATH 152—Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering, Physical Science
- MATH 251, MATH 310—Computer Engineering, Electrical Engineering, Mechanical Engineering

The table and lists on that page best represent internal demand. Another indication of demand is the enrollment of minors in these areas. All students must now take mathematics as part of their general education classes. As a result of this and other programs' requirements, most of the students enrolled in mathematics courses are not students majoring in M-ST, M-ET or the Bachelor of Science in Mathematics.

4. Program Quality

Mathematics introduces students to formal reasoning and, as a result, contributes to development of qualitative and quantitative analytic skills. The math department in its service role, as well as a major department, is proud to have promoted, to continue to promote, and to improve those indispensable skills for the entire LSSU community and all LSSU

graduates. Over the years the department has recruited and retained strong mathematicians and mathematics educators as witnessed by their recent scientific and pedagogical output:

- Dr. Grace Ngunkeng has published 3 refereed articles in the past 3 years, has presented her work at the 2013 Joint Mathematics Meetings, and has attended 6 conferences in the past 3 years.
- Dr. Kimberly Muller has published 4 refereed articles and has presented her scholarly work at 15 meetings or workshops in the past 10 years.
- Dr. Lorraine Gregory has made 6 conference presentations in the past 10 years.
- Dr. Brian Snyder has coauthored a textbook, published 1 refereed article, and attended 9 conferences in the past 10 years.
- Dr. Collette Coullard has published 5 refereed articles and made 2 conference presentations in the past 10 years.
- Dr. George Voutsadakis has published 44 research articles and participated in 6 conferences in the past 10 years.

It has developed a regional reputation and has strongly contributed to outreach activities promoting mathematics and mathematics education and, thus, increased the University's visibility and service in the community. Some examples of our state and regional involvement are:

- Dr. Brian Snyder just finished a year as chair of the Michigan Section of the Mathematical Association of America,
- Dr. Collette Coullard, Dr. Lorraine Gregory and Dr. Kimberly Muller, serve on the Eastern Upper Peninsula Math and Science Center Advisory Board,
- Dr. Collette Coullard and Dr. Kimberly Muller serve on the planning committee for the Eastern Upper Peninsula Math Teachers' Circle,
- The School of Mathematics and Computer Science hosted the Michigan Section of the Mathematical Association of America's annual meeting in 2013,
- Dr. Lorraine Gregory, Dr. Kimberly Muller and Dr. Brian Snyder have taught professional development workshops in 4 different regions across the state,
- Dr. Lorraine Gregory has been involved in several professional development activities for K-12 teachers in the Upper Peninsula, and the state, the most recent being two preconference professional development for MCTM, July 2015,
- Dr. Lorraine Gregory has served as the VP for 4 year colleges for the Michigan Council of Teachers of Mathematics,
- The School of Mathematics and Computer Science has held two Field Day experiences for area high school students, an event we hope to repeat as an annual recruiting effort,
- The School of Mathematics and Computer Science holds an annual Pi Day and math bowl for area middle school and high school students.

Moreover, some of our majors have been among the highest GPA graduates and have been awarded University-wide distinctions, many with regular placement on the Dean's list and graduating cum laude, magna com laude or summa cum laude. Of the program's graduates over the last seven years, 42.9% graduated cum laude, 14.3% graduated magna cum laude, and 14.3% graduated summa cum laude. The average GPA was 3.56. Two have been awarded Faculty Association university-wide scholarships based on overall academic excellence.

Several graduates have established and continue to distinguish themselves in their professions. We are providing three examples below. In addition to the quotes that we have included, we are grateful to these graduates for providing valuable feedback that can be used to strengthen our programs. Please note that two of these graduates received mid-year placement when a district was in a bind to fill a vacant position. However, they were both asked to return the following year to the same placement because of their excellent work.

The first example is Andrew Doerr who graduated in December of 2014. Mr. Doerr was able to obtain a mid-year placement as a mathematics teacher and golf coach at Sacred Heart Academy in Mount Pleasant. When asked about his time here, he replied, "LSSU's Math Education program prepared me to teach a variety of classes. Going in to LSSU, I was not nearly as confident with the material that I was going to be teaching as I am now. The professors were there for me in and out of the classroom, and were always available for when I needed extra assistance. I am very appreciative of the professors and the people that I met at LSSU, and they definitely have had an impact on who I am today."

Chris Ogren, who graduated from the M-ST program in 2013, worked at Kalamzoo Central High School as a 9th grade math teacher from October 2013-August 2015. In the Fall of 2015 he returned to his hometown to teach at Escanaba High School as a Geometry and AP Statistics teacher. When asked about his time here, Mr. Ogren said "I feel that at Lake

Superior State, I received an education that taught me all of the math I will need for being a teacher. I learned to not only memorize the necessary math skills, but also to think like a mathematician. I believe that the math faculty at LSSU did a great job of breaking math down to its fundamentals, and then building up to the more complex ideas. The program had a great balance of classes that challenged me on multiple levels. I especially look back and appreciate the things I learned in Math 215, College Geometry, History of Math, and Math Modeling. Most of my math classes were helpful, but those 4 are the classes I find myself referencing to students in my everyday teaching."

One of our most recent graduates, Jessica Keilholtz, accepted a mid-year placement at the middle school in Cedarville after graduating in December of 2015. They asked her to return next fall and she has accepted the position. Ms. Keilholtz said, "my content knowledge was strong enough that my only worry was classroom management and I had enough people to have my back that I made it through alright." She also indicated that her student teaching position in Brimley taught her to "handle a lot of situations so I felt well prepared." She said that, "The class that helped me the most would be the college geometry class. Being able to define shapes and show how to create them using technology was very useful."

Through feedback from these students, one area where we could support them more is outside of the mathematical content area. For example Ms. Keilholtz relied on her new colleagues to teach her where to find educational resources. Finding new approaches to teaching difficult topics was sometimes a challenge for her. There are many websites that provide these educational resources and/or tips. This could perhaps be added to the Methods course or to a series of seminars.

The Mathematics Education program was originally approved by the Michigan Department of Education in 1998. It was reapproved in 2006. In 2012, 6 programs in education were suspended by the state of Michigan and others were discontinued. Mathematics was not one of these programs. While the pass rate for the suspended programs on the state licensure exams was low, the pass rate for mathematics has remained high, typically above 90% for secondary education and recently, 100%. This compares to the state pass rate for secondary mathematics of 96.5%. There have been too few elementary mathematics majors taking the test (3 or fewer). More specific data is in the Program Assessment section. Following the suspension of programs in 2012, the School of Education sought out and completed accreditation by the national accrediting body for schools of education – The Council for the Accreditation of Educator Preparation (CAEP). This was successfully granted in October 2013. The School of Education continues to succeed, with recent ratings from the Department of Education being among the highest in the state. (http://www.lssu.edu/education/ accessed June 29, 2016)

Our programs compare favorably in its depth and quality to other peer mathematics programs. Two important documents for comparing our programs to those of others are the **Curriculum Guide to Majors in Mathematical Sciences**, published in 2015 by the Mathematical Association of America's Committee on Undergraduate Programs in Mathematics (CUPM) and **The Mathematical Education of Teachers II, (METII)** published by the Conference Board of Mathematical Sciences in 2012.

In 2015 the CUPM released its new **Curriculum Guide to Majors in the Mathematical Sciences**. It has four cognitive recommendations and nine content recommendations for programs in mathematics. Since these recommendations are brand new, we were impressed with how well our programs already fit. We will list those goals and briefly explain how we meet them. In some cases, for the sake of brevity, the recommendations are linked to our program outcomes. The first set of recommendations is for general mathematics programs, but we highlight them in order to support our earlier claim, that the placement of our programs within the department of mathematics is an added strength to the quality and rigor of our program.

Cognitive Recommendation 1: Students should develop effective thinking and communication skills. Program Outcome 8.

Cognitive Recommendation 2: Students should learn to link applications and theory. Program Outcome 6.

Cognitive Recommendation 3: Students should learn to use technological tools. Program Outcome 4.

Cognitive Recommendation 4: Students should develop mathematical independence and experience open-ended inquiry. Program Outcome 7. Specifically our use of inquiry-based learning in multiple mathematics courses and our student teaching experience.

Content Recommendation 1: Mathematical sciences major programs should include concepts and methods from calculus and linear algebra. MATH 151, MATH 152, MATH 251_{ST}, MATH 305, MATH 310_{ST}, MATH 401_{ST}

Content Recommendation 2: Students majoring in the mathematical sciences should learn to read, understand, analyze, and produce proofs at increasing depth as they progress through a major. MATH 103_{ET}, MATH 104_{ET}, MATH 215, MATH 216, MATH 321, MATH 325, MATH 341

Content Recommendation 3: Mathematical sciences major programs should include concepts and methods from data analysis, computing, and mathematical modeling. MATH 103_{ET}, MATH 104_{ET}, MATH 207, MATH 305, MATH 401_{ST}, CSCI 103_{ET}, CSCI 105, CSCI 121_{ST}

Content Recommendation 4: Mathematical sciences major programs should present key ideas and concepts from a variety of perspectives to demonstrate the breadth of mathematics. Our program has a mixture of theoretical and applied topics.

Content Recommendation 5: Students majoring in the mathematical sciences should experience mathematics from the perspective of another discipline. CSCI 105, PHYS 221_{ST}, CHEM 115_{ST}, NSCI 101_{ET}.

Content Recommendation 6: Mathematical sciences major programs should present key ideas from complementary points of view: continuous and discrete; algebraic and geometric; deterministic and stochastic; exact and approximate.

Continuous: The majority of the calculus sequence
Discrete: MATH 216_{ST}, parts of MATH 152, parts of MATH 401_{ST}
Algebraic: MATH 103_{ET}, MATH 305, MATH 341_{ST}
Geometric: MATH 104_{ET}, some topics in the calculus sequence, some topics in MATH 305, MATH 321, MATH 325 and MATH 401_{ST}
Deterministic: MATH 310_{ST}, some topics in MATH 401_{ST}
Stochastic: MATH 207, some topics in MATH 401_{ST}
Exact: Most of the calculus sequence
Approximate: Some topics in the calculus sequence, some topics in MATH 401_{ST}

Content Recommendation 7: Mathematical sciences major programs should require the study of at least one mathematical area in depth, with a sequence of upper-level courses. We don't require this.

Content Recommendation 8: Students majoring in the mathematical sciences should work, independently or in a small group, on a substantial mathematical project that involves techniques and concepts beyond the typical content of a single course. MATH 321, MATH 325, MATH 401_{ST}

Content Recommendation 9: Mathematical sciences major programs should offer their students an orientation to careers in mathematics. Students in this area are typically only interested in teaching. However, this is an area that could use improvement.

Coursework is important for the formation of a successful teacher. However, "upper-division courses typical of a mathematics major have minimal impact on the quality of a teacher's instruction, as measured by student performance." (MET II p. 53) MET II recommends that courses for prospective teachers should provide teachers with opportunities for the full range of mathematical experiences. These recommendations are as follows:

Recommendation 1: Prospective teachers need mathematics courses that develop a <u>solid understanding of the mathematics they will teach.</u> The list of courses outlined above illustrate the depth of knowledge required of students. However, not all of the courses examine the mathematics from a teacher's perspective. Notable exceptions are MATH 103_{ET}, MATH 104_{ET}, MATH321, MATH325 and the methods courses, in the context of preparing lessons and learning activities.

Recommendation 2: Coursework that allows time to engage in reasoning, explaining, and making sense of the mathematics that prospective teachers will teach is needed to produce well-started beginning teachers. Although the quality of mathematical preparation is more important than the quantity, the following recommendations are made for the amount of mathematics coursework for prospective teachers.

i) ***Prospective elementary teachers should be required to complete at least 12 semester-hours on fundamental ideas of elementary mathematics, their early childhood precursors, and middle school successors.*** MATH 103_{ET}, MATH 104_{ET} provide 10 contact hours (8 credits) of elementary and middle school mathematics content. In addition, MATH 325 reviews many definitions used in elementary mathematics, then builds on to those concepts quickly. MATH 215 and MATH 216_{ST} covers counting and the properties of integers and rational numbers.

ii) ***Prospective middle grades (5–8) teachers of mathematics should be required to complete at least 24 semester-hours of mathematics that includes at least 15 semester-hours on fundamental ideas of school mathematics appropriate for middle grades teachers.*** MATH 103_{ET}, MATH 104_{ET} provide 10 contact hours (8 credits) of elementary and middle school mathematics content. In addition, MATH 305 and MATH 325 review many definitions used in middle school mathematics, then builds on to those concepts quickly. MATH 215 and MATH 216_{ST} covers counting and the properties of integers and rational numbers.

iii) ***Prospective high school teachers of mathematics should be required to complete the equivalent of an undergraduate major in mathematics that includes three courses with a primary focus on high school mathematics from an advanced viewpoint.*** These courses include the MATH 151, MATH 152, MATH 207, MATH 215, MATH 216_{ST}, MATH 251_{ST}, MATH 305, MATH 310_{ST}, MATH 341_{ST} and MATH325.

Recommendation 3: Throughout their careers, teachers need opportunities for continued professional growth in their mathematical knowledge. Our students are prepared to begin teaching, and our faculty members are actively involved with professional development locally and in various locations in the State. Through our roles as advisors for the region's Math and Science Center, we know that there are many opportunities for teachers in the state to continue their professional development.

Recommendation 4. All courses and professional development experiences for mathematics teachers should develop the habits of mind of a mathematical thinker and problem-solver, such as reasoning and explaining, modeling, seeing structure, and generalizing. Courses should also use the flexible, interactive styles of teaching that will enable teachers to develop these habits of mind in their students. The authors of MAT II cite the Standards for Mathematical Practice included with the Common Core State Standards (CCSS-M), notably problem solving, reasoning and modeling mathematics. As described earlier in this document, our students have multiple opportunities to observe these Practices in their classrooms, especially when inquiry, proof and problem solving form a basis for the instruction.

Recommendation 5. At institutions that prepare teachers or offer professional development, teacher education must be recognized as an important part of a mathematics department's mission and should be undertaken in collaboration with mathematics education faculty. More mathematics faculty need to become deeply involved in PreK–12 mathematics education by participating in preparation and professional development for teachers and becoming involved with local schools or districts. The number of faculty who have or are currently involved in Professional Development indicates the level of importance placed on mathematics education PreK to college level. Moreover, one faculty member, Dr. Lorraine Gregory, has experience teaching in elementary and high schools, has a Doctorate in Education, and is actively involved in the School of Education as well as the mathematics department.

Recommendation 6. Mathematicians should recognize the need for improving mathematics teaching at all levels. Mathematics education, including the mathematical education of teachers, can be greatly strengthened by the growth of a mathematics education

community that includes mathematicians as one of many constituencies committed to working together to improve mathematics instruction at all levels and to raise professional standards in teaching. All faculty in the Mathematics Department are involved in the education of our students and the development of the mathematics education degree program. In addition, our faculty, with cooperation from the EUPISD and the EUP Math and Science Center, began a Math Teachers' Circle in 2013. A Math Teachers' Circle is a professional development community of middle school and high school math teachers, together with mathematicians in higher education and industry who get together to do math.

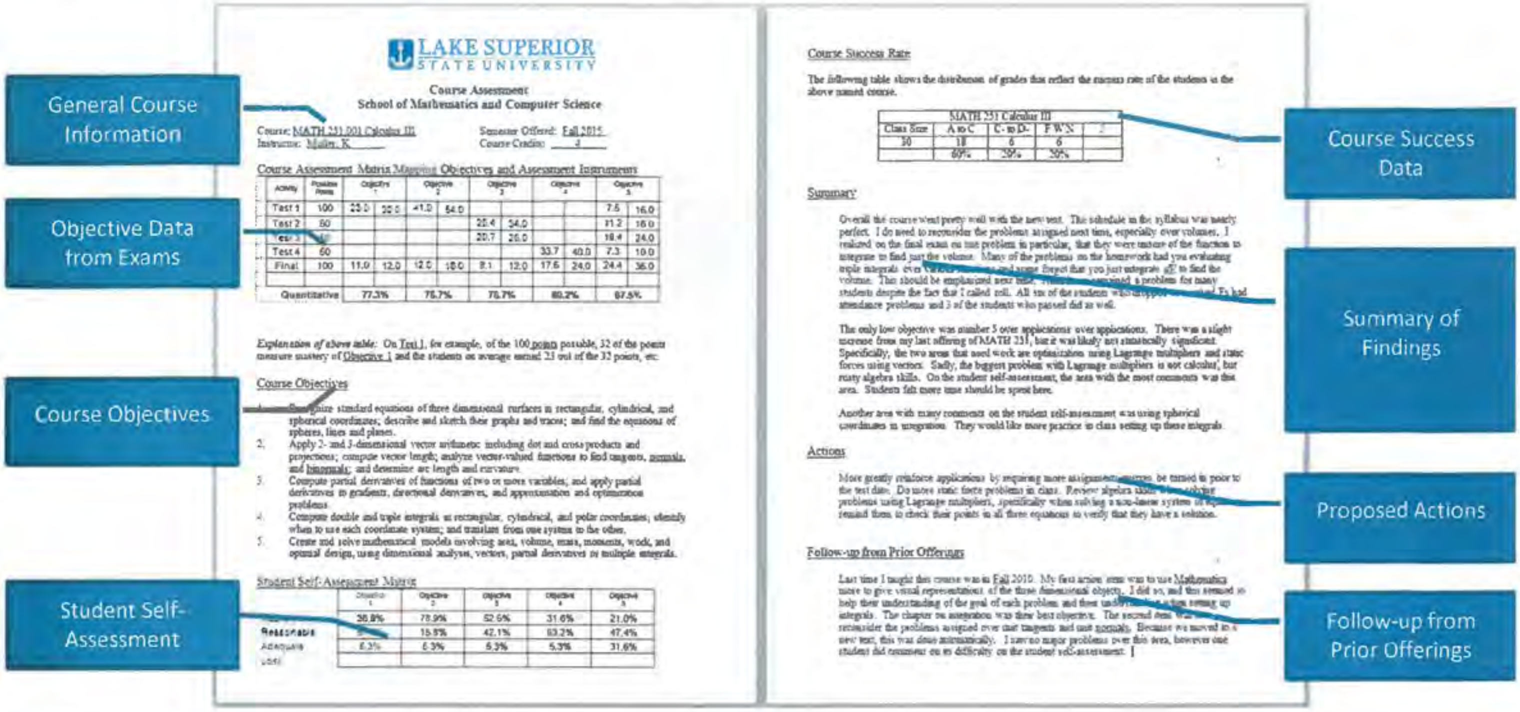
Finally, many of our classes are using technology in state-of-the-art classrooms and labs. Our School purchased many of these technologies for CAS 119, CAS 205, CAS 207, CAS 209A, CAS 210 and CAS 303 before they were more widely available on campus. Document cameras have been available for several years now, before they appeared in all classrooms across campus, and are used for a variety of purposes including displaying the content currently being discussed, student work on problems, student presentations, etc. TI84 calculators are extensively used in several classes, especially MATH207. Software specifically for educational purposes is available such as Geometer's Sketchpad. Besides technology, the department maintains a large collection of manipulatives such as place-value blocks, Algeblocks, tiles, geoboards, 2 and 3 dimensional shapes, etc. to assure that future teachers are aware of the place of these items in a rich mathematics educational experience.

5. Assessment

Our School has a well-established assessment strategy for all of its programs which began in 2008 with the establishment of a School Assessment Committee under the leadership of now Professor Emeritus Sherry Duesing. The Assessment Committee formed subcommittees by discipline and created measurable outcomes for all courses and programs by 2009 and created a mapping by 2010. All of these objectives are located on the N: drive, though some have been edited in Tracdat since that time. Those objectives were then reviewed by Professor Duesing and Dr. Gregory to ensure that the outcomes were properly worded using established terminology in the field of Education.

Course Assessment

In 2009, we created a two-page template for course objective assessment which recorded our data and a summary of how we planned to use this data to strengthen our courses, which would of course strengthen our programs as well. You can locate these old reports, beginning with assessment from 2009, on the N: drive under Assessment. Before Tracdat, we had a well-established routine of completing our course assessment documents and steadily improving our courses. We feel our progress in this regard was well-ahead of the University as a whole. Course proposals were sent to the Curriculum Committee making changes to MATH 310 and MATH 325. In the summer of 2015, in preparation for writing a previous program review the chair of the School of Mathematics and Computer Science reviewed the School's assessment on the N: drive and in Tracdat and found that many of the faculty had continued under the old process while also entering data into Tracdat. These faculty upload the School document into Tracdat as evidence using "related document". Some faculty only completed the School document, but did not enter their data into Tracdat. Some faculty entered assessment data into Tracdat, but no longer completed the School document. In the Fall of 2015, with the endorsement of Dr. David Myton, Associate Provost, the School voted to return to using the School's assessment template, with improvements that were more in line with the information that Tracdat usually required, such as a section that specifically requests "Actions" and a section for "Follow-up" on prior actions to complete the assessment loop.



On January 22, 2016, after Dr. Myton made some changes in Tracdat to align with our assessment template, Dr. Myton wrote, "Please thank your faculty for their assessment work. Your School is now the campus leader in terms of green checks and absence of red flags - congratulations!" In addition to Tracdat, many assessment reports can be found on the School's N: drive for easier viewing.

Program Assessment

The School has mapped course objectives to the program objectives. In most cases these course objectives are used to measure the program objectives. In one case the objective is measured by student placement after graduation. For those objectives where course outcome data is used, the numbers were calculated using the last semester/year of offering during the last two year cycle. Except for a few select cases of alternate year offerings, we used the data from 2015-2016. As you can see from the next table, in most cases the targeted threshold for the objective is met. Those boxes are green. There are three objectives where the numbers are lower that the target of 90%. Those boxes are red. To provide more context for how these numbers were calculated, inside the 6 courses in the M-ET program that have course outcomes aligned with Program Objective 1, there were 24 outcomes mapped to that objective. Of those 24 outcomes, 21 of the 24 were assessed as meeting the desired success rate during course assessment, giving an 87.5% percentage of course outcomes meeting the desired standard. If one more objective had met the desired standard, the objective overall would have met its 90% threshold. (Although the table shows that there is possibly some room for improvement, a quick look back at prior offerings shows that many of the course outcomes that did not meet the desired standard for this last offering, have met that standard recently. If we had chosen to do so, we could have used the "best" data instead of the most recent.) One should also note that the large majority of the objectives that did not meet the desired standard are in courses that are largely populated by students who are not majors in mathematics, M-ET or M-ST, so these numbers are likely not representative of our majors.

	Program Objectives	M-ET Courses	M-ST Courses	Targeted Threshold	Percentage of M-ET Course Objectives that Met Target	Percentage of M-ST Course Objectives that Met Target
1	Demonstrate a fundamental and foundational knowledge of mathematics by developing quantitative and abstract reasoning skills in order to build a conceptual understanding of logical structures and axiomatic systems.	MATH 103, MATH 104, MATH 215, MATH 305, MATH 321, MATH 325	MATH 215, MATH 216, MATH 305, MATH 341, MATH 321, MATH 325, MATH 401	90% of related objectives to hit targeted threshold	37.5%	85.7%
2	Demonstrate technical mathematical skills in the areas of algebra, geometry, calculus, and statistics for solving problems.	MATH 103, MATH 104, MATH 151, MATH 152, MATH 207, MATH 305, MATH 321, MATH 325	MATH 151, MATH 152, MATH 207, MATH 251, MATH 305, MATH 310, MATH 321, MATH 325	90% of related objectives to hit targeted threshold	14.3%	76.9%
3	Use their knowledge of the historical background of mathematics in enriching their own lives and the lives of their future students.	MATH 103, MATH 104, MATH 321	MATH 321	90% of related objectives to hit targeted threshold	100.0%	100.0%
4	Use software and other technology to solve problems.	MATH 103, MATH 104, MATH 207, MATH 305	MATH 207, MATH 305, MATH 401	90% of related objectives to hit targeted threshold	100.0%	100.0%
5	Use their acquired skills in the pursuit of a job and/or graduate school.			At least 80% of the respondents should be employed or in graduate school within a year of graduation.	100.0%	100.0%
6	Create mathematical models and use their mathematical and analytical skills to solve real-world problems.	MATH 103, MATH 104, MATH 207, MATH 151, MATH 152	MATH 151, MATH 152, MATH 251, MATH 310, MATH 401	90% of related objectives to hit targeted threshold	[illegible]	80.0%
7	Continue to acquire new knowledge for life-long learning in pursuit of their professional and personal goals.	MATH 215, EDUC 480, EDUC 492	MATH 215, MATH 216, MATH 341, MATH 401, EDUC 480, EDUC 492	90% of related objectives to hit targeted threshold	100.0%	100.0%
8	Communicate mathematically in their profession and the broader community.	MATH 103, MATH 104, MATH 215, MATH 321, MATH 325	MATH 215, MATH 321, MATH 325, MATH 341	90% of related objectives to hit targeted threshold	100.0%	100.0%
9	Make connections of mathematical ideas to other ideas both inside of and outside of mathematics.	MATH 103, MATH 104, MATH 207	MATH 207, MATH 151, MATH 152, MATH 401	90% of related objectives to hit targeted threshold	100.0%	100.0%

All education students must pass the MTTC licensure exam prior to student teaching. This is perhaps a better measure of whether or not these targeted graduates are meeting program outcomes. Secondary education mathematics majors take the secondary mathematics exam. Our pass rate has remained high with 100% of the M-ST majors attempting the exam passing it from 2012-2015. On the other hand, elementary mathematics majors need to first pass the elementary education exam, and may become highly qualified without taking/passing the elementary mathematics exam. Currently, the pass rate for the M-ET majors is also 100%. The same exam is taken both by students majoring in mathematics as those minoring in mathematics, so some of the students included in the table below are minors, who take many of the same courses as those who are majoring in mathematics. The majors are in blue. All but one of the minors in the secondary program were still successful, but there is less success among the minors in elementary education.

	Test Code 22 - Secondary 89 - Elementary		Test Date	Result	Score (provided only for Fail; cut score is 220)	Subareas: Mathematical Processes and Number Concepts	Patterns, Algebraic Relationships, and Functions	Measurement and Geometry	Data Analysis, Statistics, Probability, and Discrete Mathematics
Tester 1	22	major	10/13/2012	P		2	4	2	2
Tester 2	22	minor	10/13/2012	P		4	3	4	4
Tester 3	22	minor	1/5/2013	P		3	4	3	3
Tester 4	22	minor	4/13/2013	F	202	1	2	2	3
Tester 5	22	major	4/13/2013	P		4	4	3	4
Tester 6	22	minor	7/13/2013	P		2	4	2	4
Tester 7	22	minor	10/5/2013	P		4	4	3	3
Tester 8	22	major	1/4/2014	P		2	3	2	4
Tester 9	22	major	10/11/2014	P		4	4	4	4
Tester 10	22	major	11/22/2014	P		3	2	3	3
Tester 11	22	major	4/18/2015	P		4	4	4	4
Tester 12	22	major	7/11/2015	P		3	4	3	3
Tester 13	89	minor	4/14/2012	P		4	4	4	4
Tester 14	89	minor	4/14/2012	F	189	3	1	2	1
Tester 15	89	minor	7/14/2012	F	192	3	1	1	2
Tester 16	89	minor	7/14/2012	P		4	4	4	4
Tester 17	89	minor	7/14/2012	F	213	2	2	2	3
Tester 18	89	major	4/13/2013	P		4	3	3	2
Tester 19	89	minor	4/13/2013	P		4	3	3	2
Tester 20	89	minor	4/12/2014	P		4	2	2	3
Tester 21	89	minor	4/12/2014	F	206	3	2	2	1
Tester 22	89	minor	10/10/2015	P		4	4	4	4

1 = Examinee answered few or none of the questions correctly (scaled subarea score of 100-179)
2 = Examinee answered some of the questions correctly (scaled subarea score of 180-219)
3 = Examinee answered many of the questions correctly (scaled subarea score of 220-259)
4 = Examinee answered most or all of the questions correctly (scaled subarea score of 260-300)

6. Opportunity Analysis

Recruitment

Our School developed several new initiatives to increase enrollment in the past year including a **Mathematics and Computer Science Field Day** for area high school students, calling and writing potential students, developing new pamphlets and power point presentations on our programs and increasing our presence on social media. We expected it to take several years to see any increase based on our efforts, but our school shows a remarkable 58.1% increase in admits already in 2015 (the largest increase shown in the data compiled by Joe Barrs at that time). We did not see the same increases this year for these two programs. While we no longer have access to reports from Joe Barrs, we are basing this on the number of students attending orientation. From the data pre-2011, we have a market for these two degrees in the region. We need to find new ways to market our students' overwhelming success from these two programs both on the certification exams and in job placement. A major STEM recruitment push makes perfect sense right now, and we believe our school is poised to attract those attentive to the job predictions. Note that our programs are much less expensive to run than many other programs, and we have the capacity to substantially increase enrollment with little or no marginal cost. We have requested changes to the tour guide notes for admissions that highlight our programs. While it seems these changes have not yet be made, we have seen other positive changes since the arrival of Annette Hackbarth-Onson and are hopeful that our programs will be highlighted in the future. We will continue to increase our efforts in recruitment, and we will continue to point out this opportunity for non-academic departments to support our efforts.

Facilities

Our facilities requirements are minimal. We share a lab with computer science and the computers are updated on a five year rotation using course fees. The course fees for MATH103 and 104 contribute to the collection of manipulatives used in those courses.

Potential

We have streamlined our course offerings so that courses exclusively for these programs are offered only every 2 years. We also changed the course offering pattern so that students would be less likely to need several of intensive mathematics courses at once. Still, these courses typically run with an enrollment of 5-10 students, which leaves room to recruit up to 20 additional students, at no marginal cost to LSSU. We would also like to see an increase in the number of minors for these two areas.

7. Optional

While our program is not zero-cost it does pay for itself as evidenced in other sections. Most mathematics programs across the U.S. are small when compared with overall offerings because it takes a comparatively rare gift for a student to succeed in such a program. Please do not underestimate the value of our strong ties to the K-12 community. Through our joint work with area teachers we have many opportunities to interact with regional teachers and students to promote LSSU and what we have to offer. Through workshops, advisory boards, projects, we interact with teachers regularly. The school district comes to us when they have a teaching vacancy to ask for recommendations. This is a tie to the people who interact daily with our potential students that is both priceless and only costs us time. Usually this time is spent disseminating knowledge on a subject that we love.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Mathematics 2015 Program Review**
This documentation is relevant to Question number:	**12**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Provides information about these programs using a prior program review format.**

Bachelor of Science in Mathematics Program Review

1. Mission/Vision

The Bachelor of Science in Mathematics is a program of the School of Mathematics and Computer Science. The program has been in place since we broke off from Michigan Tech in 1970. Under this degree program students have the additional option of a Bachelor of Science in Mathematics with an emphasis in Actuarial and Business Applications. This option requires that the student earn a minor in accounting-finance.

> *LSSU Mission Statement*
>
> ***Our mission at Lake Superior State University is to help students develop their full potential. We launch students on paths to rewarding careers and productive, satisfying lives. We serve the regional, state, national and global communities by contributing to the growth, dissemination, and application of knowledge.***

Our mathematics program introduces students to a broad range of both pure and applied mathematics, both continuous and discrete, throughout their four years of study. Because of the broad array of mathematical experiences that our program offers our students and their many opportunities to apply this knowledge in later coursework and careers, our graduates have gone on to many different rewarding fields after leaving LSSU. These areas of graduate work or employment include, but are not limited to, pure or applied mathematics, higher education, banking, operations research, engineering, statistics, actuarial studies, mathematical modeling of weather patterns, and programming. (For more information see sections 3 and 4 on "Demand" and "Quality".) Because of our emphasis very early in MATH 215 and MATH 216 on inquiry-based student-centered learning and our requirement of a senior research experience, our graduates exit LSSU with the ability to both think independently and communicate their ideas effectively.

> *LSSU Vision Statement*
>
> ***Our programs grow and evolve in ways that keep our graduates at the cutting edge of technological and societal advances. As such, we will be viewed by our constituents as:***
>
> - ***The preferred regional choice for students who seek a quality education which provides a competitive edge in an evolving job market.***
> - ***An institution where relevant concepts are taught by quality faculty, and are paired with practical real-world experience to provide a well-rounded education.***
> - ***An institution which capitalizes on its location to instill graduates with an understanding of environmental issues and an overarching desire to be responsible stewards of the environment.***
> - ***A University that is highly student centered and empowers all students to realize their highest individual potential.***

Our program also supports the University Vision in several different ways. One of our program outcomes is that graduates should be able to "use software and other technology to solve problems". Several of our classes support this outcome including Linear Algebra, Graph Theory, Mathematical Modeling, Applied Statistics, and Principles of Programming. As for quality faculty, except in rare cases, all of our program courses are taught by faculty who hold a doctorate in a field of pure or applied mathematics, statistics or mathematics education. The rare exceptions include courses where there is a co-teacher with a terminal degree in a related field, such as computer science or engineering. All of these faculty members have publications in their respective fields, one had a previous successful career at a tier one university, one has had more than 50 publications since coming to LSSU, two have received teaching awards, and one has co-authored a textbook in his field. Another program outcome is for successful graduates to "create mathematical models and use their mathematical and analytical skills to solve real-world problems." Many of our courses have course objectives tied to this program outcome, including MATH 151, 152, 251, 310, 351, 401, and 411. Also our capstone course provides the real-world experience of doing independent research or study. One of our greatest areas of strength is the individual attention that our graduates receive. All of our classes are small with 30 or fewer students. When one compares this with larger state universities, which have large lecture classes for first year students, we provide a uniquely student-centered atmosphere in the classroom. Our introductory proof sequence has 15 or fewer students and is typically taught using inquiry based learning. This is a very student-centered approach where students present the material to each other.

There are several areas of the Strategic Plan supported by our program. Some of these are emerging and others are more established.

- **2.1 LSSU will increase enrollment.** This year we offered a Field Day experience for area high school students where we introduced students to topics in mathematics and computer science using hand-on activities. We also contacted admitted students after they were accepted, made new brochures and power point slides for our programs, increased the visibility of our Pi Day activities and saw a 20.0% increase in admitted students for this program (and 58.1% increase in admitted students for the School).

- **2.5 LSSU will graduate students who have had an exceptionally good university experience.** The one-on-one attention that our graduates receive gives them a chance to exceed beyond expectations. Of four of our alumni who are known to have recently finished their master's or Ph.D. programs, their median entering ACT math score was 27.5. Note that 28 is the prerequisite score for our calculus sequence. Our program helped them to meet their full potential.
- **4.1 LSSU will increase high-impact educational experiences in BS/BA degree programs.** In addition to requiring a senior project we try to periodically offer special topics courses such as logic, cryptography, computational geometry and game theory. These courses are often favorites of our students and supplement their degree program.
- **4.3 LSSU will improve the tracking process of graduate success.** We have been tracking our graduates' placements three months after graduation since 2012 and have increased efforts to track them later.
- **4.6 LSSU will increase the number of students participating in professional conferences and workshops.** This is not an area we have highly encouraged in the past, but we have had two students attend conferences this year, one of whom will be presenting at a conference in August 2015 and received a grant to support his travel.
- **6.1 LSSU will define assessment and engage in meaningful, institutionalized assessment activities.** Our school has been doing course assessment with well-established objectives for many years. Our program assessment efforts are emerging.
- **6.2 LSSU will utilize appropriate and developing technology to facilitate effective and enriched learning experiences across the campus community.** This is an area in which we excel. In fact we purchased and used many technologies such as i-Pads, tablets and document cameras before they were more widely available across campus. We also use many educational software packages in our courses to enhance student understanding of difficult mathematical concepts.

There are several areas that distinguish these programs from our main competitors in the state. One is the small class size, especially at the calculus level. Another is a strong mixture of both pure and applied coursework. Several programs focus on the theoretical aspects of math and several on applied mathematics, but ours has a strong mixture of both. Our actuarial program seems to be unique in that it requires the minor in accounting/finance which is a larger requirement than the other schools with this concentration.

2. Productivity

The faculty and adjuncts in mathematics teach a large percentage of classes that are not required by our majors. This includes developmental courses (MATH 087, MATH 088, MATH 102) and general education courses (MATH 110, MATH 111, MATH 131, MATH 207). There are also courses that are taught as service to other programs (MATH 103, MATH 104, MATH 112), courses only required by the Secondary Teaching Program (MATH 321, MATH 325) and courses that are filled by a variety of majors including Mathematics, Mathematics—Elementary Education, Mathematics—Secondary Education, Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering and Physical Science (MATH 151, MATH 152, MATH 251, MATH 308, MATH 310). Using data from two consecutive academic years (2013-2014 and 2014-2015) this can be summarized with the following percentage of our instructional load.

- Developmental—23.8%
- General Education—37.0%
- Requirements of other Programs—9.9%
- B.S. in Mathematics Secondary Teaching Only—2.8%
- Mathematics Requirement with Heavy Service—18.1%
- Mathematics and Mathematics Secondary Education Requirements—5.3%
- B.S. in Mathematics Only—3.2%

Note that only 3.2% of the instructional load is used only for this program, making this program a rather inexpensive program compared to most programs on campus. Only 11.3% of the load is used exclusively by the two mathematics programs. (This includes the 3.2%.)

The next comparison, to the right, with other academic areas was made using the faculty load report summary for 2014-2015. Because of our heavy service load our ratio of student credit hours per faculty instructional load hours is the 4th highest division on campus and our ratio of student credit hour per faculty contract hour is the 3rd highest division on campus. (Instructional load does not include release time and Faculty Contract Hours do. Some areas receive a larger percentage of release time than others.) This data deals with instructional load. The next table further shows the total enrollment in our courses over the previous 5 academic years (this year was not yet available in Argos).

	Faculty			Student Credit Hours per Instructional Load Hour	Rank of SCH per ILH	Student Credit Hour per Contract Hour	Rank of SCH per CH
	Instructional Load	Total Contract Hours	Student Credit Hours				
Business Fall	124.532	139.532	2344.000	18.034	5	16.910	5
Business Spring	146.409	149.409	2542.084				
CJ FS EMS Fall	109.494	107.494	2371.000	20.955	2	20.763	2
CJ FS EMS Spring	106.609	110.609	2157.500				
Education Fall	36.130	39.130	600.990	11.622	9	9.841	9
Education Spring	46.730	58.730	362.000				
Engineering Fall	112.663	123.532	1136.510	9.708	11	9.063	10
Engineering Spring	114.680	119.984	1070.500				
English Fall	150.589	164.353	2391.500	16.202	6	14.841	6
English Spring	130.441	142.441	2161.730				
Hum, Arts, SS Fall	176.619	188.619	4955.500	28.365	1	26.563	1
Hum, Arts, SS Spring	191.836	204.836	5495.740				
Lib Studies Fall	6.333	12.003	82.000	10.636	10	4.875	11
Lib Studies Spring	4.667	11.997	35.000				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]				
Nursing Fall	150.667	170.667	1821.500	11.861	8	10.517	8
Nursing Spring	154.500	173.500	1798.001				
RS-ES Fall	81.998	90.998	1116.000	13.482	7	12.086	7
RS-ES Spring	73.834	82.834	985.000				
Sciences Fall	298.792	334.562	5754.800	18.942	3	17.000	4
Sciences Spring	250.555	277.555	4650.992				

Course Enrollment						
COURSE	TITLE	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
MATH081	Pre-Algebra I	110	139	98	91	56
MATH082	Pre-Algebra II	108	136	99	92	56
MATH083	Pre-Algebra III	111	136	98	93	57
MATH084	Introductory Algebra I	224	231	205	168	124
MATH085	Introductory Algebra II	236	239	216	167	126
MATH086	Introductory Algebra III	237	242	224	173	127
MATH102	Intermediate Algebra	247	242	250	210	179
MATH103	Number Sys/Prob Solv Elem Teac	32	20	12	12	24
MATH104	Geometry/Measurement Elem Teac	32	29	18	18	12
MATH110	Explorations in Mathematics	32	62	59	35	79
MATH111	College Algebra	288	307	332	315	315
MATH112	Calculus Business/Life Science	97	120	112	96	91
MATH131	College Trigonometry	54	86	73	85	103
MATH151	Calculus I	83	92	97	103	89
MATH152	Calculus II	46	54	57	57	67
MATH207	Prin of Statistical Methods	220	253	295	268	243
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MATH251	Calculus III	39	31	42	24	24
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MATH308	Probability and Math Stats	33	27	29	26	9
MATH309	Applied Statistics	0	9	0	7	4
MATH310	Differential Equations	37	35	38	23	30
MATH321	History of Mathematics	13	20	13	5	9
MATH325	College Geometry	9	0	7	0	5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MATH351	Graph Theory	7	0	7	0	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MATH411	Advanced Topics in Calculus	0	15		7	0
MATH490	Ind Res Topics in Mathematics	1	2	2	4	3

Developmental*	1273	1365	1190	994	725
General Education (Primarily)	320	369	391	350	394
Service (Primarily)	161	169	142	126	127
Service and General Education	54	86	73	85	103
Service and Math Ed	220	253	295	268	243
Math Ed	22	20	20	5	14
Math and/or Math Ed Major with Large Service Requirement	238	239	263	233	219
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Math Major Requirement	8	26	9	18	7

*Note that these are one hour courses and often a student enrolls in three of these at a time.

Note the key to the table summarizes the constituents of each course. All LSSU graduates must take at least some mathematics at or above the level of MATH 110. The high enrollment in developmental coursework is partially due to double counting, but it is largely due to the large percentage of under-prepared students at LSSU.

The other enrollment numbers come from the following program requirements. The following courses are specifically required by other majors (than mathematics, mathematics secondary teaching or mathematics elementary teaching).

- MATH 103 & MATH 104—Elementary Education
- MATH 111—Accounting, Biology, Business Administration, Computer Networking, Conservation Biology, Finance & Economics, Electrical Engineering Technology, Fish Health, Fisheries and Wildlife Science, Forensic Chemistry, Geology, Industrial Technology, Manufacturing Engineering Technology, Medical Laboratory Science, Parks and Recreation

- MATH 112—Biology, Computer Science, Conservation Biology, Criminal Justice Criminalistics, Electrical Engineering Technology, Environmental Health, Environmental Science, Finance & Economics, Forensic Chemistry, Fire Science Engineering Technology, Fish Health, Fisheries and Wildlife Science, Geology, Manufacturing Engineering Technology, Medical Laboratory Science.
- MATH 131—Computer Science, Electrical Engineering Technology, Industrial Engineering Technology, Manufacturing Engineering Technology
- MATH 207—Athletic Training, Biochemistry, Computer Networking, Computer Science, Criminal Justice (Corrections, Criminalistics, Generalist, Homeland Security, Law Enforcement, Loss Control, Public Safety), Electrical Engineering Technology, Environmental Science, Exercise Science, Fire Science, Forensic Chemistry, Geology, Industrial Technology, Manufacturing Engineering Technology, Medical Laboratory Science, Nursing, Parks and Recreation, Physical Science
- MATH 151 & MATH 152—Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering, Physical Science
- MATH 251, MATH 308, MATH 310—Computer Engineering, Electrical Engineering, Mechanical Engineering

Other than the 3.2% of the instructional load (or 11.3% if you include the mathematics education program), our mathematics degree program has very few expenses that are program specific. The needed software licenses, computers, instructional technologies and paper usage are more than covered by our course fees. The average salary of those 6 faculty who primarily teach mathematics program courses was $53,555 in 2014-2015. The average instructional load needed exclusively for the mathematics program is 7.25 instructional hours per year. If you include both the B.S. in Mathematics program and the B.S. in Mathematics—Secondary Education, the total hours needed exclusively for those two programs, and no other high enrolled service programs, is 25.6 instructional hours per year. This is approximately one faculty member's load. (All of our faculty typically teach overload, largely due to a lack of qualified adjuncts in the area.) Using a five year average of enrollment (in those courses only required by the two mathematics majors) those courses yield 244.8 student credit hours times $433 per credit hour, totaling $105,998.40. This would more than cover one faculty member's salary and benefits. Again there are factors not considered in this simple estimation such as our increasing attempt to offer courses less often, which will reduce future costs, and the University's tuition plateau, but it would seem the costs to the university are minimal, especially considering our large service role.

While our mathematics program enrollment overall is small, we have not seen the dramatic decrease in enrollment that LSSU has seen as a whole. The following data was pulled from Argos.

	Bachelor of Science in Mathematics	Bachelor of Science in Mathematics Secondary Teaching	Minors in Mathematics
Fall 2006	10		13
Fall 2007	8		11
Fall 2008	8		6
Fall 2009	9		7
Fall 2010	13	16	5
Fall 2011	11	19	4
Fall 2012	14	12	8
Fall 2013	12	9	14
Fall 2014	11	9	8

The number of students for the Bachelor of Science in Mathematics Secondary Teaching is included in the above table because 10 of the required courses for that program are also in the Bachelor of Science in Mathematics program. Seven courses are required for the minor in mathematics. Five of the courses in the program are also in the degree requirements for the engineering programs. (Many of our minors are engineering majors.) Two of the courses are required for a chemistry degree. The next table contains the fall enrollment numbers for the 15 public universities in Michigan for even numbered years (these years were all that were available for the data by major) from the Ipeds database from the National Center for Educational Statistics. (There are slight differences in the numbers that Argos is reporting and the numbers reported by Ipeds. This could be due to the time of reporting.)

	2012			2010			2008			2006		
Institution Name	Mathematics Majors	Undergraduates	Percentage of Mathematics Majors	Mathematics Majors	Undergraduates	Percentage of Mathematics Majors	Mathematics Majors	Undergraduates	Percentage of Mathematics Majors	Mathematics Majors	Undergraduates	Percentage of Mathematics Majors
Central Michigan University	36	21332	0.17	26	21633	0.12	27	20540	0.13	135	20129	0.67
Eastern Michigan University	78	18927	0.41	84	18554	0.45	74	17283	0.43	53	18245	0.29
Ferris State University	52	13271	0.39	48	13168	0.36	31	12250	0.25	29	11413	0.25
Grand Valley State University	572	21317	2.68	560	20986	2.67	517	20416	2.53	469	19578	2.40
Lake Superior State University	14	2582	0.54	12	2588	0.46	8	2557	0.31	9	2889	0.31
Michigan State University	427	37354	1.14	462	35921	1.29	389	36205	1.07	390	35821	1.09
Michigan Technological University	81	5611	1.44	92	5715	1.61	72	6025	1.20	81	5630	1.44
Northern Michigan University	25	8474	0.30	20	8719	0.23	32	8598	0.37	28	8880	0.32
Oakland University	201	16190	1.24	131	15530	0.84	124	14397	0.86	129	13701	0.94
Saginaw Valley State University	104	9310	1.12	72	9116	0.79	59	8190	0.72	55	7933	0.69
University of Michigan-Ann Arbor	450	27979	1.61	341	27027	1.26	290	25994	1.12	246	25555	0.96
University of Michigan-Dearborn	116	7328	1.58	108	7006	1.54	105	6588	1.59	103	6448	1.60
University of Michigan-Flint	17	6984	0.24	21	6874	0.31	28	6155	0.45	26	5600	0.46
Wayne State University	79	19342	0.41	30	20837	0.14	32	20122	0.16	56	20892	0.27
Western Michigan University	59	19478	0.30	71	19966	0.36	52	19854	0.26	62	20081	0.31

The percentage of students that are mathematics majors at LSSU is around ½ of one percent. This represents an increase over time. In 2012, that placed us at the median of the public Michigan institutions with those institutions with lower numbers in red. (The data comparing mathematics secondary education on Ipeds was unavailable because it grouped all education majors together. This data would be useful because in degree conferral rates, below, our numbers are combined.)

The table to the right has to do with degree conferral. The table contains both the Bachelor of Science in Mathematics and the Bachelor of Science in Mathematics Secondary Teaching because before 2009, the institutional data was combined. It is also combined for all years when reporting data to Ipeds.

Academic Year	Bachelor of Science in Mathematics	Bachelor of Science in Mathematics Secondary Teaching	Total
2014-2015	3	2	5
2013-2014	2		2
2012-2013	3	3	6
2011-2012	2	5	7
2010-2011	4	1	5
2009-2010	1	1	2
2008-2009	6		6
2007-2008	6		6
2006-2007	4		4

On a national level, data is collected every decade. According to the Conference Board of Mathematical Sciences 2010 survey at http://www.ams.org/profession/data/cbms-survey/cbms2010, there were a total of 16,938 degrees in mathematics, actuarial science or mathematics education awarded in 2009-2010. There were 2774 four-year institutions in that year, giving an **average of 6.1 related mathematics degrees per four year institution**. Our total degrees awarded for those programs is typically around 5, making us only slightly smaller than average. The next table compares our percentage of the conferred degrees to those of the other public institutions in Michigan from Ipeds. Red again denotes percentages that are below ours. (The change from only even years to the years 2012 and 2013 was only based on the availability of data from Ipeds. We are again unsure why the totals in Argos and Ipeds are slightly different.)

Institution Name	2013 Bachelor of Science in Mathematics Degrees Awarded	2013 Total Bachelor's Degrees Awarded	2013 Percentage of Degrees Awarded	2017 Bachelor of Science in Mathematics Degrees Awarded	2017 Total Bachelor's Degrees Awarded	2017 Percentage of Degrees Awarded
Central Michigan University	15	5991	0.250376	11	6163	0.178485
Eastern Michigan University	19	4553	0.417307	12	4131	0.290487
Ferris State University	14	3358	0.416915	13	3396	0.382803
Grand Valley State University	119	5479	2.171929	116	5313	2.183324
Lake Superior State University	6	512	1.171875	9	499	1.803607
Michigan State University	68	10821	0.628408	90	11026	0.816252
Michigan Technological University	20	1453	1.376462	28	1522	1.839685
Northern Michigan University	4	1785	0.22409	6	1743	0.344234
Oakland University	21	3820	0.549738	20	3641	0.5493
Saginaw Valley State University	22	1776	1.238739	15	1672	0.897129
University of Michigan-Ann Arbor	212	12390	1.711057	159	11814	1.345861
University of Michigan-Dearborn	17	1682	1.010702	21	1689	1.243339
University of Michigan-Flint	2	1510	0.13245	7	1474	0.474898
Wayne State University	16	5490	0.291439	15	5682	0.263992
Western Michigan University	13	5381	0.241591	13	5371	0.242041

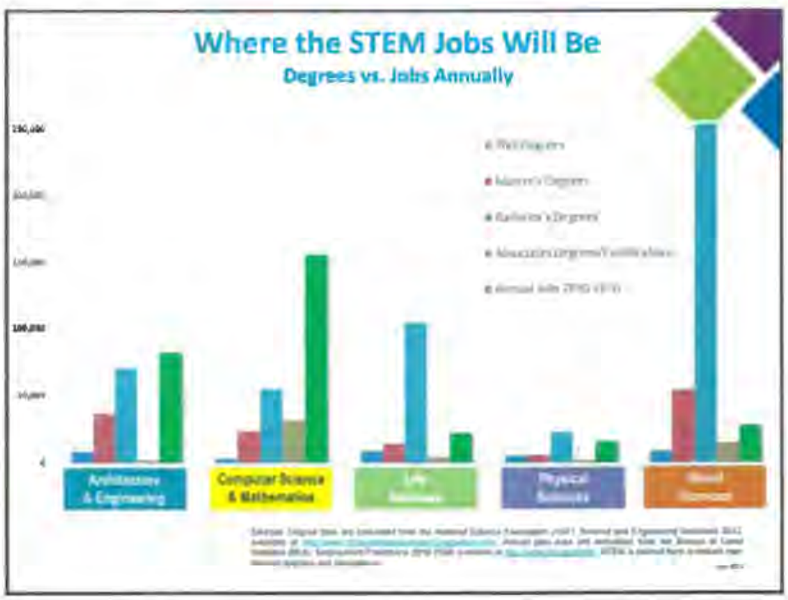
Note when comparing the percentage of the total awarded degrees that are Bachelor of Science in Mathematics Degrees, our University ranks 5th among the 15 state Universities.

Using Argos to estimate the terms to graduation for this program, the average was 7.70 terms for majors in this program over the last 4 years and 8.19 for LSSU graduates as a whole. These data appear to include transfer students, whose minimum number of terms was 4. It is therefore possible that there are confounding factors in making a comparison with the University as a whole without the actual data.

3. Internal and External Program Demand

External Demand:

Demand for mathematicians and actuaries is strong. The federal government's Labor of Statistics Occupational Outlook Handbook indicates that between 2012 and 2020, employment of mathematicians is projected to grow 23 percent. This growth is much faster than the average of all occupations. At the same time employment of statisticians is projected to grow 27 percent. Mathematicians will be needed to analyze the increasing volume of digital and electronic data while the growth in demand for statisticians is expected to result from more widespread use of statistical analysis to make informed business, healthcare and policy decisions. Another reason for the increase is the increase in available data from the Internet which will open up new areas for analysis. The figure shows that mathematics and computer science fields are two of the only STEM fields where there is more demand than there are students in the pipeline.



One exciting aspect of a mathematics degree is the many fields available to individuals with strong mathematics backgrounds. Our graduates go on to a variety of fields where mathematics is a core need. Here are some examples of those fields to demonstrate a wide range of demand. Other graduates are highlighted in the "Quality" section.

- [redacted] ('09); after finishing his PhD in Industrial Engineering from Iowa State University, began work for the Air Force Research Laboratory Information Directorate working with data mining methods.
- [redacted] ('07); after finishing her PhD from University of Wisconsin-Madison in Atmospheric and Oceanic Science, mathematically modeling weather patterns, took a job for the Department of Interior in Colorado in meteorology.

- [redacted] ('10); is the pupil and finance accountant at Sault Area Public Schools.
- [redacted] ('11); after finishing his master's degree in applied mathematics, teaches at Delta Community College.
- [redacted] ('12); Human Resources Analyst at Alpena Regional Medical Center.
- [redacted] ('14); Geographic Information System Specialist at Apple.

Internal Demand:
Refer back to page 3 for programs that require the Bachelor of Science in Mathematics program courses. The largest constituents outside of mathematics are:

- MATH 151 & MATH 152—Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering, Physical Science
- MATH 251, MATH 308, MATH 310—Computer Engineering, Electrical Engineering, Mechanical Engineering

However, that list did not include the courses required for the Mathematics—Secondary Teaching and Mathematics—Elementary Teaching Majors. The secondary teaching major in mathematics requires 10 of the same courses as the mathematics program (including CSCI 105) and the elementary teaching major in mathematics requires 5 of the same courses (including CSCI 105).

4. Program Quality

Mathematics introduces students to formal reasoning and, as a result, contributes to development of qualitative and quantitative analytic skills. The math department in its service role, as well as a major department, is proud to have promoted and to continue to promote and to improve those indispensable skills for the entire LSSU community and all LSSU graduates. Over the years the department has recruited and retained strong mathematicians and mathematics educators as witnessed by their recent scientific and pedagogical output:

- Dr. Grace Ngunkeng has published 3 refereed articles in the past 2 years, has presented her work at the 2013 Joint Mathematics Meetings, and has attended 5 conferences in the past 2 years.
- Dr. Kimberly Muller has published 4 refereed articles and has presented her scholarly work at 11 meetings in the past 10 years .
- Dr. Lorraine Gregory has made 6 conference presentations in the past 10 years.
- Dr. Brian Snyder has coauthored a textbook, published 1 refereed article, and attended 9 converences in the past 10 years.
- Dr. Collette Coullard has published 5 refereed articles and made 2 conference presentations in the past 10 years.
- Dr. George Voutsadakis has published 44 research articles and participated in 6 conferences in the past 10 years.

It has developed a regional reputation and has strongly contributed to outreach activities promoting mathematics and mathematics education and, thus, increased the University's visibility and service in the community. Some examples of our state and regional involvement are:

- Dr. Brian Snyder is the current chair of the Michigan Section of the Mathematical Association of America,
- Dr. Collette Coullard, Dr. Lorraine Gregory and Dr. Kimberly Muller, serve on the Eastern Upper Peninsula Math and Science Center Advisory Board,
- Dr. Collette Coullard and Dr. Kimberly Muller serve on the planning committee for the Eastern Upper Peninsula Math Teachers' Circle,
- The School of Mathematics and Computer Science hosted the Michigan Section of the Mathematical Association of America's annual meeting in 2013,
- Dr. Lorraine Gregory, Dr. Kimberly Muller and Dr. Brian Snyder have taught professional development workshops in 4 different regions across the state,
- The School of Mathematics and Computer Science held a Field Day for area high school students, an event we hope to repeat as an annual recruiting effort,
- The School of Mathematics and Computer Science holds an annual Pi Day and math bowl for area middle school and high school students.

Moreover, some of our majors have been among the highest GPA graduates and have been awarded University-wide distinctions, many with regular placement on the Dean's list and graduating cum laude, magna com laude or summa cum laude. Of the program's graduates over the last seven years, 35.3% graduated cum laude, 17.6% graduated magna cum laude, and 5.8% graduated summa cum laude. The average GPA was 3.37. Only 29.4% of these most recent graduates entered LSSU with this major. The remaining students had majors such as accounting, chemistry, computer or mechanical engineering, computer science, liberal arts, literature, or mathematics secondary education. Our program helps LSSU to retain these gifted students.

Several graduates have established themselves in positions of leadership and continue to distinguish themselves in their respective professions and to further showcase our major's and the University's value to the community and to the work force. Some of these have already been mentioned:

Year Graduated	Name	LSSU GPA	Honors and Awards	Immediately After Graduation: Graduate School	Immediately After Graduation: Job	Current Position (if known and different from first)
2015	[redacted]	[redacted]	Magna Cum Laude	Master of Science in Statistics Program at Oregon State University, Corvallis, OR, supported by a Graduate Teaching Assistantship		
	[redacted]	[redacted]			IFS Operations Specialist at State Street Bank and Trust Company, Kansas City, MO	
	[redacted]	[redacted]	Magna Cum Laude		Customer Service Specialist at Best Buy	
2014	[redacted]	[redacted]	Cum Laude		Geographic Information System Specialist at Apple Inc., Cupertino, CA	
2013	[redacted]	[redacted]	Cum Laude	MS/PhD Program in Industrial and Systems Engineering at Rensselaer Polytechnic Institute, Troy, NY, supported by a Graduate Research Assistantship		Application Developer, Elza Corp, Danvers, MA
	[redacted]	[redacted]	Summa Cum Laude	Master of Science in Statistics Program at Michigan Technological University, Houghton, MI, supported by a Graduate Teaching Assistantship		
2012	[redacted]	[redacted]		Master of Arts in Statistics Program at Wayne State University, Detroit, MI		Remodeling Crew Member, Medlodge, Allen Park, MI
	[redacted]	[redacted]				Human Resources Analyst, Alpena Regional Medical Center, Alpena, MI
	[redacted]	[redacted]				United States Air Force
2011	[redacted]	[redacted]			Office Manager for The Asphalt Doctor, Green Bay, WI	
	[redacted]	[redacted]	Cum Laude	Master of Science in Statistics Program at Western Michigan University, Kalamazoo, MI, supported by a Graduate Teaching Assistantship		
	[redacted]	[redacted]			Analyst for the Royal Bank of Canada, Thunder Bay, Ontario	Project Manager (IT-Related Projects Portfolio), North West Health Alliance, Thunder Bay, Ontario
	[redacted]	[redacted]	Magna Cum Laude	Master of Science in Mathematics Program at Oakland University, Rochester, MI, supported by a Graduate Teaching Assistantship		Adjunct Instructor at Delta Community College
2010	[redacted]	[redacted]				Pupil and Finance Accountant at Sault Area Public Schools
2009	[redacted]	[redacted]	Cum Laude	Master of Science in Statistics Program at Portland State University, Portland, OR, supported by a Graduate Teaching Assistantship		
	[redacted]	[redacted]	Cum Laude		Computer Programmer for an Insurance Company, Lansing, MI	
	[redacted]	[redacted]	Cum Laude	PhD Program in Industrial Engineering at Iowa State University, Ames, IO, supported by a Graduate Research Assistantship		Air Force Research Laboratory Information Directorate

This program compares favorably in its depth and quality to other peer mathematics programs. In 2015 the Mathematical Association of America's Committee on Undergraduate Programs in Mathematics (CUPM) released its new **Curriculum Guide to Majors in the Mathematical Sciences**. It has four cognitive recommendations and nine content recommendations for programs in mathematics. Since these recommendations are brand new, we were impressed with how well our program already fit. We will list those goals and briefly explain how we meet them. In some cases, for the sake of brevity, the recommendations are linked to our program outcomes.

Cognitive Recommendation 1: Students should develop effective thinking and communication skills. Program Outcome 7.

Cognitive Recommendation 2: Students should learn to link applications and theory. Program Outcome 5.

Cognitive Recommendation 3: Students should learn to use technological tools. Program Outcome 3.

Cognitive Recommendation 4: Students should develop mathematical independence and experience open-ended inquiry. Program Outcome 6. Specifically our use of inquiry-based learning in multiple mathematics courses and our senior project requirement.

Content Recommendation 1: Mathematical sciences major programs should include concepts and methods from calculus and linear algebra. MATH 151, MATH 152, MATH 251, MATH 305, MATH 310, MATH 401, MATH 411

Content Recommendation 2: Students majoring in the mathematical sciences should learn to read, understand, analyze, and produce proofs at increasing depth as they progress through a major. MATH 215, MATH 216, MATH 341, MATH 351

Content Recommendation 3: Mathematical sciences major programs should include concepts and methods from data analysis, computing, and mathematical modeling. MATH 308, MATH 309, MATH 401, CSCI 105, CSCI 121

Content Recommendation 4: Mathematical sciences major programs should present key ideas and concepts from a variety of perspectives to demonstrate the breadth of mathematics. Our program has a mixture of theoretical and applied topics.

Content Recommendation 5: Students majoring in the mathematical sciences should experience mathematics from the perspective of another discipline. CSCI 105, PHYS 231, and when possible MATH 310 is co-taught with a faculty member from engineering.

Content Recommendation 6: Mathematical sciences major programs should present key ideas from complementary points of view: continuous and discrete; algebraic and geometric; deterministic and stochastic; exact and approximate.

Continuous: The majority of the calculus sequence, MATH 411
Discrete: MATH 216, parts of MATH 152, MATH 351
Algebraic: MATH 305, MATH 341
Geometric: Some topics in the calculus sequence, some topics in MATH 305, MATH 351 and MATH 401
Deterministic: MATH 310, MATH 351, some topics in MATH 401, MATH 411
Stochastic: MATH 308, MATH 309, some topics in MATH 401

Exact: Most of the calculus sequence, some topics in MATH 351

Approximate: Some topics in the calculus sequence, some topics in MATH 351, MATH 401, MATH 411

Content Recommendation 7: Mathematical sciences major programs should require the study of at least one mathematical area in depth, with a sequence of upper-level courses. MATH 308, MATH 309

Content Recommendation 8: Students majoring in the mathematical sciences should work, independently or in a small group, on a substantial mathematical project that involves techniques and concepts beyond the typical content of a single course. MATH 490

Content Recommendation 9: Mathematical sciences major programs should offer their students an orientation to careers in mathematics. This is an area that needs improvement. We advise students individually, but do not have a formal process for this.

In addition, we attempt to consistently update our offerings, aligning them with new demands in the field of knowledge and the marketplace, as witnessed by our special topics offerings in logic, cryptology, game theory and computational geometry. We also plan curriculum updates as needed. In the upcoming year we plan to make several changes which would strengthen Content Recommendations 5 and 6. These will be discussed under "Assessment". Moreover, the School has been among the pioneers in installing a consistent and regular assessment process for its courses. This will also be discussed in "Assessment".

Finally, many of our classes are using technology in state-of-the-art classrooms and labs. Our School purchased many of these technologies for CAS 119, CAS 205, CAS 207, CAS 209A, CAS 210 and CAS 303 before they were more widely available on campus. All of our majors are required to complete a capstone course involving some undergraduate research component or a special study course of an advanced undergraduate character. Recent students have studied topics in fractal theory, actuarial science, Fourier transforms, numerical analysis, optimization models, modular arithmetic algorithms for mobile applications, and economic analysis of the Soo locks. It is also relevant to the Strategic Plan that some of these projects have included interdisciplinary work straddling the boundaries of various majors throughout campus or the community.

5. Assessment

Our School has a well-established assessment strategy for all of its programs which began in 2008 with the establishment of a School Assessment Committee under the leadership of now Professor Emeritus Sherry Duesing. The Assessment Committee formed subcommittees by discipline and measurable outcomes were created for all courses and programs by 2009 and a mapping was created by 2010. All of these objectives are located on the N: drive, though some have been edited in Tracdat since that time. Those objectives were then reviewed by Professor Duesing and Dr. Gregory to ensure that the outcomes were properly worded using established terminology in the field of Education.

Course Assessment

In 2009, we also created a two-page template for course objective assessment which recorded our data and a summary of how we planned to use this data to strengthen our courses, which would of course strengthen our programs as well. You can locate these old reports, beginning with assessment from 2009, on the N: drive under Assessment.

Before Tracdat, we had a well-established routine of completing our course assessment documents and steadily improving our courses. We feel our progress in this regard was well-ahead of the University as a whole. Course proposals were sent to the Curriculum Committee making changes to MATH 310, MATH 325, and MATH 411. We are also in the process of discussing another set of curriculum proposals regarding MATH 261 and MATH 421. (This is further outlined in Section 6 on "Opportunity Analysis".)

Now we find ourselves in 2015 with a dilemma largely created by Tracdat and the lack of clear communication by the School to new faculty members, as well as an assessment leadership hole left by Professor Sherry Duesing's retirement. (We will work to remedy this immediately.) Many of the faculty have continued under the old process while also entering data into Tracdat. These faculty upload the School document into Tracdat as evidence using "related document". Some faculty only complete the School document, but do not enter their data into Tracdat. Some faculty enter assessment data into Tracdat, but no longer complete the School document. It is our plan to have a meeting of School faculty early in the Fall of 2015 to discuss how we wish to report the data, while recognizing that it is being done.

In the summer of 2015, Dr. Kimberly Muller, Chair of the School of Mathematics and Computer Science reviewed the assessment reports for this program, both on the N: drive (pre-Tracdat) and on Tracdat. For those courses where the standard template is available, Dr. Muller found clear evidence of assessment data being used to change the amount of time spent on topics, the problems assigned, the methods of coverage of some material, the sequence of topics covered, etc. In cases where the form had been uploaded to Tracdat, she found that action items were not always made to demonstrate via Tracdat these changes, nor follow-ups on these items recorded in Tracdat to match the attached assessment document. There were a few courses where assessment data was minimal, leaving room for improvement, but overall assessment is being done. (The one exception is MATH 261 which is discussed in Section 6.) For data that is being uploaded without the School template and summary, it was found that it was less clear what actions are being done to improve the course when necessary, though some actions had been submitted. This again highlights the need for a School meeting on assessment to put us back on track.

Program Assessment

The School has mapped the course objectives to the program objectives. In most cases these course objectives are used to measure the program objectives. In one case the objective is measured by student placement after graduation. (These data were also in section 4 of this document.) For only one objective was the targeted threshold not met for the 2014-2015 academic year.

	Program Objectives	Courses	Targeted Threshold	Success Rate
1	Demonstrate a fundamental and foundational knowledge of mathematics by developing quantitative and abstract reasoning skills in order to build a conceptual understanding of logical structures and axiomatic systems.	MATH 215, MATH 216, MATH 305, MATH 341, MATH 351, MATH 401	90% of related objectives to hit targeted threshold	90.5%
2	Demonstrate technical mathematical skills in the areas of algebra, geometry, calculus, and statistics for solving problems.	MATH 151, MATH 152, MATH 251, MATH 305, MATH 308, MATH 309, MATH 310, MATH 351, MATH 411	90% of related objectives to hit targeted threshold	98.8%
3	Use software and other technology to solve problems.	MATH 305, MATH 309, MATH 351, MATH 401	90% of related objectives to hit targeted threshold	100.0%
4	Use their acquired skills in the pursuit of a job and/or graduate school.		At least 80% of the respondents should be employed or in graduate school within a year of graduation.	100.0%
5	Create mathematical models and use their mathematical and analytical skills to solve real-world problems.	MATH 151, MATH 152, MATH 251, MATH 310, MATH 351, MATH 401, MATH 411	90% of related objectives to hit targeted threshold	94.4%
6	Continue to acquire new knowledge for life-long learning in pursuit of their professional and personal goals.	MATH 215, MATH 216, MATH 341, MATH 401, MATH 490	90% of related objectives to hit targeted threshold	87.5%
7	Communicate mathematically in their profession and the broader community.	MATH 215, MATH 341, MATH 490	90% of related objectives to hit targeted threshold	100.0%

It was also noted that that this objective was low due to only one low-enrolled course in a single semester and the desired threshold is typically met. We will reassess the program in two years after another full rotation of courses to determine if further action needs to be made.

6. Opportunity Analysis

Recruitment

Our School developed several new initiatives to increase enrollment in the past year including a **Mathematics and Computer Science Field Day** for area high school students, calling and writing potential students, developing new pamphlets and power point presentations on our programs and increasing our presence on social media. We expected it to take several years to see any increase based on our efforts, but our school shows a remarkable 58.1% increase in admits already this year (the largest increase shown in the data compiled by Joe Barrs). We invite the administration to take advantage of this initial recruitment success by placing ours into the chosen set of programs, including biology, criminal justice, engineering, fire science and nursing , that regularly receive major emphasis in the LSSU promotional materials and presentations. A major STEM recruitment push makes perfect sense right now, and we believe our school is poised to attract those attentive to the job predictions. Note that our programs are much less expensive to run than those other programs, and we have the capacity to substantially increase enrollment with little or no marginal cost. Note that Mathematics and Computer Science produced 11 BS graduates in 2014-2015, compared to 14 BS graduates from the School of Engineering. Imagine what we could do if we had access to the level of support and resources of the SOE! We will continue to increase our efforts in recruitment, and we will continue to point out this opportunity for non-academic departments to support our efforts.

Facilities

Our facilities requirements are minimal. We share a lab with computer science and the computers are updated on a five year rotation using course fees.

Potential

Only 9 of the 17 BS Mathematics graduates in the past 7 years began their LSSU careers as mathematics majors. The majority started off as engineering majors, and 2 started as accounting majors. Thus, our program continues to provide an attractive option for retaining our strong analytical students.

We have streamlined our course offerings so that courses exclusively for the BS Mathematics program are offered only every 2 years. Still, these courses typically run with an enrollment of 7-10 students, which leaves room to recruit up to 20 additional BS Mathematics students, at no marginal cost to LSSU.

Section 4 provides strong evidence of the high quality of our BS Mathematics program is of high quality, but we do expect to make one change. We have not offered the required course MATH 261 Numerical Methods in several years, having instead offered a series of special topics courses in cryptography, game theory, logic, and computational geometry. These courses are often students' favorites and draw students from other majors. We would like to formalize this special-topics practice within our BS Mathematics program. Alternately, we may opt to require MATH 421 Real Analysis, since it would benefit the majority of our students who continue on to graduate school. Obviously, this course would then join the 2-year rotation. A third option is to replace the MATH 261 requirement with MATH 325 College Geometry. The first 2 options are cost neutral, whereas the third option would provide a net savings, since MATH 325 is a required course in the BS Mathematics—Secondary Education program.

Our BS Mathematics program is strong. Our graduates get into graduate school and get jobs. Recent experience indicates recruitment efforts yield results. We hope for support to build upon these arenas of potential.

7. Optional

While our program is not zero-cost it does pay for itself as evidenced in other sections. We would also like to again draw your attention to the tables in Section 2 that demonstrate that we are at the median of mathematics programs in the state relative to overall enrollment. Most mathematics programs across the U.S. are small when compared with overall offerings because it takes a comparatively rare gift for a student to succeed in such a program. However, a vast majority of universities still have mathematics programs to lend legitimacy to liberal arts and STEM offerings, draw talented faculty with terminal degrees and attract these gifted students to their ranks.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Computer Science 2014 Program Review**
This documentation is relevant to Question number:	**12**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Provides information about these programs using a prior program review format.**

Bachelor of Science Program in Computer Science

Part 1: Mission / Vision / Strategic Plan

The School of Mathematics and Computer Science can trace its existence to the time when Lake Superior State University (then Lake Superior State College) was granted 4-year status by the State of Michigan in 1966. At that time, the Department of Mathematics consisted of 8 faculty members, and offered the Bachelor of Arts degree in Mathematics, as well as coursework to support many other programs on campus. Computer Science, as a formal discipline, was added to the unit's curricular responsibilities in 1981. A number of degree programs have come and gone, and the unit has been aligned with a number of different disciplines in a variety of academic configurations over the years, but the original core of instruction in Mathematics and Computer Science has remained intact.

At the present time, the School of Mathematics and Computer Science offers these degree programs:

- BS Mathematics & Mathematics – Actuarial and Business Applications Concentration
- BS Mathematics – Secondary Education & Mathematics – Elementary Education
- BS Computer Science & Computer Science – Secondary Education
- BS Computer Networking & Computer Networking, Web Development Concentration
- Associates – Computer Science
- Associates - Internet/Network Specialist & Internet/Network Specialist – Web Development

In addition, we sponsor minors in Mathematics, Mathematics – Secondary and Elementary Teaching, Computer Science, Computer Science – Teaching, and Web Development.

Our program in Computer Science fully aligns with LSSU's Mission to "launch students on paths to rewarding careers and productive, satisfying lives." In the 2014 "100 Best Jobs" list published by US News & World Reports, five of the top 12 career paths - Software Developer, Systems Analyst, Web Developer, Information Security Analyst, and Database Administrator - are based on an educational background in Computer Science. Further, LSSU's Vision Statement asserts that "Our programs grow and evolve in ways that keep our graduates at the cutting edge of technological and societal advances." It is no stretch to argue that Computer Science is at the forefront of technological advancement.

The overwhelming majority of the coursework specific to the Computer Science program at LSSU is taught by faculty members holding doctorates in the discipline, and the curriculum was updated earlier in the 2013-14 academic year to be in full conformance with the most recent Computer Science Curriculum Guidelines, published in 2013 by the Joint Task Force on Computing Curriculum of the Association for Computing Machinery and the IEEE Computer Society.

An accreditation process for programs in Computer Science was first established in 1984, but we have not, as yet, submitted our Computer Science program for accreditation. While accreditation doesn't seem to be a factor in employment opportunities, it does appear that more universities are now seeking accreditation in Computer Science.

Part 2: Productivity

Enrollments in Computer Science have fallen, for no obvious reason, over the past two academic years, as illustrated in the following table:

Student with declared majors in Computer Science (including the discontinued programs in Computer Information Systems and Computer and Mathematical Sciences).

Fall, 2008	Fall, 2009	Fall, 2010	Fall, 2011	Fall, 2012	Fall, 2013
41	40	38	44	32	26

We are planning to launch some initiatives in the coming academic year in an effort to reverse this trend. It is our belief that, if we can get effectively the word out to prospective students about the opportunities available to graduates from our program, that this trend can be reversed.

Ideally, we'd like to see the number of graduates each year being close to 25% of the number of students. We have found, though, that many of our incoming students declare majors in Computer Science, but, due to weak backgrounds in Mathematics, often end up instead pursuing degrees in Computer Networking. The table below shows the number of graduates in both programs over the past several years:

Graduates in Computer Science and Computer Networking

	2007-08	2008-09	2009-10	2010-11	2011-12	20012-13
Computer Science	8	6	4	6	2	5
Computer Networking	7	9	8	9	10	6

The following tables show the instructional loads over the past several years in Computer Science courses. Many of the courses that we offer are taken by students in both Computer Science and Computer Networking, as well as students in Computer Engineering, and also those pursuing minors in Geographic Information Systems.

Computer Science Load Analysis					
	Fall Semester				
	Total Credits	Total Contract	Total Enrollment	Total SCH	SCH Per Contract Hr
2009 - 2010	51	52.63	373	693	13.17
2010 - 2011	52	56.33	373	729	12.94
2011 - 2012	51	53.57	406	738	13.78
2012 - 2013	50	54.67	369	709	12.97
2013 - 2014	45	49.00	309	585	11.94

Computer Science Load Analysis					
	Spring Semester				
	Total Credits	Total Contract	Total Enrollment	Total SCH	SCH Per Contract Hr
2009 - 2010	46	49.33	287	698	12.12
2010 - 2011	57	61.33	404	773	12.60
2011 - 2012	55	59.00	320	603	10.22
2012 - 2013	56	58.67	329	631	10.76
2013 - 2014	53	56.67	325	644	11.36

Two significant observations can be made about the information in these two tables. First, the "Student Credit Hour per Faculty Contract Hour" ratio has remained steadily between a low of 10.22 and a high 13.78. Since many of our courses include lab components, and, in many cases, the sizes of those lab components is restricted by physical space and equipment constraints, these figures are not particularly out-of-line. At the same time, though, there is still some room for growth in enrollments. If all courses offered reached their ideal "maximum" capacity, the credit hours per contract hour would be approximately 16. For contrast, the "Student Credit Hour per Faculty Contract Hour" ratio in Mathematics, where only MATH 103, 104, and 325 include lab components, lies between 25 and 30 in the fall semester, and 20 to 25 in the spring during the same time frame.

The second conclusion to be drawn from this data relates to the load being placed on faculty. At the present time, four full-time faculty members are responsible for teaching all but one of our Computer Science courses. During the time frame covered by these tables, the teaching loads – total contract hours divided by 12 – range from a low of 4.08 in the fall semester of 2013 to a high of 5.11 in the spring semester of 2011. In practical terms, this means that the faculty in Computer Science cannot absorb any additional load without incurring excessive amounts of overload.

Part 3: Demand

According to the US Bureau of Labor Statistics, demand for graduates in Computer Science is expected to be high for the foreseeable future. Their January, 2014 report shows the following demand and salary rates for careers that would typically employ Computer Science graduates:

Job Title	Growth by 2022	New Jobs	Salary
Computer & Research Information Scientist	15%	< 5,000	$75K+
Computer & Information Systems Manager	15%	50,000+	$75K+
Computer Network Architect	15%	10,000 – 50,000	$75K+
Computer Network Support Specialist	17%	10,000 – 50,000	$55-75K
Computer Programmer	8%	10,000 – 50,000	$55-75K
Computer Systems Analyst	25%	50,000+	$75K+
Database Administrator	15%	10,000 – 50,000	$75K+
Information Security Analyst	37%	10,000 – 50,000	$75K+
Network and Computer System Administrator	12%	10,000 – 50,000	$55-75K
Software Developers	22%	50,000+	$75K+
Web Developers	20%	10,000 – 50,000	$55-75K

Similar prospects are cited in the US News & World Reports "100 Best Jobs" list for 2014:

1. Software Developer (140,000 new positions by 2022)
2. Systems Analyst (24.5 percent employment growth projection by 2022)
9. Web Developer (20 percent employment growth projection by 2022)
11. Information Security Analyst (36.5 percent employment growth projection by 2022)
12. Database Administrator (17,900 new positions by 2022)
23. Operations Research Analyst (27 percent employment growth projection by 2022)
24. IT Manager (50,900 new positions by 2022)
30. Computer Programmer (8.3 percent employment growth projection by 2022)
52. Computer Systems Administrator (42,900 new positions by 2022)
78. Computer Support Specialist (123,000 new positions / 17 percent growth by 2022)

While we do not have a comprehensive system in place for tracking recent our graduates, we have had contact with 7 of the 8 graduates of our Computer Science, as well as the lone graduate from the discontinued Computer and Mathematical Sciences and Computer Information Systems programs, and all 9 of these alumni are employed in positions directly related to their degree programs.

Enrollment for our Computer Science coursework comes primarily from the majors and minors offered within our School, including the Mathematics and Computer Networking programs. However, students in Computer Engineering also take at least 4 Computer Science courses - CSCI 105, CSCI 121, either CSCI 201 or CSCI 221, and CSCI 342, while students pursuing a minor in Geographic Information Systems are required to take CSCI 105 and CSCI 211.

Part 4: Quality

Many of the ideas put forth in George Kuh's 2008 article on high-impact educational practices are an integral part of our program in Computer Science. All of our students in Computer Science, Computer Networking, and Mathematics are expected to enroll in our first-year seminar course, CSCI 103: Survey of Computer Science, during their first semester at LSSU. In addition, students from both the Computer Science program and the Computer Networking programs take a variety of courses together, including CSCI 103, 105, 121, 221, 263, 351, and 371. While part of the reason for this overlap is pragmatism related to course-size considerations, we feel that students in both areas have benefited from working together in these shared classes.

Computer Science students are required to participate in project experiences, both on an individual basis in CSCI 291: Computer Science Project during their sophomore year, and as part of a team in CSCI 418: Senior Projects I, and CSCI 419: Senior Projects II, during their senior year. These project courses combine writing requirements, collaboration with both classmates and community-based clients, and a capstone experience.

Interestingly, our inclusion of these features within the Computer Science program pre-date Kuh's 2008 article.

We've been able to effectively use our relatively modest budge to provide state-of-the-art instructional facilities. We maintain two dedicated computer labs and a student research and workroom, as well as two classrooms with dedicated computers, document cameras, and data projectors. We follow a rotating five-year equipment replacement plan to ensure that the equipment in all of these facilities is capable of supporting the ever-increasing demands of modern software.

We maintain three high-powered servers that are dedicated to our programs, and also use a number of virtualized servers to support the needs of our programs and the faculty and students in our department. Recent equipment upgrades will allow us to easily increase the use of virtualized servers to meet the needs of our programming classes, as well as provide test environments for student learning. The project to set up this new server was handled by a group of our CSCI 418/419 students.

Our department has agreements with several software vendors, including Microsoft, VMware, Apple, Adobe, and Wolfram. These licensing arrangements allow us to provide students with access to the latest software packages from these vendors, all of whom are leaders in their respective areas. Some of these agreements even allow students to obtain free copies of a variety of software products for use on their personal computers.

In addition to the variety of software vendors with whom we maintain paid contracts, we also make extensive use of free software packages that allow us to set up new lab experiences reflecting the current trends in the software industry. For example, we've been able to utilize freely available code bases and development tools to teach our students the skills they need to create software for handheld devices, to create tools that support both the client and server sides of web applications, to interface with database systems, and to explore modern operating system environments.

Because of the rapidly evolving nature of Computer Science, we are required to update our curriculum and course content on a regular basis. As noted in Part 5 of this report, we undertook a major curriculum revision to bring our program back into alignment with the most widely followed standards for Computer Science curriculum.

While this program doesn't specifically lend itself to taking advantage of LSSU's unique physical environment, we have been able to effectively leverage the locale to our advantage. Both the campus and the local community have been very receptive of offers to utilize our students for project activities in support of the CSCI 291 and CSCI 418/CSCI 419 courses. Delaney Software, a national software development firm, opened an office here in Sault Ste. Marie specifically to gain access to our students, several of whom have held internship positions, and subsequently move on to permanent employment with Delaney, in the last few years.

While the number of graduates in Computer Science has been relatively low over the past several years, there is no question that these graduates have been successful. One recent graduate went on to pursue a graduate degree in Computer Science at Trinity College in Dublin, Ireland, while others were accepted for graduate study in Computer Science at Western Michigan University and Central Michigan University. All of the recent graduates we've been able to reach who did not pursue graduate school are employed in positions related to the discipline, with job titles that include "Applications Developer," "System Designer/Developer," "Database Analyst," and "C++ Programmer."

Part 5: Assessment

Our last review of the Bachelor of Science in Computer Science degree took place in the Spring, Summer, and Fall semesters of 2013. During that process, the faculty members in Computer Science looked at both the courses required by our curriculum, as well as the objectives for those courses, and how they map to the program objectives. We also took the opportunity to align our curriculum with the newest version of Computer Science Curricula 2013: Curriculum Guidelines for Undergraduate Degree Programs in Computer Science, available at http://cs2013.org/final-draft/CS2013-final-report.pdf. This report is the recognized source for curriculum guidance in Computer Science. The publication is produced by the Joint Task Force on Computing Curricula, sponsored by the Association for Computing Machinery and the IEEE Computer Society.

One of the initial concerns that started the process was a decrease in student performance in the courses that follow CSCI 121. When we last addressed this issue, we chose to introduce a new course, CSCI 122, that was intended to provide a bridge between CSCI 121 and CSCI 201, giving the students additional time to develop basic programming skills before moving on in the sequence. Several topics were proposed for the class, which would also address other concerns about student preparedness in other upper level courses.

With several years of data available - both formally in TracDat, as well is indirectly, through student advising, discussion with students, student self-assessment, etc. - we met to discuss the effectiveness of CSCI 122. Upon review of the situation, we concluded that CSCI 122 was not meeting our needs. We discussed several possibilities aimed at improving student performance. At the same time, the draft of the previously mentioned curriculum guidelines was released, and we choose to adapt our discussion of the future of CSCI 122 into a full program review.

During this process, we developed a curriculum mapping[1], as well as a list of the core areas of computer science identified in Curricula 2013. With this focus on core areas, we worked to map course objectives to core areas, as well as program objectives.

One outcome of this round of program review was the restoration of CSCI 201 as a prerequisite for our Sophomore-level projects course, CSCI 291. One concern with the CSCI 122 proposal from the last review was the need to drop this prerequisite because it introduced a 5-semester sequence into the 4-semester AS program that also uses these courses. Spring 2014 was the last semester that students were allowed to take CSCI 291 without having first had CSCI 201. During that semester, all the students who had successfully completed CSCI 201 passed the class, while those students who hadn't completed CSCI 201 failed the class. While this is an extreme (and singular) instance, it does provide an example of the data available. It also serves to illustrate a problem in student learning that was identified by our program review, and our action to solve this problem.

The other outcomes and changes of this program review can be seen through the package of curricular changes that were submitted to the LSSU Curriculum Committee[2]. In fact, the most

1 Available on TracDat

2 Also Available on TracDat

obvious evidence of our continued work in program and course assessment is the number of things that we send to curriculum committee over the years.

Our department plan is to review each of our major areas (Computer Science, Computer Networking, Web Development, and Mathematics) on a rotating schedule. In general, this does happen, about once every four years. However, our program assessment and changes are not completely driven by that schedule. Changes in technologies and common Computer Science practices, changes in the resources that are available to our department, as well as a desire to address problems as they occur (rather than wait until the next time through the rotation) mean that we will make changes outside of the normal rotation. Additionally, changes to some of the courses that support multiple of our degrees sometimes necessitate changes to the program outside of the normal rotation.

Several years ago, our department adopted a standard form for reporting on assessment data at the end of the semester. This form was based on, and partly driven by, data that were needed by the Engineering Department for their ABET accreditation. This form is still used by most of the faculty in the department, but unfortunately does not readily lend itself to TracDat entry. We are currently working as a department to come up with a new plan / form that will meet the needs of the department, as well as allow for easier storage in TracDat. Implementation of this has been delayed by changes made to how / what types of information can be entered into TracDat.

Currently, we are in the process of mapping our curricular objectives directly to our program objectives. The version of program objectives in TracDat is current as of the start of this process. The version of course objectives in TracDat has been updated for all classes that we have access to. Due to difficulties in updating portions of our programs area, some of the latest changes, as well as ones that are currently under discussion, have not yet been uploaded to TracDat.

Our long-term goals and plans for the next four years are to evaluate the effectiveness of the changes most recently implemented, approved by Curriculum Committee in the fall semester of 2013. These changes are scheduled for implementation as the courses are offered over the next two years. Should something come up which requires more immediate attention, then we would deal with that in a timely manner. There is ample evidence from prior years Curriculum Committee agenda that we do so. Otherwise, our next formal review of this program is planned for 2016-2017.

Our primary areas for focused evaluation of these changes in the next years are student success in CSCI 291 as well as CSCI 418 and CSCI 419. Both of these classes provide a good indicator for student success after graduation, as they are project classes wherein most of the students have external clients that they need to complete tasks for. If students are prepared to complete those tasks for these clients, then they are prepared to do the same thing after graduation "on the job."

6. Opportunity Analysis

The single most important goal for the program in Computer Science is to increase enrollments. In the long term, we would like to see a minimum of 15 to 20 new students enter the program each year, preferably with a Mathematics ACT score of 23 or higher. Students with weaker mathematics skills can succeed in our Computer Networking or Web Development programs, but tend to struggle in the main-stream Computer Science curriculum.

With the high demand levels for graduates trained in Computer Science, we're mystified by the relative low yield we experience in the freshman class each year. Nationwide, Computer Science enrollments have historically been cyclic, but most schools are reporting an up-turn, while we are seeing disappointingly low numbers for the 2014-15 academic year.

This coming fall, we will be launching a "Mathematics and Computer Science Field Day," aimed at drawing the interest of local high school students We're also working to develop other outreach activities in an effort to attract a larger audience to this program.

Assuming we can attain a stable level of enrollment, we would like to investigate the desirability of pursuing accreditation, and also look at adding a Masters-level program in Computer Science, perhaps in the form of a "4 + 1" program.

At the present time, accreditation does not seem to be an impediment to students seeking employment. Unlike disciplines like engineering or nursing, accreditation is not viewed as a requirement, but there does seem to be a renewed interest in Computer Science accreditation, and it could be used as a positive recruiting tool.

We're in very good shape with laboratory facilities. We maintain two dedicated lab environments – one for programming-related activities, and a second for networking-related activities – primarily using revenues generated through course fees. Computer hardware is replaced on a four to five year cycle, and we've been able to keep current with software needs. In large part this is due to our participation in programs such as Microsoft's DreamSpark initiative, which, for a relatively modest annual fee, allows us to not only provide software for the labs, but also for our students, who can download a variety of products for their personal use.

While our staffing level is adequate for our current needs, some of our faculty members are almost constantly on overload. This does negatively impact their ability to be actively engaged in research. If our freshmen class was to grow beyond 25 students, it is possible that we would need to add at least one more faculty line in order to cover all of the required courses.

Appendix Cover Sheet

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School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Computer Science 2016 Program Review Monitoring Report**
This documentation is relevant to Question number:	**12**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Provides information about these programs using a prior program review format.**

Monitoring Report for the Bachelor of Science in Computer Science and Related Programs

This monitoring report is submitted in response to the request dated 9 October 2014 for additional commentary and follow up on the Program Review for the Bachelor of Science in Computer Science degree. This letter requested information on 4 things (the fifth being the request for this report to be produced). We also wish to address some of the comments from the 'track changes' of the original Program Review submission. The requested items are:

1. Revisit the goals for program growth relative to current enrollment.
2. Identify effective and meaningful assessment measures for each program outcome.
3. Develop and document evidence supporting program claims, and of the school's successes in 'closing the loop', showing how what you found was used to make changes and how those changes impacted student learning/achievement.
4. Update Tracdat with course/program assessment findings, evidence and actions.

The following lays out the Timeline of the Program Review Process and associated curricular changes:

May – June 2013	Program structure and content reviewed with respect to a preliminary release of Computer Science Curricula 2013 – Association of Computing Machinery
June – July 2013	Course content and degree progression reviewed
July – August 2013	Various proposals for content changes, course changes, and degree progression streamlining are generated and evaluated
October 9, 2013	*Notification of Intent to Change* submitted to the Curriculum Committee
October 23, 2013	Ten *Course Change Proposals*, two *New Course Proposals*, and ten *Program Change Proposals* are submitted to the Curriculum Committee based upon the prior review and evaluation process
October 23, 2013	All twenty-two proposals are "Approved With Amendment" by the Curriculum Committee
November – December 2013	Advisors inform current BS CS students of the programmatic and course changes
January 13, 2014	New and changed courses begin to be phased in while deleted/to-be-changed courses are "taught out" for current majors in Computer Science and related programs New/changed courses offered: CSCI 121, CSCI 371, CSCI 434 Deleted/to-be-changed courses taught out: CSCI 122, CSCI 201, CSCI 291
May 2014	BS Computer Science Program Review submitted
August 25, 2014	BS CS program "teach out" of the old program courses is completed New/changed courses offered: CSCI 201, CSCI 351
October 9, 2014	BS CS Program Review Report is reviewed and commented upon by the Provost's Council and all related materials are posted to the LSSU website
October 9, 2014	Provost informs Chair Thomas Boger by memo that the Provost's Council review has been completed and identifies five points of emphasis for the Monitoring Report scheduled for February 1, 2016

January 12, 2015 New/changed courses offered: CSCI 291, CSCI 411
August 31, 2015 New/changed courses offered: CSCI 342, CSCI 415

Item 1:

Coming up with numbers for program growth and enrollment in this program is somewhat difficult. Ideally, we would like to see about 15-20 students in our upper level courses. This would give us a good faculty to student ratio. However, to ensure those numbers at the junior and senior level, we would need to have larger freshman classes. The school, however, lacks the load necessary to accommodate the additional bodies in the lower level classes, particularly with the reduction by one (non-replacement of Dr. Terwilliger) and possibly by two (potential non-replacement of Dr. Kalata) of the faculty capable of teaching Computer Science courses. Furthermore, many of those entry level classes (CSCI 105, CSCI 121, etc) are shared by students from not only the CS major, but also the Networking major, certain Engineering majors, GIS students, and others.

Our goal that matches the course load available to the program would map out to about 55 students, spread out as 20 – 15 – 10 – 10. Note that most of our upper division B.S. Computer Science courses are alternate year in order to make more effective use of the limited faculty hours we have. At a 10 – 10 split for juniors and seniors our upper division required courses would have an approximate class size of 20. For some of these courses, the class size would be larger due to their use as a) required courses in other programs (e.g. CSCI 341 by Computer Engineering) and b) elective courses used by other majors that are minoring in CS.

The biggest hurdle to our students continues to be the CSCI 201 class. Once they are past that class, our retention rate is significantly better. With 15 – 25 students for sophomore level classes (depending on incoming math placement, students do not always take sophomore classes at the right time), and at a class size of 20 for freshman classes, the pipeline and load capacity would, in effect, be full. No additional load would be required for junior/senior classes; an additional section of lab for classes like CSCI 221 would probably suffice. However, assuming a steady level or an uptick in freshman from the other majors may require additional sections of freshman classes. With the drop in CS faculty from 4 to 3, there is no spare load (assuming maximum overload by all faculty) to accommodate that. If the drop is from 4 to 2, we will be unable to cover the courses required to graduate students in four years. In order to realize the goals for student increases, we have made significant efforts to recruit into our programs since the original submission of our Program Review.

In the Fall 2014 semester, we developed a Math and Computer Science Field Day for local high-school students. In the 2014, this brought close to 80 students on campus for a day of activities related to all programs offered by our school. In the 2015 event, we had attracted around 55 to 60 local students to campus. To create this event, we utilized the Columbus Day/Canadian Thanksgiving date when LSSU classes were not held. The funding for the event came from our advertising budget.

We have also participated in EUP College Night but this event rarely develops students that were not already interested in CS. In addition, we supplied materials to the Admissions Office to be distributed at the Escanaba FIRST Robotics event in March 2015 and again for use by Admissions during the FIRST Robotics season in 2016. At the first ever LSSU FIRST Robotics District event, the School of Mathematics and Computer Science also had a table with students helping to provide coverage and answer questions during the two days of the event. We used about $100 of our advertising funding to provide event-related giveaways. We also supplied materials to Ryan Sigmon in Admissions to promote our programs in the Minnesota STEM College Fair. He reported back that there was a great deal of interest in our materials. We also participate in Mindtrekkers, the Grand Traverse Stem Symposium, and Minecraft summer camps.

We continue to contact admitted students via email and letters to try to increase our rate of conversion from "admits" to "enrolled." It is too early to tell if this approach is succeeding, but the analysis of our admissions and conversions has led to an observation that a significant number of our applicants (about 22%) fail to complete their applications. The following table provides the raw data for applications, admissions, and eventual attendance:

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Applications Started	24	46	41	46	47	27
Applications Completed	18	35	32	36	38	21
Admits	18	28	31	35	38	19
Enrolled	10	8	10	10	12	?

Of significant concern is the drop-off (mirroring the drop overall across campus) in the number of applications from 2015-16 to 2016-17. The number of applications started and the number of applications completed had been very consistent over the past four years; however the numbers for the upcoming fall semester are down significantly. This might be due to any number of factors and without further data collection and analysis it would be irresponsible to speculate as to the actual cause.

The following table shows the total number of majors in the B.S. C.S. program at all levels:

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Declared Majors (B.S.)	32	22	29	25	32	35 (Projected)

Our projection for the 2016-17 school year is based upon a loss of six graduating seniors, a net-loss of zero majors due to non-retentions (losses) and changes of majors (gains), an estimate of five FTIC freshmen (due to the lower overall applications and admits for Fall 2016) and a net-gain of three transfer students.

On the other hand, we would like to note one positive change with respect to our marketing and admissions. With the hire of Dr. Hackbarth-Onson, we have witnessed a larger emphasis being placed upon the recruitment of students into our programs. If this trend continues, we expect that the results to be realized in two to three years from now, given that the recruiting sweet-spot is generally accepted to be at the sophomore/junior year of high school. That is, an increase in recruiting profile now affects your numbers in two-to-three years since all seniors and many juniors have already made their choices of where to apply.

Items 2 and 4:

Program level measures, findings, and actions have been added and uploaded to TracDat based on information for the 2014-2015 school year. With the retirement of Tom Boger, the resignation of Mark Terwilliger, and the non-tenuring of Dr. Kalata, the duties assigned for the collection and processing of some of the information will need to be altered. Dr. Terwilliger, for instance, had been handling the alumni job-placement survey. The composition of the evaluating committee for Sophomore and Senior projects will also need to be re-thought, as it is our understanding that a term-position may not sit on such a committee.

We would also like it noted that according to Dr. Myton, this program now has 100% for all course level assessments (excepting classes that have not been offered yet) entered into (or pending entry into) TracDat.

Though not mentioned in the October 9, 2014 response letter, there were several comments related to the lack of a curricular map. This curricular map was referenced by us in the program review. The document can be found in the 'Program (MATH-COMP.SCIENCE) - Computer Science BS' folder, 'General' subfolder. This document has been updated since the initial program review to reflect the curricular changes in the last year.

Item 3:

The changes to the curricular mapping (and curriculum) are a direct result of the end of semester meeting covering student presentations and projects for the Sophomore (CSCI 291) and Senior (CSCI 418/419) Projects. Several participating faculty noted deficiencies in the oral and written presentation skills of the students. The decision was reached to add ENGL 306 to the curriculum in order to address this problem. The addition of this course to the degree requirements has already shown some benefit, even though we only have one year's worth of data at which to look. The involved faculty members were pleased enough with the interim results to recommend the inclusion of this course into the Computer Networking degree as well (where a similar problem was noted).

The faculty are currently looking at the outcomes for the CSCI 201 course. We desire a more consistent performance for all of our students in this course and we are taking under consideration a change of language and outcomes to the introductory course, CSCI 105, which we believe is being taught at a level that does not serve well the follow-on courses. Any change to this course, and to the core programming sequence overall, would occur no earlier than the Fall 2017 semester.

Although not necessarily as a result of assessment, the non-hiring of a replacement for Dr. Terwilliger and the tenure-denial of Dr. Kalata have created some curricular problems related to the courses that only these two faculty members cover. For instance, the newly revised CSCI 411 that was introduced in the Spring 2015 semester now has no qualified faculty to teach the course. It is a required course in the BSCS curriculum and is scheduled to be taught in the Spring 2017 semester. Changes will need to be made to courses such as this, and to our curriculum, to adjust to the skill set of the remaining faculty. We have already looked at CSCI 411 and the best alternative currently is to modify this course's topic to be intelligent systems and work with our engineering colleagues to have the course listed on the minor in robotics (replacing the deleted CSCI course on expert systems).

Conclusion

We have enacted the changes related to our 2014 Program Review. All changes have now been implemented and we have begun assessing their impact upon our outcomes. Because of the uncertainty of our faculty positions, we may need to make further curriculum changes in the near future.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Computer Networking 2016 Program Review**
This documentation is relevant to Question number:	**12**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Provides information about these programs using a prior program review format.**

School of Mathematical and Computer Sciences
Program Review for
Bachelor of Science in Computer Networking
and
Bachelor of Science in Computer Networking – Web Development Optional

Summer 2015

Part I – Mission / Vision / Strategic Plan (1 Page)

[In order to simplify the writing of this document, both the Bachelor of Science in Computer Networking and the Bachelor of Science in Computer Networking – Web Development are simply referred to as the Bachelor of Science in Computer Networking. Only in places where there are important differences between the two options will those differences be pointed out.]

The Bachelor of Science in Computer Networking was first offered at LSSU in 2002. Originally, it was a joint program with Sault College, in Ontario, Canada. Due to a combination of quality control issues and increased difficulty in border crossing for the students, the cooperative effort was phased out and the program was housed completely within the school between 2007 and 2010. In 2009, a web development option was added for students who wanted to concentrate on the web development aspects of Computer Networking, instead of generalizing.

There is some basic overlap with the Computer Networking degree and the Computer Science degree. Many of these are introductory courses, however, we have deliberately structured two junior level courses to include both sets of students so that they may see both sides of the picture. Students seeking jobs in Computer Networking must understand how computers work in order to network them efficiently, and meet the needs of their users. They must also understand basic programming concepts as they seek to automate portions of their jobs. Students in Computer Science must understand networking and user models in order to create software and systems that are actually usable and meet the needs of clients.

The Bachelor of Science in Computer Networking is fully in line with the University, College (as of June 2015), and School Mission statements, as well as the University Vision Statements. These statements emphasize the need to "launch students on rewarding careers", involve students in "life-long learning", and preparing students for careers "crucial to the progress of our nation in the 21st century". As one considers the changes to both national and international infrastructures, it should be obvious that a knowledge of Computer Networking, as well as the ability to keep pace with the changes in that field will be essential to students looking for jobs both in the near future, as well as long term. Already, in 2015, it is hard to find a job that is not impacted by the presence of either the internet (as an external network) or the need to network machines inside a businesses infrastructure (internal network).

Our compliance with HLC Assumed Practice A.7.a comes in three parts:

The Bachelors Degree in Computer Networking prepares students to take and complete a number of nationally recognized certification exams, including those CompTia, Novell, Linux Foundation, Cisco, and others. The need for students to have these certifications has never been universal, or even required by the majority of employers, but our students have been prepared to pass certification exams if their employer requires it. We have also been very successful in allowing waivers for some of our introductory classes for students who transfer into LSSU with the certifications in hand (mostly for community colleges, who often structure their networking offerings directly around a particular certification exam).

All but a single two-course sequence in the Bachelor of Science in Computer Networking is taught by faculty who hold terminal degrees either in the field, or a closely related field. That two-course sequence is currently taught by an adjunct, but we are looking for a replacement in order to bring the teaching of that class in line with HLC requirements for adjunct teaching of a class (the previous instructor had significant professional experience with the topic, but has no advanced degree).

There is no current national or international standards of accreditation for Computer Networking that we might align ourselves with. We instead, have formed our program around the major areas that professionals in Computer Networking need to know for the types of networking jobs that are available, as well as the major topics of concern in those fields (computer security, for instance).

Part II – Productivity (Argos)

Argos does not provide separate numbers for the Web Development degree option, all data in Argos is lumped into CMPTN-BS. This is another reason that we have combined the review of these two programs into a single document. The number of graduates for the Computer Networking Degrees is shown in Table 1. The ten year average is 8.1, and the 5 year average is 7.6.

05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15
10	7	9	8	9	10	6	11	6	5

Table 1: Graduates in Computer Networking (both Degrees)

Table 2 shows the student count for just the networking degree over an eight year span. Data for 05-06 and 14-15 were not available in Argos when the report was run. The average number of students enrolled as networking majors is 34.8. The average for the last five years (of data) is 31.8. Note that when assuming an average of 4 years to complete a degree, and comparing these number to our graduation rate, we account for approximately 93% of students. This number is not exact, as there are a number of transfer students, students who change major, and other factors to consider.

06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14
36	45	37	35	34	31	32	27

Table 2: Student Count for Computer Networking (both Degrees)

Since all Computer Networking and Computer Science students are advised by one of the five (Professor Boger still has some CS advisees, even though he only teaches Mathematics courses now) of us, the totals here and from the CS program review last year provide a guide to the number of advisees each faculty has.

Argos is not particularly helpful in extracting data for courseload relevant solely to this program. One primary difficulty is that the 4 faculty who teach courses also teach courses that apply solely to the Computer Science degree, as well as service courses and classes for some of the Mathematics degrees. We have also (as overload) taught from time to time courses for the Engineering disciplines as well as Teacher Ed. Argos, it seems, will only report things by School.

We did extract some data from Argos though, for the school (and other schools) as a whole. For the school as a whole, we have the fourth largest average class size (20 or 16, depending on Fall or Spring semester). The school as a whole generates about 10.4% of the total Student Credit hours over the course of the year. Much of that load is the service course taught in the math curriculum, but as previously stated, the four CS/CN faculty regularly teach part of that load.

Currently, all but one course sequence in the CS/CN curriculum is taught by full time faculty. Due to HLC qualification issues, we are looking at options to absorb that course into our teaching load as well. Computer Science and Networking faculty regularly teach overload (more than the 12 contract hours defined in the faculty contract) in order to cover all the classes needed for our students to graduate on time. We also routinely carry more than the contract mandated number of preps (a median of 5.3 over the last four years).

The lab and classroom facilities used by this program (which are shared by Computer Science and Mathematics) are completely funded by student lab fees. The Networking program shares the same 1/2 time support staff used by the rest of our programs.

Part III – Demand (1 Page, Internal and External)

According to the US Bureau of Labor Statistics, demand for graduates in Computer Networking is expected to be high for the foreseeable future. Their January, 2014 report shows the following demand and salary rates for careers that would typically employ Computer Science graduates:

Job Title	Growth by 2022	New Jobs	Salary
Computer & Research Information Scientist	15%	< 5,000	$75K+
Computer & Information Systems Manager	15%	50,000+	$75K+
Computer Network Architect	15%	10,000 – 50,000	$75K+
Computer Network Support Specialist	17%	10,000 – 50,000	$55-75K
Information Security Analyst	37%	10,000 – 50,000	$75K+
Network and Computer System Administrator	12%	10,000 – 50,000	$55-75K
Web Developers	20%	10,000 – 50,000	$55-75K

Similar prospects are cited in the US News & World Reports "100 Best Jobs" list for 2015:

8. Information Security Analyst (36.5 percent employment growth projection by 2022)
11. Web Developer (20 percent employment growth projection by 2022)
20. Operations Research Analyst (27 percent employment growth projection by 2022)
21. IT Manager (50,900 new positions by 2022)
31. Computer Systems Administrator (42,900 new positions by 2022)
77. Computer Support Specialist (123,000 new positions / 17 percent growth by 2022)

In comparing programs in Computer Networking at other schools, note that the term is used to mean two different sub-fields. Some Universities offer a program called 'Computer Networking' that is the study of data transmission across a distributed system. These programs are often housed as part of Computer Engineering, and are more concerned with the hardware and algorithms used to transmit the data. Ferris State has such a program. This type of program is not what we are attempting to offer, and should not be used for comparison.

'Computer Networking' is also used to refer to the study of managing the hardware and resources of a network for the effective and secure use of those resources. These programs are concerned with the effective management and security of resources for the users of those resources (sometimes referred to as Information Technology). Our program is of this type.

There are a number of programs at the Associates level both in the state and outside that offer courses in Computer Networking. There are a number of Computer Science programs in the state (MTU, for instance) that offer some courses in Computer Networking topics, but most of them are add-ons to a more traditional Computer Science degree. None of them have either the breadth or the depth of coverage that we do in areas of operating system management, computer security, and network hardware management.

Dr. Terwilliger has begun a process of conducting alumni surveys approximately 3 months after each graduating class. We get about an 80% response rate, and are able to fill in some of the missing data (job placement, for instance) from other sources. This tool has let us know the percentages of our students that get jobs or go on to graduate school. Copies of the last three years worth of job placement data have been uploaded to TracDat. The 2015 survey will be sent out later this summer, and so it's data is not available.

Enrollment for our Computer Network coursework comes primarily from the majors and minors offered within our School. However, students in Computer Engineering take CSCI 221, and students in Fine Arts can take also take up to 9 web development courses as part of their degree. Courses in web development have also been taken by students as electives from PR/Communication, Fine Arts, and Liberal Studies. Many of our Computer Science majors take courses in Computer Networking in order to add breadth to their degree and expand their employment options after graduation.

Part IV – Quality (2 Pages)

Many of the ideas put forth in George Kuh's 2008 article on high-impact educational practices are an integral part of our program in Computer Science. All of our students in Computer Science, Computer Networking, and Mathematics are expected to enroll in our first-year seminar course, CSCI 103: Survey of Computer Science, during their first semester at LSSU. In addition, students from both the Computer Science program and the Computer Networking programs take a variety of courses together, including CSCI 103, 105, 121, 221, 263, 351, and 371. While part of the reason for this overlap is pragmatism related to course-size considerations, we feel that students in both areas have benefited from working together in these shared classes.

Computer Science students are required to participate in project experiences, both on an individual basis in CSCI 292: Computer Networking Project during their sophomore year, and as part of a team in CSCI 418: Senior Projects I, and CSCI 419: Senior Projects II, during their senior year. These project courses combine writing requirements, collaboration with both classmates and community-based clients, and a capstone experience. Final evaluation of these projects is done both by their community-based client, as well as the faculty of the school. As all students who graduate from either of these degrees are required to take both CSCI 418 and CSCI 419 here at LSSU, we can claim that 100% of our students have participated in research, service learning, and experiential learning activities as part of this curriculum. Of course, they also meet this requirement in other classes as well.

We've been able to effectively use our relatively modest budget to provide state-of-the-art instructional facilities. We maintain two dedicated computer labs and a student research and workroom, as well as two classrooms with dedicated computers, document cameras, and data projectors. We follow a rotating five-year equipment replacement plan to ensure that the equipment in all of these facilities is capable of supporting the ever-increasing demands of modern software.

We maintain three high-powered servers that are dedicated to our programs, and also use a number of virtualized servers to support the needs of our programs and the faculty and students in our department. Recent equipment upgrades will allow us to easily increase the use of virtualized servers to meet the needs of our programming classes, as well as provide test environments for student learning. The project to set up this new server was handled by a group of our CSCI 418/419 students. These students have also made use of our virtualized environment to set up systems for Dr. Kalata's summer camp, as well as other school initiatives.

Our department has agreements with several software vendors, including Microsoft, VMware, Apple, Adobe, and Wolfram. These licensing arrangements allow us to provide students with access to the latest software packages from these vendors, all of whom are leaders in their respective areas. In addition to the variety of software vendors with whom we maintain paid contracts, we also make extensive use of free software packages that allow us to set up new lab experiences reflecting the current trends in the software industry. For example, we've been able to utilize freely available code bases and development tools to teach our students the skills they need to create software for handheld devices, to create tools that support both the client and server sides of web applications, to interface with database systems, and to explore modern operating system environments, and interactions.

There is no formal accreditation body for Computer Networking. So, we have chosen to model our program around three things. First, for coursework common to both the Computer Science and Computer Networking degrees, we have followed the ACM Computer Science Curricula 2013: Curriculum Guidelines for Undergraduate Degree Programs in Computer Science, available at http://cs2013.org/final-draft/CS2013-final-report.pdf. This report is the recognized source for curriculum guidance in Computer

Science. The publication is produced by the Joint Task Force on Computing Curricula, sponsored by the Association for Computing Machinery and the IEEE Computer Society. Courses that are common to both the Computer Science and Computer Networking majors are assessed regularly to see that they meet the needs of both sets of students, and any changes to the curriculum intended to affect one area are carefully analyzed to see how they will affect the other.

Second, we have identified certification exams relevant to our coursework offerings and ensured that content of those courses covers the material on the certification exams. We have endeavored **not** to make the course a 'prep' for the certification exam, however, as many community colleges have done. Rather, we have looked at the exams and/or topics covered by the exams, and compared them against the content covered by the classes to make sure that we have not missed any vital components. We have had a number of students who have gone on to take certification exams after the relevant classes, and they have reported back that they were well prepared for doing so.

Many of the classes that cover material on certification exams are specifically designed to take student learning to higher levels than simply reproducing material read from the study book. We expect students to analyze competing products, and to apply knowledge to simulated real-world problems. No such textbooks exist for most of the classes where this applies.

We have incorporated material for such exams for some of the web design exams [Adobe certifications of Adobe Certified Associate (ASA)], operating system classes [Novell and Microsoft certifications for several products through their respective companies, and Linux certification through either Linux Foundation or CompTia], basic hardware [A+ certification through CompTia], basic and advanced networking hardware [Network+ through CompTia, and Cisco certification through Cisco], and web development [The World Organization of Webmasters (WOW at www.joinwow.org), the International Webmaster Association (IWA), and CompTIA].

Third, the very nature of this discipline, and the continuing nature of change in it has spurred curricular development in ways that are not as easy to cover via the last two methods. We present four examples of how this has influenced our curriculum.

A] Studies continue to show that a very significant (up to 30% in some surveys) continue to use outdated (95, 98, XP) versions of Microsoft Windows. There is a very real possibility that our students will be required to maintain these obsolete systems, and even to interface them to their more modern (Windows 7, 8, 2013) counterparts. Most textbooks have already completely discarded their coverage of these older systems. We however, have kept some coverage, and deliberately address issues with maintaining compatibility for these older systems. We target both the necessary steps for doing it, as well as the advantages [mostly legacy system support] and disadvantages to such an approach.

B] Because we were early adopters of VMware's VMAP program, we were able to integrate virtual machine technologies into a number of our Operating Systems classes. This is a great strength of our program compared to many others, as our students are able to (required to) manage multiple different virtual versions of some of the Operating Systems, instead of the single machine they are assigned in more traditionally run courses. Our students are able to not only work with more variants of software, but able to study the interactions between them. This is useful to them not only for the reason stated above, but because they are able to monitor the controlled exchange of information between their virtual machines, and have both a better understanding as well as be able to analyze security and protocol issues between machines (any machines, not just dis-similar Operating Systems).

C] When both Heartbleed (an exploit in the SSL security protocol implementations discovered 2 years ago), and the Bash bug (popularized as Shellshock in the media, from 2014) hit the scenes, we were immediately able to address these within the already existing framework of our curriculum. We were able to discuss not only the real problem with these two incidents, but also the real solution, and the problems inherent in many of the popularly proposed solutions. Were our curriculum tied to a specific exam, we would not have been able to integrate that as easily, or as early (the first textbooks talking about these two are just hitting the markets now).

D] We have incorporated new technologies in web development; such as implementation, design, and administration of content management systems starting about 2012. This is before the technology had become mainstream (such as the new system being sold to the university). These same technologies are considered alongside and as alternatives to traditional web development strategies by our students for real-world clients in our projects classes. Students are required to justify (to the faculty) their choices in whether to use, not to use, or to integrate both methods into their projects.

Part V – Assessment (2 Pages)

The Bachelor of Science in Computer Networking and the Bachelor of Science in Computer Networking – Web Development have both had components reviewed over the course of the last four years. Our last full review of the program was in 2009, when we added the Web Development option to the curriculum. Instead, our review and assessment efforts for these programs in the last 6 years have centered around five concerns, or external problems that we have had with content in the programs. Some of these have been directly motivated by assessment of students performance, others have been motivated by the need to mitigate external problems in ways that minimally impacts the learning outcomes and quality of the program as a whole.

The first such issue was the loss of our qualified adjuncts for the old CSCI 271, CSCI 303, and CSCI 305. Since taking over these classes from Sault College, we had been using adjuncts who held current certifications for the material to teach these classes. Due to changes in their lives, they were no longer able to adjunct these classes for us, and we were faced with the need to either drop these classes from the curriculum, or find a way to integrate the material into either existing classes, or fit the classes into available faculty load. After considerable discussion, we decided to condense the material from CSCI 271 (Novell System Administration) and CSCI 303 and CSCI 305 (Windows System Administration) into a pair of classes CSCI 248 and CSCI 348. This gave us the ability to salvage most of the content, but also the ability to add a compare and contrast component to these two Network Operating Systems (NOS) not previously present (since there was no requirement that students take CSCI 271 before or after the 303-305 sequence). We have also been able to add a small bit of material covering the interactions between dissimilar NOS's that we were previously unable to cover. This is very useful to our students as it is increasingly common to find larger companies utilizing multiple NOS's for different corporate components (most often supporting a legacy system that they are unwilling, or unable to migrate to a more recent NOS).

Student self-assessment feedback has indicated that students sometimes find keeping both sets of operating system parameters to be sometimes confusing. On the other hand, they have also reported that seeing multiple ways of performing the same tasks helps them to understand what is actually happening in the system. We are discussing ways to deal with the first set of comments, and are pleased to see that we have been successful with the second set.

The second issue was a need to increase our emphasis on security. Network security is one of the biggest issues today. Sadly, in many ways, network security **implementation** has not moved much in the last decade. In response to student performance in a number of classes, we have added another class on Computer Security (CSCI 263), as well as begun to specifically identify good and bad security practices in a number of other classes (CSCI 121, CSCI 248, CSCI 371, among others). Students are also assessed on whether they are following good security practices in these classes. Student feedback on self-assessment forms indicates that they do not like this emphasis, but student feedback from graduates indicates that they are finding it very useful in their careers.

The third issue we addressed was a concern about web development students being able to successfully pass CSCI 422 (Network Security). This class is a very rigorous class, and in order to fit in all relevant material, relies very heavily on material covered in previous classes; far more so than most pre-requisite requirements. Since the Web Development students do not take as many of the general network classes as their generalist counterparts, they have not had the depth of experience with the background material, and student performance was significantly lower for them than the regular networking students. After considerable discussion, we decided that the coverage of security (as it relates to web development) was just as well covered by the combination of material covered in CSCI 275 and CSCI 348. CSCI 422 does cover some aspects of web security, but covers a number of other aspects of security as well).

Web development students already take CSCI 275, and so we decided to give them an option to take either CSCI 348 or CSCI 422. CSCI 348 is the second half of the Network Operating Systems sequence (taken after CSCI 248), and CSCI 422 is taken after CSCI 412. Most Web Development students have ended up taking CSCI 348 since the change.

Our fourth area of concern was potential overlap or missing material between a number of courses in the regular networking degree, and those particular to the Web Development degree. When originally mapped out, there was a fairly clear understanding of what should be taught in each of the new courses, and effort was expended to ensure that pre-requisites were sufficient to prepare students, but not excessive enough to delay or hinder graduation. However, after a time, offering patterns, patterns in the order that students take classes, as well as changing needs for coverage of material in some classes was leading to a perceived overlap in some content between classes. Additionally, feedback from student self-evaluations indicated that some content was not being covered. Several of us met last summer to address these concerns, and to reinforce and renew the mappings as to which content material would be covered in which classes. We reached several decisions during these meetings. We present two of these here.

We needed to provide additional emphasis to some basic networking concepts in earlier classes. This material was already being covered in those classes, but students were not retaining the material for the upper level classes. This emphasis should (follow-up assessment is in-progress as of this writing) reduce the student perception of not having covered the material, as well as improve student performance on the material in follow-on classes.

With the option to take CSCI 348, and the alternate year offering for CSCI 275, there is no guarantee which of these two classes students may take first. In fact, it is possible they may take them both at the same time, or that they only ever take one of them. CSCI 275 concerns itself exclusively with Web server administration, whereas CSCI 348 has such at a lower level, but only as one component of the course. We wanted to ensure that important web administration topics were included in both classes, so as to reach all students. We also wanted to make enough different in topic presentation so that students taking both classes are exposed to different ways of looking at the same topic, so as to reinforce it, rather than belabor it. Dr. Kalata and Dr. Schemm were able to meet separately to discuss some methodologies as well as assessment metrics that achieve these goals. They were first implemented in Spring 2015, and seem to have been successful. We are awaiting further data, though before putting the matter to rest.

Finally, after discussions about senior project options (for all our degrees) we decided to consolidate our three senior project options in a single 2-course sequence. At the same time, we re-wrote the course description to better inform future employers what the content of the class is. This will allow students to better market themselves to potential employers, as well as educate students as to the options for senior projects available to them. This new language has just taken effect, so we are not able to evaluate it's effects at this time.

Additional documentation on most of these can be found in the curriculum proposals that accompanied these changes. We have also uploaded 'screenshots' of some of the discussion boards from these meetings (some are no longer available). Such documentation can be found in the Tracdat Document repository. We have also uploaded a curriculum map to the relevant Document repositories as well.

Part VI – Opportunity Analysis (1 Page)

Our biggest long term goal, as well as our biggest challenge is to grow the program. We can fairly easily accommodate another 10-20 students in these programs. This growth would lead to some additional sections of some of the lab classes, which could be covered by the existing faculty at the same load, with the 'cost' that they not be able to teach Mathematics / other classes. Increasing enrollment beyond that would require either restructuring the load, the coursework (or offering patterns) or the hiring of additional faculty.

In the last several years, the university has not been willing to market our program or recruit students for us, and so we have taken the initiative in marketing and recruitment ourselves. Dr. Kalata and Dr. Smith have attended a number of events with some of our students both to broaden their horizons, as well as to get the word out about our programs. Our projects classes have solicited projects and internships off campus that we have able to leverage as marketing tools. Last fall, we held our first "Mathematics and Computer Science Field Day". We were able to invite over 50 high schoolers to campus to learn and experiment with elements of Computer Science, Computer Networking, and Mathematics. Plans are already underway for hosting it again this fall. We have also attempted a number of other outreach programs, and are looking at several others to get the word out about our programs. Dr. Kalata and others have also been actively promoting us on social media, and has set up a school presence through several of them.

Attracting students to the program should not be a significant hurdle. The degrees are consistently rated as among the most in demand, and given our societies reliance on technology, isn't likely to change in the near future. The difficulty has been getting the word out to the right students. We have also started trying to work with High School guidance counselors to help them understand what Computer Science and Computer Networking really are (they aren't just that you like to play computer games all day). Our internal marketing efforts have been able to allow us to connect with local area schools and counselors. However, in order to increase our student count by the stated amount we recommend the University marketing and admissions develop a more comprehensive plan to market our specific program at all recruitment events, on social media regularly and substantially in the visuals and articles within university marketing and alumni materials.

We have been working with some of the community colleges to get transfer agreements in place either as 2+2 or 3+1 in order to increase the number of upper level students that we have. Some of these have already been approved by the school and are awaiting final approval by administration, others are in earlier stages of development.

Our lab and classroom facilities have been almost completely funded by our student computer lab fee money. These funds have allowed us to maintain a five year rotation on our lab and classroom computers, pay for the specialized software that we use, and provide most of the support needed to maintain them (we do rely on Bruce for warranty support via the University's Dell contract, as well as IT for access to the University's Microsoft Office license). Dr. Schemm works with the faculty in the school to make sure that the facilities in our 2 labs, research room, and 2 classroom spaces are up to date with what faculty are trying to do.

Both of the degrees reviewed in this document already have Associates Degree versions of the program. We have been successful in using that to attract some non-traditional students to the program. The Michigan TIP program will often pay for the Associates degree version of our degrees. Afterward, students can seamlessly transition into the Bachelors degree (which they then have to find other forms of aid for).

PART 2: Degree-Level Review

Degree Program: Bachelors in Computer Networking

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

13. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

    See included document FourColumnBSinCN.pdf.

Degree assessment for this program is handled in two ways. First, the capstone course for this program is the Senior Projects sequence (CSCI 418 and CSCI 419). As part of the evaluation of student projects, faculty in the Computer Science and Computer Networking areas meet to discuss student performance, as well as evaluation success of the students on our four program level outcomes.

The second method used to assesses the program level outcomes is to look at the aggregate of course level assessment for courses taught that semester that are tied to each of the four program level objectives. These aggregate level assessments indicate that in general, we are reaching our goals. Specific places where we have trouble (students do not meet the goals) are usually related to a specific class, and are commented on, and tweaked at the course level. Years ago, our school adopted an end-of-semester reporting form for course assessment that (among other things) specifically addresses things that did not go well in a course, as well as proposed changes to address that. Please see the numerous examples in TracDat of such data.

14. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

During some of the annual meetings to discuss projects, we have observed that students have successfully completed the project portion of the course, but have had issues with the professional communications required as part of the project (both to us as well as their clients). After discussion with the English Department, ENGL 306 was made a requirement of the degree. We only have a couple years of data (inconclusive, since students could elect to continue under their old degree requirements that did not include ENGL 306) since this was implemented, but we have noticed an improvement, both in their ability to deal with their clients as well as the professionalism of their final presentations.

It should be noted that the BS in Computer Science was the first of the two Bachelor's degrees to make this change, and that because we noticed some improvement (even from the limited data of 1 year) we determined to change the Bachelors Degree in Computer Networking the following year.

An example of changes made from aggregate data review are the reorganization of topics between CSCI 248, CSCI 275, and CSCI 348 which took place. We noted that students in the upper level classes (CSCI 325, CSCI 348, and CSCI 419) were getting inconsistent coverage in some of the web service content. After some further investigation, we noted that students could get to upper level classes without having taken all the lower level courses (due to alternate year or other odd offering patterns). To correct the problem additional coverage of the basic topics was moved to the earlier classes. This change has improved student performance.

A second example of a change here is a pending decision to increase the pre-req on CSCI 211 from CSCI 105 to CSCI 121. We have found that many students do not have the programming experience to be able to handle writing database applications currently. Ironically, the pre-req was originally lowered specifically to accommodate Computer Networking majors (who take fewer programming classes, and had less need for database material). Feedback from instructors teaching the class, as well as a recent survey of the job market shows that this area is significantly more important to our Computer Networking students, so we will be increasing the pre-req to make the course more beneficial to the students and their future employers (our real clients).

Quality, Resources and Support (CC 3.A)

15. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

For basic information, please see the attached degree audit (document BS Computer Networking_F16.xlsx) and curricular map (document BS_CN_CurricularMap2018.xls) for this program. The degree audit was specifically requested, and represents the current course completion required to earn this degree. The curricular map shows how each of these courses relate to the four program level outcomes for the degree program (the first four columns), as well as the Institutional Level Outcomes (ILOs).

The Program Level Objectives were updated in 2018 to make them easier to assess and measure. We also decided at the same time to show the relationship of our courses to the university ILOs at the same time, as these ideas are core to the profession of Computer Science. Almost all jobs in this field revolve around taking the needs of clients, industry accepted standards (security for example), which often are not understood or even valued by clients and producing a unique system to meet the needs of those clients. The inclusion of the University ILOs allow us to focus on both the technical aspects of the field (our program learning outcomes) as well as the service aspect that most jobs in this area have (university ILOs). While almost all our courses touch on the ILOs in some way, courses tagged as related to the ILOs have a higher level of relation to them.

Intellectual Inquiry (CC 3.B).

16. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

Almost every course in this degree involves the analyzing of needs for a computer networking system, as well as setting it up to work with the actual users of the system (communication). Any of the programming or scripting classes (CSCI 105, CSCI 121, CSCI 281, CSCI 371, etc) involve the input (collecting), processing (analyzing), as well as output (communication) of information.

For most of the lab classes (CSCI 248, CSCI 348, CSCI 412, CSCI 422, etc) students are required to demonstrate that their setup is correct by using the system in it's intended manner. For web servers, for instance, this would be by creating and 'hosting' web pages on their server. These pages would be unique to the student creator, and independent of server software.

Many of the projects for our upper level courses (CSCI 348, CSCI 412, CSCI 422, for instance) are virtualized system setups, and as such are nearly impossible to reproduce as part of this document (since we would also need to include the virtualization system, the lab setup, etc). Others (CSCI 281, CSCI 351, CSCI 371) are only meaningful when viewed within the context of specialized hardware or software setups. We have, however, attached examples of senior project materials that our students presented as part of the senior symposium. Please see the attached appendix on Senior Projects. It contains multiple examples of posters as well as power point presentations from student work.

Type response here.

Appendix Cover Sheet – Curriculum Map

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**BS_CN_CurricularMap2018.xls**
This documentation is relevant to Question number:	**Question 15– BS in Computer Networking**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Revised Curriculum Map for our new program objectives as of Spring 2018. Includes courses that also map to the University ILOs.**

LSSU B.S. Computer Networking - Program Objectives

After successful completion of our degree requirements, the student will be able to:

	Analyze the needs of a user, design a computer network system to satisfy those needs, and install, modify and maintain the network environment relative to both hardware and software.	Design, install, and implement appropriate security, intrusion detection, and troubleshooting techniques and methodologies in a communication network.	Evaluate changes in technology, security, and user needs based on accepted and updated best practices in the field.	Communicate technical information relative to problems and solutions to both other professionals in the field as well as involved non-technical persons.	Students will develop and clearly express complex ideas in written and oral presentations. (ILO)	Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem. (ILO)	Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. (ILO)	Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a problem, or achieving a goal. (ILO)
CSCI 103	I	I		I	I			I
CSCI 105	I					I	I	
CSCI 106	I		I					
CSCI 121	I							
CSCI 163			R	I	I	I		I
CSCI 211	I							
CSCI 221	I	I	R					
CSCI 248	R	I	R					
CSCI 263		R	I	R	I			R
CSCI 281		R	R			R		
CSCI 292	R A	R A	R A	R A	R A	R A	R A	R A
CSCI 323		R	R					
CSCI 348	M	M		R	R	R		
CSCI 351	M		M					
CSCI 371	M						M	
CSCI 412	M	M		M	M	M		
CSCI 418	M A	M A	M A	M A	M A	M A	M A	M A
CSCI 419	M A	M A	M A	M A	M A	M A	M A	M A
CSCI 422		M	M					M
MATH 111				R		R		
MATH 207				R		R		
BUSN 121				I				
BUSN 231				R	R			
ENGL 306				M	M			

Key: "I"=Introduced; "R"=reinforced and opportunity to practice; "M"=mastery at the senior or exit level; "A"=assessment evidence collected

ILOs are also covered by University General Education Requirements. Items listed here supplement those topics and assessments.

Appendix Cover Sheet – Degree Audit

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Computer Networking_F16.xlsx**
This documentation is relevant to Question number:	**Question 15 – BS in Computer Networking**
Briefly summarize the content of the file and its value as evidence supporting program review:	**The requested current Degree Audit sheet (current as of Fall 2018) for the BS in Computer Networking.**

School of Mathematics & Computer Science

Fall 2016

Degree Audit: Bachelor of Science in Computer Networking

Name: ______________________ ID # ______________________

Advisor's Signature: ______________________ Chair's Signature: ______________________

General Education

Communication (9 cr)

Course	Credits		Grade
ENGL 110	3	________	___
ENGL 111	3	________	___
COMM 101	3	________	___

Social Science (6-7 cr)

Course	Credits		Grade
BUSN 121	3	________	___
________	___	________	___

Social Science Diversity (3-4 cr)

Course	Credits		Grade
________	___	________	___

Humanities (minimum 6 credits)

Two courses from two different areas (Humanities approved courses)

Course	Credits		Grade
________	___	________	___
________	___	________	___

Mathematics (3-4 cr)

Satisfied by degree requirements

Natural Science (8 cr)

Course	Credits		Grade
________	___	________	___
________	___	________	___

Free Electives (or Minor) (17-20 cr)

Course	Credits		Grade
________	___	________	___
________	___	________	___
________	___	________	___
________	___	________	___

Departmental Requirements (68 cr)

Computer Science (59 cr)

Course	Credits		Grade
CSCI 103	3	________	___
CSCI 105	3	________	___
CSCI 106	3	________	___
CSCI 121	4	________	___
CSCI 163	3	________	___
CSCI 211	3	________	___
CSCI 221	3	________	___
CSCI 248	3	________	___
CSCI 263	3	________	___
CSCI 281	3	________	___
CSCI 292	4	________	___
CSCI 323	3	________	___
CSCI 348	3	________	___
CSCI 351	3	________	___
CSCI 371	3	________	___
CSCI 412	3	________	___
CSCI 418	3	________	___
CSCI 419	3	________	___
CSCI 422	3	________	___

Mathematics (6 cr)

Course	Credits		Grade
# MATH 111	3	________	___
MATH 207	3	________	___

Satisfies Gen Ed Math Requirement

Other Requirements (9 cr)

Course	Credits		Grade
* BUSN 121	3	________	___
BUSN 231	3	________	___
ENGL 306	3	________	___

* Satisfies Social Science Gen Ed Requirement

________ At least 124 total credits

________ At least 50% of school 300/400 level credits earned at LSSU

________ At least 30 of last 60 credits earned at LSSU

________ 2.0 Overall GPA

________ 2.5 GPA in School Requirements

Appendix Cover Sheet – Four Column Report

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**FourColumnBSinCN.pdf**
This documentation is relevant to Question number:	**Question 13– BS in Computer Networking**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Four column report from TracDat.** **Note: First two objectives were not added by our school, they were added by administration and are not maintained by us. Mission Statement is also not ours, and was not put there by us.**

Assessment: Program Four Column

Computer Networking BS

Program (CoIS) - Computer Networking BS

Mission Statement: We equip our graduates for success through emphasis on rigorous programs, hands-on experiences, and interaction with highly-qualified faculty members who are centered on student success.
Assessment Contact: Dr. Evan Schemm

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Program Review - The Program provides evidence in support of Program Review in accordance with the Higher Learning Commission Criteria for Accreditation (4.A. The institution demonstrates responsibility for the quality of its educational programs. 1. The institution maintains a practice of regular program reviews.) **Goal Status:** Active **Goal Category:** Periodic Program Review	**Indirect - Report/Audit - Internal** - The Program conducts evidence-supported regular program review. The Program addresses the key components of the , incorporates feedback from assessment activities, and documents the impact of assessment findings and subsequent actions on student learning. **Criteria Target:** The Program Review will address the following criteria: 1. Contribution to LSSU Mission/Vision 2. Metrics of Productivity 3. Internal and External Program Demand 4. Program Quality 5. Program Assessment 6. Opportunity Analysis	**Finding Reporting Year:** 2015-2016 **Goal met:** Yes A Program Review was completed and submitted to Dr. Myton (06/08/2018) **Related Documents:** ComputerNetworkingProgramReview.pdf	
2.1 Program Enrollment - Strategy 2.1 The Program establishes realistic goals for program enrollment that are optimistic, realistic, achievable. **Goal Status:** Active **Goal Category:** Enrollment	**Regular, recurring** - The program sets goals for program enrollment which are time-based, progressive, achievable and quantitative. **Criteria Target:** Program Enrollment		

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	Growth Goal: ___________ by ________		
Analyze Needs - The students will be able to analyze the needs of a user, design a computer network system to satisfy those needs, and install, modify and maintain the network environment relative to both hardware and software. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.5 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year End faculty evaluation of projects and presentation aggregate score of 4.25 (1 to 5). Includes 1 non-performing team. (05/30/2018)	**Use of Result:** Evaluate again after next years projects class. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End aggregate course data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 163 [Troubleshooting and Repair of Personal Computers], CSCI 281 [Introduction to UNIX and Networking], CSCI 412 [UNIX Network Administration], and CSCI 422 [UNIX Network Administration] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 248 [Network Operating Systems I], CSCI 348 [Network Operating Systems II], and CSCI 412 [UNIX Network Administration] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Evaluate again during next program review. (05/29/2018)
Design - The students will be able to design, install, and implement appropriate security, intrusion detection, and troubleshooting techniques and methodologies in a communication network. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.5 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year end faculty evaluation of projects and presentation has an aggregate score of 3.75 (1 to 5). Includes 1 non-performing team (05/30/2018)	**Use of Result:** Evaluate again after next projects class. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 163 [Troubleshooting and Repair of Personal Computers], CSCI 281 [Introduction to UNIX and Networking], CSCI 412 [UNIX Network Administration], and CSCI 422 [UNIX Network Administration] shows students successfully completing these classes were able to meet this goal at least 70% of the	**Use of Result:** Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
more measurable and applicable.	year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 248 [Network Operating Systems I], CSCI 348 [Network Operating Systems II], CSCI 412 [UNIX Network Administration], and CSCI 422 [Network and Computer Security] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Evaluate again during next program review. (05/29/2018)
Security and Best Practices - The students will be able to evaluate changes in technology, security, and user needs based on accepted and updated best practices in the field. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.5 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year end evaluation of Projects and presentations has an aggregate score of 3.38 (1 to 5). Includes 1 non-performing team (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 281 [Introduction to UNIX and Networking], CSCI 412 [UNIX Network Administration], and CSCI 422 [UNIX Network Administration] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 248 [Network Operating Systems I], CSCI 348 [Network Operating Systems II], CSCI 412 [UNIX Network Administration], and CSCI 422 [Network and Computer Security] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Evaluate again during next program review. (05/29/2018)
Communications - The students will be able to communicate technical information relative to problems and solutions to both other professionals in the field as well as involved non-	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.5 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year end evaluation of projects and presentations has aggregate score of 3.5 (1 to 5). Includes one non-	**Use of Result:** Evaluate again after next years projects. (05/30/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
technical persons. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex ideas in written and oral presentations. **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Exam/Quiz - within the course** - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	performing team. (05/30/2018) **Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 163 [Troubleshooting and Repair of Personal Computers], and CSCI 412 [UNIX Network Administration] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 248 [Network Operating Systems I], CSCI 348 [Network Operating Systems II], and CSCI 412 [UNIX Network Administration] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Evaluate again during next program review. (05/29/2018)

Appendix Cover Sheet – Senior Projects Samples

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**PosterPresentations.zip**
This documentation is relevant to Question number:	**Question 16– BS in Computer Science** **Question 16– BS in Computer Networking**
Briefly summarize the content of the file and its value as evidence supporting program review:	**This zip file contains Posters (36x48) and or PowerPoint presentations for Senior Project presentations from the last four years. They are grouped together as some teams consist of both Computer Science and Computer Networking majors.**

IRIS
Integration and Reporting Information System

[redacted]
School of Mathematics and Computer Science
Lake Superior State University
Spring 2018

Client:
Jason Kronemeyer
Director of Technology and REMC 22
Eastern Upper Peninsula Intermediate School District

LAKE SUPERIOR STATE UNIVERSITY

Problem

The EUPISD technology department supports more than a dozen school districts and thousands of computers. When a student, teacher, or staff member calls to receive service on their device, the team has to search three different systems to obtain information required to support their clients. This process is time consuming. The EUPISD requested an application that gives a simple interface to search all three systems and display all relevant information for the given device.

Approach

- Design a **Microsoft PowerApp** that accepts the user's input, an asset number, and returns a page with information related to the user's search.
- Utilize the **Google GSuite** API to query Chromebook data.
- Leverage the **Solarwinds Web Help Desk** API to query asset data.
- Write a SQL Stored Procedure to search the **Microsoft SCCM** database.
- Combine data from the systems based on the primary key: serial number.

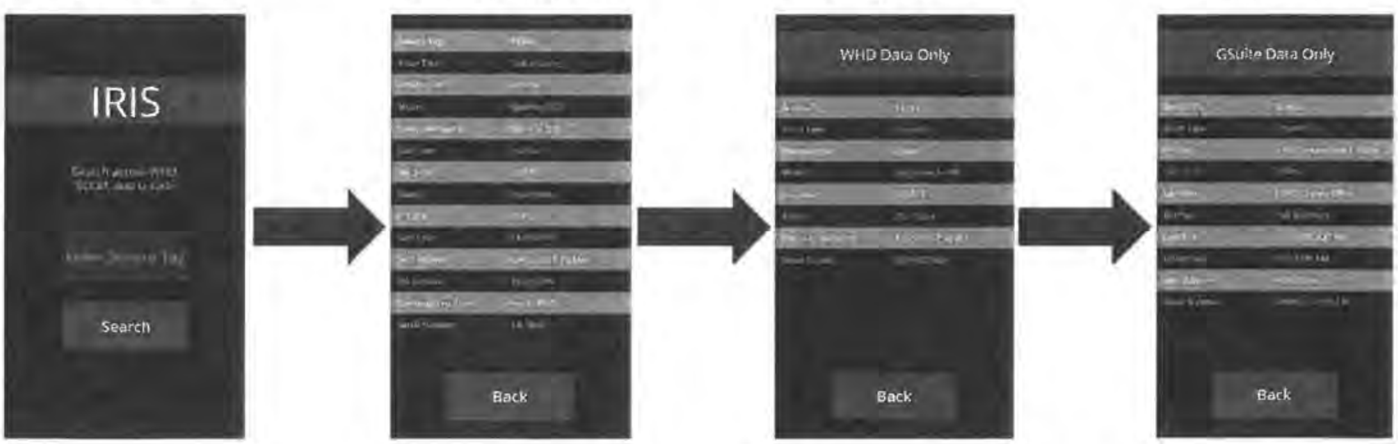
Requirements

- Simple – When the tech is using IRIS, they are already actively multitasking with the client. This application should be simple and straightforward as to not get in the way of the support of their client.
- Fast – The application should be able to retrieve the information quickly in order to efficiently assist their clients.
- Fresh – The data provided must be accurate and up-to-date. With students using devices every hour, the information of the devices is ever changing.

Outcomes

The application is a fast and efficient tool already being used by the technology team at the EUPISD to help assist their clients and thousands of devices separated by hundreds of miles. Rather than searching across the multiple systems, the techs can use this application to increase their efficiency and focus on their clients.

Simple Search | **Unified Results** | **Non-standard** | **Secondary Search**



Road Condition Reporting and Management System

[redacted]

School of Mathematics and Computer Science
Lake Superior State University

Client: Christopher Smith
Assistant Professor at LSSU

LAKE SUPERIOR STATE UNIVERSITY

Problem

Our initial client was looking for a technology-based solution to streamline the data collection and maintenance of Michigan roads. This included gathering public complaints pertaining to road conditions as well as an interface to the data collected. This data was meant to assist in the allocation of Michigan Department of Transportation resources.

The legacy solution consisted of having a maintenance crew drive every road to assess its condition. This process was very slow and costly.

Overview

The Road Condition Reporting and Management System (RCRMS) was developed to collect complaints of road conditions and present the data, in various forms, to a party that may be able to positively affect the road conditions. To that end, we developed an iOS mobile application and a web application.

The mobile application is the interface which the public may use to report various road complaints to our database.

The web application serves as the portal to visualize the data, from the database, for city, county, and state administrative users.

Functional Requirements

The client requires a proof of concept technology based solution for a community-wide data collection and management system whose primary function is to:

- Streamline the process of reporting problems with Michigan roads
- Summarize data and generate maps through an automated process on the database server
- Deliver summary reports to administrators
- Measure progress in making road repairs
- Measure performance of individual programs and the system as a whole

Mobile Application Functional Requirements:

The mobile application will serve the primary function in the following ways:

- Reports data to the backend
- Simplistic user interface to prevent driving distractions

Side Menu

Quick Reporting

Report Page

3D Touch

Map View

Functional Requirements Cont.

Web Application Functional Requirements:

To serve the primary function, the web application must accomplish the following:

- Short term retention of client specific reports
- Ability to present data in jurisdiction specific reporting
- Report maintenance(i.e. mark reports as having been completed)
- Client specific assessment of needs
- Retention of client specific GPS (Global Positioning System) data
- Ability to track client specific goals and outcomes
- Ability to share road quality reports across agencies

Learning Outcomes

Technologies:
- Xcode IDE
- Swift 4.0
- SiriKit
- Google Maps APIs (Application Programming Interface)
- HTML (HyperText Markup Langauge), CSS (Cascading Style Sheets), JS (JavaScript), Firebase
- Nodejs, npm, Firebase CLI (Command-Line Interface)

Customer loss and pivot to an alternate client with changing requirements mid-project.
Practice working with other developers, in different scopes, toward the same end.
Working knowledge of code repositories like GitHub, and the collaboration benefits therein.

Current State:
- Working iOS application prototype
- Functional web application

Moving Forward:
- Publish iOS application
- Application email verification
- Meta data collection
- Handle Firebase querying quirk

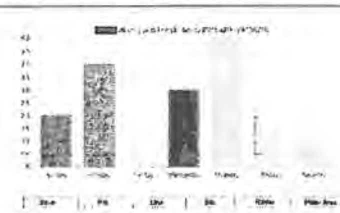


Chart View

Student Information System

[redacted]
School of Mathematics and Computer Science
Lake Superior University
Spring 2017

LAKE SUPERIOR STATE UNIVERSITY

Client:
Maplewood Baptist Academy
Terri Hill

Problem

Maplewood Baptist Academy is a private school that has gone through a number of Student Information Systems, but has been unable to find one that suits their needs. With insufficient IT staff, and requiring a student information system that could easily be maintained and updated by on site faculty, It was our duty to provide a technology based solution for a student information system that could meet the needs of Maplewood Baptist Academy.

Requirements

- Provide a method of grading students.
- User interface allowing Students, Faculty, and Parents to view grades and implement changes.
- Ability to generate report cards and transcripts, both individually and en-mass.
- View student, and parent/guardian information.
- Import and Export data without ongoing support by software vendors.
- Meet standard security requirements for Data Security, and Technical Standards.
- Improved communication between students, faculty, and parents.

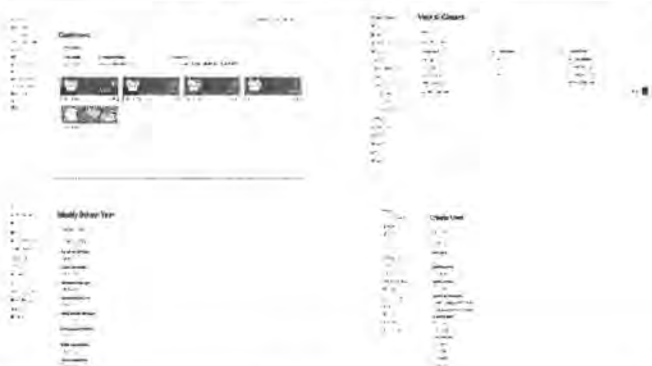
Approach

In order to deal with multiple devices, a web interface was decided on as the best method of access to the system. The team went with a combination of PHP, MariaDB, HTML, CSS, a little bit of Bash, and Javascript. This combination allowed for the creation of a system that is flexible to changes, and resilient to time. Future-proofing was kept in mind during the development of the project.Version control was used to track changes made on the project, and in the event of an unwanted change, the code could be easily reverted to an earlier time.

Outcomes

The goal is to develop a student information system that can be easily used and maintained without any need for onsite IT support. The SIS will allow faculty to easily maintain and edit information regarding; student grades, generation of report cards/transcripts, communication between students and their parents, large scale CSV data importing and exporting, student grade legacies, and access to all required information regarding students and their parents.

Administrator



Teacher

Student

Parent

INSPIRE TENNIS WILDCATS TENNIS TEAM APP

LAKE SUPERIOR STATE UNIVERSITY

[redacted]
School of Mathematics and Computer Science
Lake Superior University
Spring 2017

John Gardiner
Inspire Tennis Wildcats Tennis Team Head Coach and Founder
Nelson, New Zealand

Problem

John Gardinner has established a business that allows players to venture to the United States to pursue their tertiary degree through their various sports. Particularly John specializes in tennis and has created a tennis team, with his players, which mimics how a university team in the States in managed to give the players an idea of what to expect.

What John was looking for is an application that will allow the players and the players of the parents within the team to easily communication among one another. He also wanted other information pertaining to the team to be readily available to them such as their sponsors, events and training schedules, a gallery, coaching videos as well as the ability for them to upload statistics from their recent matches while at a tournament.

Overview

The application to be produced will be written in Swift 3.0 programming language to be compatible with Apple devices running iOS operating systems. These devices include the various models of iPhones, iPads, and other Apple devices. The application is to be completed and handed off by April 24, 2017. The application shall clearly promote the Wildcats tennis team and be simple and easy to use for people of all ages.

Requirements

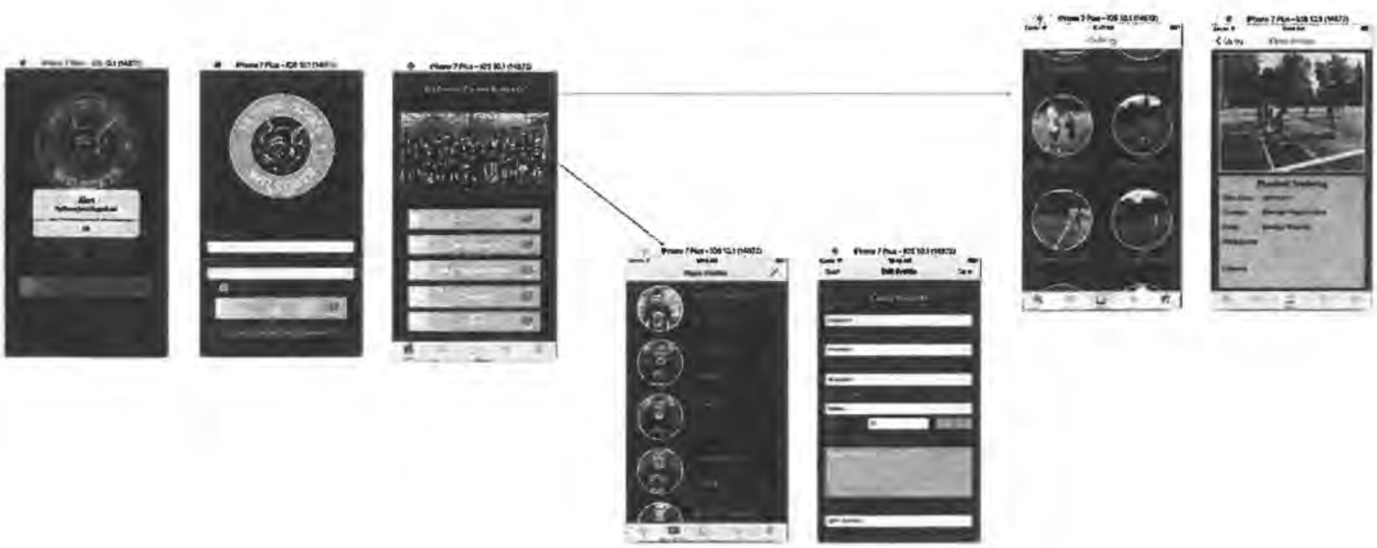
- The application shall have an initial page that displays the team's logo and links to the login page.
- The application shall provide the team with login credentials that allows them to login to the app using their own accounts.
- The application shall have 5 main views:
  - The main 'team area' that links to the events and training schedules, tournament statistics and a chatroom.
  - Player profile information
  - Gallery
  - Sponsors page
  - Coaches corner.
- The application shall be connected to a database that holds all the information pertaining to the different views and login information.
- The application shall include notifications to the user.

Outcomes

The production of this application has been beneficial in extending my knowledge in iOS application development, including various aspects of the Swift operating language, and its associated integrated development environment, Xcode. I have also learned how to set up a live chatroom on a server using sockets.

One of the most prominent learning outcomes however is how to connect my application to a MySQL database using PHP in the most efficient way within my application. This includes using JSON in Xcode to send and receive data from my database based on the query that was performed, and handling the success or failure of this in a way that the application will smoothly notify the client. Furthermore, I have also becoming more comfortable with using Core Data and learning more of its features. I have also learned how to set up my own database and export from a local server set up on my computer to a hosting service online.

Lastly, I have learned how to communicate regularly in dealing with a client in the real world.



PART 2: Degree-Level Review

Degree Program: Bachelors in Computer Science

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

13. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

    See included document FourColumnBSinCS.pdf.

Degree assessment for this program is handled in two ways. First, the capstone course for this program is the Senior Projects sequence (CSCI 418 and CSCI 419). As part of the evaluation of student projects, faculty in the Computer Science and Computer Networking areas meet to discuss student performance, as well as evaluation success of the students on our four program level outcomes.

The second method used to assesses the program level outcomes is to look at the aggregate of course level assessment for courses taught that semester that are tied to each of the four program level objectives. These aggregate level assessments indicate that in general, we are reaching our goals. Specific places where we have trouble (students do not meet the goals) are usually related to a specific class, and are commented on, and tweaked at the course level. Years ago, our school adopted an end-of-semester reporting form for course assessment that (among other things) specifically addresses things that did not go well in a course, as well as proposed changes to address that. Please see the numerous examples in TracDat of such data.

14. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

During some of the annual meetings to discuss projects, we have observed that students have successfully completed the project portion of the course, but have had issues with the professional communications required as part of the project (both to us as well as their clients). After discussion with the English Department, ENGL 306 was made a requirement of the degree. We only have a couple years of data (incomplete, since students could elect to continue under their old degree requirements that did not include ENGL 306) since this was implemented, but we have noticed an improvement, both in their ability to deal with their clients as well as the professionalism of their final presentations.

It should be noted that the BS in Computer Science was the first of the two Bachelor's degrees to make this change, and that because we noticed some improvement (even from the limited data of 1 year) we determined to change the Bachelors Degree in Computer Networking the following year.

Finally, after reviewing performance this last semester (2018) we have decided to make ENGL 306 a pre-req for CSCI 418 so that students have the benefit of the material for both parts of Senior Projects, since a number of them have put off the class until their senior year and are taking it concurrently.

An ongoing area of concern that we have noticed and discussed relevant to the aggregate data is the performance and skillset of students coming out of CSCI 121 and CSCI 201. This has been an ongoing concern for a number of years. We are continuing to look at ways that we can change content and content delivery in those two classes to improve student performance and retention.

A related concern is the effect setting those as once-a-year classes coupled with alternate year offerings for upper level classes has on our students ability to graduate on time. Data from the last two years (pulled from Argos) shows that are students are averaging 10.5 semesters until graduation. Anytime a student comes into the program with insufficient math, fails a class, or does not take a class when they should increases their graduation time by at least a semester. Being able to offer CSCI 121 and CSCI 201 every semester would allow students to fix the first two problems at a delay of only 1 semester instead of up to 2 years.

Quality, Resources and Support (CC 3.A)

15. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

For basic information, please see the attached degree audit (BS Computer Science_F15.xlsx) and curricular map (document BS_CS_CurricularMap2018.xls) for this program. The degree audit was specifically requested, and represents the current course completion required to earn this degree. The curricular map shows how each of these courses relate to the four program level outcomes for the degree program (the first four columns), as well as the Institutional Level Outcomes (ILOs).

The Program Level Objectives were updated in 2018 to make them easier to assess and measure. We also decided at the same time to show the relationship of our courses to the university ILOs at the same time, as these ideas are core to the profession of Computer Science. Almost all jobs in this field revolve around taking the needs of clients, industry accepted standards (security for example), which often are not understood or even valued by clients and producing a unique system to meet the needs of those clients. The inclusion of the University ILOs allow us to focus on both the technical aspects of the field (our program learning outcomes) as well as the service aspect that most jobs in this area have (university ILOs). While almost all our courses touch on the ILOs in some way, courses tagged as related to the ILOs have a higher level of relation to them.

Intellectual Inquiry (CC 3.B).

16. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

Almost every course in this degree involves the analyzing of needs for a computer program, as well as setting it up to work with the actual users of the system (communication). Any of the programming or scripting classes (CSCI 105, CSCI 121, CSCI 201, CSCI 351, CSCI 371, etc) involve the input (collecting), processing (analyzing), as well as output (communication) of information.

For some classes, students have a significant free-form project as part of the course requirements (CSCI 321, CSCI 371, etc). Students are required to create a unique project within the framework of the assignment. Many of these projects require additional software and/or specific runtime environments to be able to use, and would be difficult to document here.

Instead, however, we have attached examples of senior project materials that our students presented as part of the senior symposium. Please see the attached appendix on Senior Projects. It contains multiple examples of posters as well as power point presentations from student work.

Type response here.

Appendix Cover Sheet – Curriculum Map

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**BS_CS_CurricularMap2018.xls**
This documentation is relevant to Question number:	**Question 15– BS in Computer Science**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Revised Curriculum Map for our new program objectives as of Spring 2018. Includes courses that also map to the University ILOs.**

LSSU B.S. Computer Science - Program Objectives

After successful completion of our degree requirements, the student will be able to:

	Analyze the needs of a user, design a computer software system to satisfy those needs, and write and debug computer programs needed for that system.	Evaluate and implement solutions to programming problems using appropriate algorithms, programming languages, user interfaces, and utilities.	Evaluate changes in technology, software, and user needs based on accepted and updated best practices in the field.	Communicate technical information relative to problems and solutions to both other professionals in the field as well as involved non-technical persons.	Students will develop and clearly express complex ideas in written and oral presentations. (ILO)	Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem. (ILO)	Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. (ILO)	Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a problem, or achieving a goal. (ILO)
CSCI 103				I	I			I
CSCI 105		I				I	I	
CSCI 121	I	R						
CSCI 201		R						
CSCI 211	I		I					
CSCI 221	I		I					
CSCI 263			R	R	I			
CSCI 291	R A	R A	R A	R A	R A	R A	R A	R A
CSCI 321		M	R					
CSCI 325	R							
CSCI 326	R							
CSCI 341		M		M		M		
CSCI 342		R						
CSCI 351		M	R	R				
CSCI 371		M	R					
CSCI 411				M	R			
CSCI 415		M	M					
CSCI 418	M A	M A	M A	M A	M A	M A	M A	M A
CSCI 419	M A	M A	M A	M A	M A	M A	M A	M A
CSCI 434		M		M				
MATH 131				R		R		
MATH 112				R		R		
MATH 151				R		R		
MATH 207				R		R		
BUSN 121				I				
ENGL 306				M	M			

Key: "I"=Introduced; "R"=reinforced and opportunity to practice; "M"=mastery at the senior or exit level; "A"=assessment evidence collected

ILOs are also covered by University General Education Requirements. Items listed here supplement those topics and assessments.

Appendix Cover Sheet – Degree Audit

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Computer Science_F15.xlsx**
This documentation is relevant to Question number:	**Question 15– BS in Computer Science**
Briefly summarize the content of the file and its value as evidence supporting program review:	**The requested current Degree Audit sheet (current as of Fall 2018) for the BS in Computer Science.**

Degree Audit: Bachelor of Science in Computer Science

Name: ______________________ ID # ______________________

Advisor's Signature: ______________________ Chair's Signature: ______________________

General Education

Communication (9 cr)			Grade
ENGL 110	3	______	___
ENGL 111	3	______	___
COMM 101 **or** COMM 201 **or** COMM 225	3	______	___

Social Science (minimum 6 credits)
Two courses from two different disciplines

BUSN 121	3	______	___
______	___	______	___

Cultural Diversity (minimum 3 credits)

______	___	______	___

Humanities (minimum 6 credits)
Two courses from two different disciplines
(Humanities approved courses)

______	___	______	___
______	___	______	___

Mathematics (3-4 cr)
Satisfied by degree requirements

Natural Science (minimum 7 credits)
Two courses from two different disciplines-one with a lab

______	___	______	___
______	___	______	___

Free Electives (or Minor) (13-16 cr)

______	___	______	___
______	___	______	___
______	___	______	___
______	___	______	___

Departmental Requirements (72 cr)

Computer Science (62 cr)			Grade
CSCI 103	3	______	___
CSCI 105	3	______	___
CSCI 121	4	______	___
CSCI 201	4	______	___
CSCI 211	3	______	___
CSCI 221	3	______	___
CSCI 263	3	______	___
CSCI 291	4	______	___
CSCI 321	3	______	___
CSCI 325 or CSCI 326	3	______	___
CSCI 341	4	______	___
CSCI 342	4	______	___
CSCI 351	3	______	___
CSCI 371	3	______	___
CSCI 411	3	______	___
CSCI 415	3	______	___
CSCI 418	3	______	___
CSCI 419	3	______	___
CSCI 434	3	______	___

Mathematics (10 cr)			
*MATH 131	3	______	___
MATH 112 or MATH 151	4	______	___
MATH 207	3	______	___

*Satisfies Mathematics General Education requirement

Other Requirements (6 cr)			
#BUSN 121	3	______	___
ENGL 306	3	______	___

#Satisfies Social Science General Education requirement

______	At least 124 total credits
______	At least 50% of school 300/400 level credits earned at LSSU
______	At least 30 of last 60 credits earned at LSSU
______	2.0 Overall GPA
______	2.5 GPA in School Requirements

Appendix Cover Sheet – Four Column Report

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**FourColumnBSinCS.pdf**
This documentation is relevant to Question number:	**Question 13– BS in Computer Science**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Four column report from TracDat.** **Note: First two objectives were not added by our school, they were added by administration and are not maintained by us. Mission Statement is also not ours, and was not put there by us.**

Assessment: Program Four Column

Computer Science BS

Program (CoIS) - Computer Science BS

Assessment Contact: Dr. Christopher Smith

Mission Statement: We equip our graduates for success through emphasis on rigorous programs, hands-on experiences, and interaction with highly-qualified faculty members who are centered on student success.

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Analyze Needs - The students will be able to analyze the needs of a user, design a computer software system to satisfy those needs, and write and debug computer programs needed for that system. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.5 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year end evaluation of projects and presentations has aggregate score of 4.33 (1 to 5). (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 103 [Survey of Computer Science], CSCI 121 [Principles of Programming], CSCI 321 [Computer Graphics]], and CSCI 371 [Multi-Platform Application Development] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Data from CSCI 121 has prompted investigations into how to increase student use of office hours, as well as methods that might be used to increase student attempts of homework assignment. Failure in the class is almost universally attributable to turning in less than 33% of assignments. Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes	**Use of Result:** Review goal again during next program review.

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
		Aggregate grade data from CSCI 201 [Data Structures and Algorithms], CSCI 415 [Computer Organization and Architecture], and CSCI 371 [Multi-Platform Application Development] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	(05/29/2018)
Implement - The Students will be able to evaluate and implement solutions to programming problems using appropriate algorithms, programming languages, user interfaces, and utilities. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.5 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year End evaluation of projects and presentations has aggregate score of 4.00 (1 to 5). (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 103 [Survey of Computer Science], CSCI 121 [Principles of Programming], CSCI 321 [Computer Graphics]], and CSCI 371 [Multi-Platform Application Development] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Data from CSCI 121 has prompted investigations into how to increase student use of office hours, as well as methods that might be used to increase student attempts of homework assignment. Failure in the class is almost universally attributable to turning in less than 33% of assignments. Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 201 [Data Structures and Algorithms], CSCI 415 [Computer Organization and Architecture], and CSCI 371 [Multi-Platform Application Development] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Review goal again during next program review. (05/29/2018)
Best Practices - The students will be	**Direct - Capstone Project - including**		

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
able to evaluate changes in technology, software, and user needs based on accepted and updated best practices in the field. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.5 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year end evaluation of projects and presentations has aggregate score of 3.33 (1 to 5). (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 103 [Survey of Computer Science], CSCI 121 [Principles of Programming], CSCI 321 [Computer Graphics]], and CSCI 371 [Multi-Platform Application Development] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Data from CSCI 121 has prompted investigations into how to increase student use of office hours, as well as methods that might be used to increase student attempts of homework assignment. Failure in the class is almost universally attributable to turning in less than 33% of assignments. Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 103 [Survey of Computer Science], CSCI 415 [Computer Organization and Architecture], and CSCI 371 [Multi-Platform Application Development] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Evaluate goal again during next program review. (05/29/2018)
Communications - The students will be able to communicate technical information relative to problems and solutions to both other professionals in the field as well as involved non-technical persons. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.5 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year end evaluation of projects and presentations has aggregate score of 3.5. This exceeds the Sophomore score of 2.79, suggesting that ENGL 306 has been useful for our students. This is a very limited dataset (3 projects) though, and more years of data is needed. (05/30/2018)	**Use of Result:** Evaluate again after next projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course	**Finding Reporting Year:** 2016-2017	**Use of Result:** Data from CSCI 121

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
Goal Level (Bloom/Webb): Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex ideas in written and oral presentations. **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	**Goal met:** Yes Aggregate grade data from CSCI 103 [Survey of Computer Science], CSCI 121 [Principles of Programming], CSCI 321 [Computer Graphics]], and CSCI 371 [Multi-Platform Application Development] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	has prompted investigations into how to increase student use of office hours, as well as methods that might be used to increase student attempts of homework assignment. Failure in the class is almost universally attributable to turning in less than 33% of assignments. Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 103 [Survey of Computer Science], CSCI 291 [Computer Science Project], and CSCI 415 [Computer Organization and Architecture] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Evaluate goal again during next program review. (05/29/2018)

Appendix Cover Sheet – Senior Projects Samples

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**PosterPresentations.zip**
This documentation is relevant to Question number:	**Question 16– BS in Computer Science** **Question 16– BS in Computer Networking**
Briefly summarize the content of the file and its value as evidence supporting program review:	**This zip file contains Posters (36x48) and or PowerPoint presentations for Senior Project presentations from the last four years. They are grouped together as some teams consist of both Computer Science and Computer Networking majors.**

IRIS

Integration and Reporting Information System

[redacted]
School of Mathematics and Computer Science
Lake Superior State University
Spring 2018

Client:
Jason Kronemeyer
Director of Technology and REMC 22
Eastern Upper Peninsula Intermediate School District

LAKE SUPERIOR STATE UNIVERSITY

Problem

The EUPISD technology department supports more than a dozen school districts and thousands of computers. When a student, teacher, or staff member calls to receive service on their device, the team has to search three different systems to obtain information required to support their clients. This process is time consuming. The EUPISD requested an application that gives a simple interface to search all three systems and display all relevant information for the given device.

Approach

- Design a **Microsoft PowerApp** that accepts the user's input, an asset number, and returns a page with information related to the user's search.
- Utilize the **Google GSuite** API to query Chromebook data.
- Leverage the **Solarwinds Web Help Desk** API to query asset data.
- Write a SQL Stored Procedure to search the **Microsoft SCCM** database.
- Combine data from the systems based on the primary key: serial number.

Requirements

- Simple – When the tech is using IRIS, they are already actively multitasking with the client. This application should be simple and straightforward as to not get in the way of the support of their client.
- Fast – The application should be able to retrieve the information quickly in order to efficiently assist their clients.
- Fresh – The data provided must be accurate and up-to-date. With students using devices every hour, the information of the devices is ever changing.

Outcomes

The application is a fast and efficient tool already being used by the technology team at the EUPISD to help assist their clients and thousands of devices separated by hundreds of miles. Rather than searching across the multiple systems, the techs can use this application to increase their efficiency and focus on their clients.

Simple Search | Unified Results | Non-standard | Secondary Search

Road Condition Reporting and Management System

[redacted]

School of Mathematics and Computer Science
Lake Superior State University

Client: Christopher Smith
Assistant Professor at LSSU

LAKE SUPERIOR STATE UNIVERSITY

Problem

Our initial client was looking for a technology-based solution to streamline the data collection and maintenance of Michigan roads. This included gathering public complaints pertaining to road conditions as well as an interface to the data collected. This data was meant to assist in the allocation of Michigan Department of Transportation resources.

The legacy solution consisted of having a maintenance crew drive every road to assess its condition. This process was very slow and costly.

Overview

The Road Condition Reporting and Management System (RCRMS) was developed to collect complaints of road conditions and present the data, in various forms, to a party that may be able to positively affect the road conditions. To that end, we developed an iOS mobile application and a web application.

The mobile application is the interface which the public may use to report various road complaints to our database.

The web application serves as the portal to visualize the data, from the database, for city, county, and state administrative users.

Functional Requirements

The client requires a proof of concept technology based solution for a community-wide data collection and management system whose primary function is to:

- Streamline the process of reporting problems with Michigan roads
- Summarize data and generate maps through an automated process on the database server
- Deliver summary reports to administrators
- Measure progress in making road repairs
- Measure performance of individual programs and the system as a whole

Mobile Application Functional Requirements:

The mobile application will serve the primary function in the following ways:

- Reports data to the backend
- Simplistic user interface to prevent driving distractions

Side Menu

Quick Reporting

Report Page

3D Touch

Map View

Functional Requirements Cont.

Web Application Functional Requirements:

To serve the primary function, the web application must accomplish the following:

- Short term retention of client specific reports
- Ability to present data in jurisdiction specific reporting
- Report maintenance(i.e. mark reports as having been completed)
- Client specific assessment of needs
- Retention of client specific GPS (Global Positioning System) data
- Ability to track client specific goals and outcomes
- Ability to share road quality reports across agencies

Learning Outcomes

Technologies:

- Xcode IDE
- Swift 4.0
- SiriKit
- Google Maps APIs (Application Programming Interface)
- HTML (HyperText Markup Langauge), CSS (Cascading Style Sheets), JS (JavaScript), Firebase
- Nodejs, npm, Firebase CLI (Command-Line Interface)

Customer loss and pivot to an alternate client with changing requirements mid-project.
Practice working with other developers, in different scopes, toward the same end.
Working knowledge of code repositories like GitHub, and the collaboration benefits therein.

Current State:

- Working iOS application prototype
- Functional web application

Moving Forward:

- Publish iOS application
- Application email verification
- Meta data collection
- Handle Firebase querying quirk

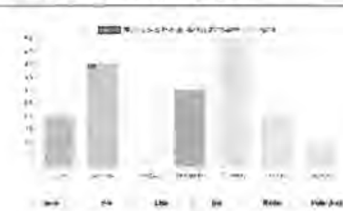


Chart View

Student Information System

[redacted]
School of Mathematics and Computer Science
Lake Superior University
Spring 2017

LAKE SUPERIOR STATE UNIVERSITY

Client:
Maplewood Baptist Academy
Terri Hill

Problem

Maplewood Baptist Academy is a private school that has gone through a number of Student Information Systems, but has been unable to find one that suits their needs. With insufficient IT staff, and requiring a student information system that could easily be maintained and updated by on site faculty, It was our duty to provide a technology based solution for a student information system that could meet the needs of Maplewood Baptist Academy.

Requirements

- Provide a method of grading students.
- User interface allowing Students, Faculty, and Parents to view grades and implement changes.
- Ability to generate report cards and transcripts, both individually and en-mass.
- View student, and parent/guardian information.
- Import and Export data without ongoing support by software vendors.
- Meet standard security requirements for Data Security, and Technical Standards.
- Improved communication between students, faculty, and parents.

Approach

In order to deal with multiple devices, a web interface was decided on as the best method of access to the system. The team went with a combination of PHP, MariaDB, HTML, CSS, a little bit of Bash, and Javascript. This combination allowed for the creation of a system that is flexible to changes, and resilient to time. Future-proofing was kept in mind during the development of the project.Version control was used to track changes made on the project, and in the event of an unwanted change, the code could be easily reverted to an earlier time.

Outcomes

The goal is to develop a student information system that can be easily used and maintained without any need for onsite IT support. The SIS will allow faculty to easily maintain and edit information regarding; student grades, generation of report cards/transcripts, communication between students and their parents, large scale CSV data importing and exporting, student grade legacies, and access to all required information regarding students and their parents.

Administrator

Teacher

Student

Parent

INSPIRE TENNIS WILDCATS TENNIS TEAM APP

LAKE SUPERIOR
STATE UNIVERSITY

[redacted]
School of Mathematics and Computer Science
Lake Superior University
Spring 2017

John Gardiner
Inspire Tennis Wildcats Tennis Team Head Coach and Founder
Nelson, New Zealand

Problem

John Gardinner has established a business that allows players to venture to the United States to pursue their tertiary degree through their various sports. Particularly John specializes in tennis and has created a tennis team, with his players, which mimics how a university team in the States in managed to give the players an idea of what to expect.

What John was looking for is an application that will allow the players and the players of the parents within the team to easily communication among one another. He also wanted other information pertaining to the team to be readily available to them such as their sponsors, events and training schedules, a gallery, coaching videos as well as the ability for them to upload statistics from their recent matches while at a tournament.

Overview

The application to be produced will be written in Swift 3.0 programming language to be compatible with Apple devices running iOS operating systems. These devices include the various models of iPhones, iPads, and other Apple devices. The application is to be completed and handed off by April 24, 2017. The application shall clearly promote the Wildcats tennis team and be simple and easy to use for people of all ages.

Requirements

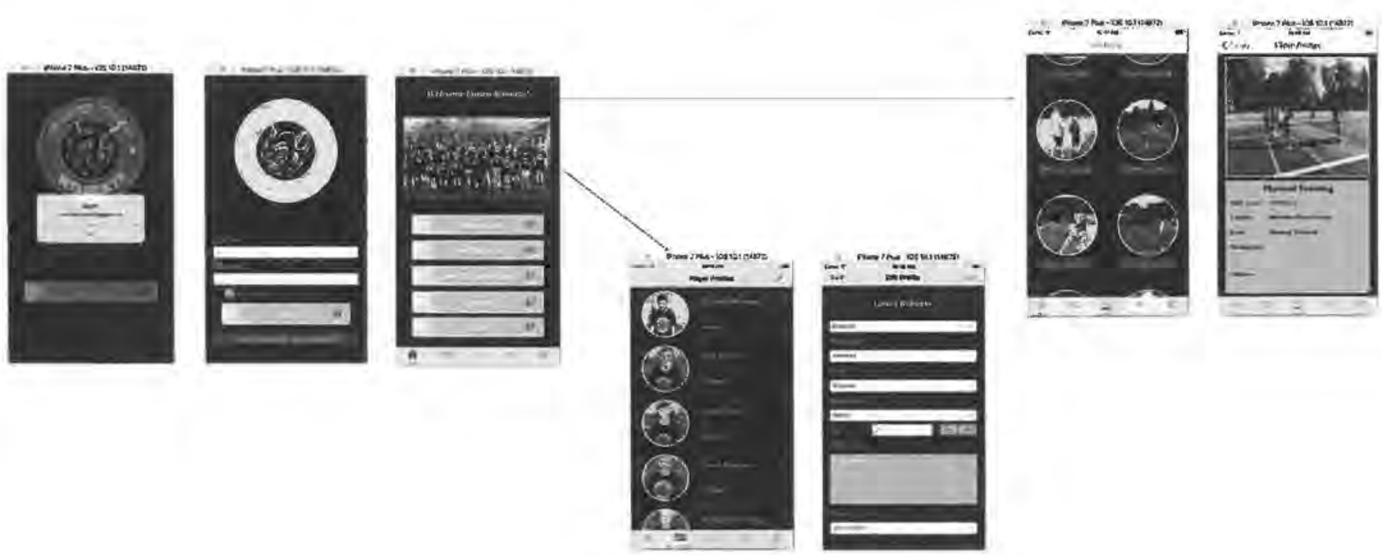
- The application shall have an initial page that displays the team's logo and links to the login page.
- The application shall provide the team with login credentials that allows them to login to the app using their own accounts.
- The application shall have 5 main views:
  - The main 'team area' that links to the events and training schedules, tournament statistics and a chatroom.
  - Player profile information
  - Gallery
  - Sponsors page
  - Coaches corner.
- The application shall be connected to a database that holds all the information pertaining to the different views and login information.
- The application shall include notifications to the user.

Outcomes

The production of this application has been beneficial in extending my knowledge in iOS application development, including various aspects of the Swift operating language, and its associated integrated development environment, Xcode. I have also learned how to set up a live chatroom on a server using sockets.

One of the most prominent learning outcomes however is how to connect my application to a MySQL database using PHP in the most efficient way within my application. This includes using JSON in Xcode to send and receive data from my database based on the query that was performed, and handling the success or failure of this in a way that the application will smoothly notify the client. Furthermore, I have also becoming more comfortable with using Core Data and learning more of its features. I have also learned how to set up my own database and export from a local server set up on my computer to a hosting service online.

Lastly, I have learned how to communicate regularly in dealing with a client in the real world.



PART 2: Degree-Level Review

Degree Program: Associates in Internet Network Specialist

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

13. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

    See included document FourColumnASinCN.pdf.

Degree assessment for this program is handled in two ways. First, the capstone course for this program is the Computer Networking Project (CSCI 292). As part of the evaluation of student projects, faculty in the Computer Science and Computer Networking areas meet to discuss student performance, as well as evaluation success of the students on our four program level outcomes.

The second method used to assesses the program level outcomes is to look at the aggregate of course level assessment for courses taught that semester that are tied to each of the four program level objectives. These aggregate level assessments indicate that in general, we are reaching our goals. Specific places where we have trouble (students do not meet the goals) are usually related to a specific class, and are commented on, and tweaked at the course level. Years ago, our school adopted an end-of-semester reporting form for course assessment that (among other things) specifically addresses things that did not go well in a course, as well as proposed changes to address that. Please see the numerous examples in TracDat of such data.

14. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

During the last couple annual meetings (since the introduction of ENGL 306 as a course in the Bachelors Degree version of this degree), we have noted the difference in communication ability between Senior Projects (capstone for the Bachelors Degree in the same area) and Computer Networking Project (the sophomore capstone for this degree). Because the degree is a two year degree, we do not (at this time) anticipate adding ENGL 306 as a part of this degree because it would delay completion of the degree by at least one semester for students that do not take their regular English sequence during their freshman year. Instead, we have pulled some of the formalized documentation that is used in the senior project class, and required students to use them in this class.

This has not only standardized the communications requirements for the students (each instructor was using their own instrument), but better prepares those who are going on for the Bachelors Degree.

In order to ensure that projects are of a sufficient difficulty level (without being too difficult for Sophomores) we changed how projects are admitted to the project pool 3 years ago. Prior to that point, projects were found by individual instructors of the three projects classes (CSCI 291, CSCI 292, and CSCI 418) and students had the opportunity to choose one of their instructors projects or suggest their own (which would then be approved or not by their instructor). We found that there was enough variation year to year, both with the caliber of projects available as well as the criteria used to evaluate the projects difficulty level, that we needed to standardize things better.

To facilitate that, we created a CS projects working group (consisting of all current CS / CN faculty) that evaluates all projects that are submitted for a year. Combined, they evaluate the difficulty of the assignment (Sophomore or Senior), the category of the project (primary knowledge areas required to complete), as well as fitness for this type of course (we have, for example, determined not to accept any more projects from commercial clients for a variety of reasons). This change allows a more meaningful standard for comparing student performance on projects.

As an example of the use of aggregate data, we have been considering for the last year the entrance and exit performance for students taking CSCI 211. In order to make the course more accessible for students in this major, the pre-req for this course was changed to CSCI 105 a number of years ago. At the time, the programming language used for both classes was the same, and so students were able to learn the material within the programming context they were already familiar with. As languages, and needs change over the years, we have changed the programming language for CSCI 105 twice, but not addressed the transition for 105 to 211. It is becoming more of a requirement that students be able to competently access and manipulate database data from within the context of a programming language, and not just as a standalone (which is how the course has been taught for the last three offerings, as the students have not taken a programming course in one of the primary languages used for programmatic manipulation of databases). We are in the final steps internally of putting together a curriculum proposal to change the pre-req of this class to CSCI 121 so that students will have had such language exposure. Our biggest concern (and the reason we have not done so yet) is that this may potentially delay students graduation by extending a pre-req chain to include a once-a-year class.

Quality, Resources and Support (CC 3.A)

15. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

For basic information, please see the attached degree audit (document AS in Internet Network Specialist__F15.xlsx) and curricular map (document AS_CN_CurricularMap2018.xls) for this program. The degree audit was specifically requested, and represents the current course completion required to earn this degree. The curricular map shows how each of these courses relate to the four program level outcomes for the degree program (the first four columns), as well as the Institutional Level Outcomes (ILOs).

The Program Level Objectives were updated in 2018 to make them easier to assess and measure. We also decided at the same time to show the relationship of our courses to the university ILOs at the same time, as these ideas are core to the profession of Computer Science. Almost all jobs in this field revolve around taking the needs of clients, industry accepted standards (security for example), which often are not understood or even valued by clients and producing a unique system to meet the needs of those clients. The inclusion of the University ILOs allow us to focus on both the technical aspects of the field (our program learning outcomes) as well as the service aspect that most jobs in this area have (university ILOs). While almost all our courses touch on the ILOs in some way, courses tagged as related to the ILOs have a higher level of relation to them.

Intellectual Inquiry (CC 3.B).

16. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

Almost every course in this degree involves the analyzing of needs for a computer networking system, as well as setting it up to work with the actual users of the system (communication). Any of the programming or scripting classes (CSCI 105, CSCI 121, CSCI 281, etc) involve the input (collecting), processing (analyzing), as well as output (communication) of information.

In the Network Operating Systems lab classes (CSCI 248) students are required to demonstrate that their setup is correct by using the system in it's intended manner. For web servers, for instance, this would be by creating and 'hosting' web pages on their server. These pages would be unique to the student creator, and independent of server software.

Unlike our Senior Projects class, Sophomore Computer Networking Projects students are not required to participate in the Senior Symposium Poster presentation. They are required give an oral presentation on their material, but are not required to use slides to do so. Please see some examples of various student hand-ins and other project related materials in the Appendix labeled Sophomore Projects Samples.

Type response here.

Appendix Cover Sheet – Curriculum Map

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**AS_CN_CurricularMap2018.xls**
This documentation is relevant to Question number:	**Question 15– AS in Computer Networking**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Revised Curriculum Map for our new program objectives as of Spring 2018. Includes courses that also map to the University ILOs.**

LSSU A.S. Internet / Network Specialist - Program Objectives

After successful completion of our degree requirements, the student will be able to:

	Install and maintain network systems according to specifications given to them.	Assist in the analysis of security monitoring, intrusion detection, and troubleshooting techniques and methodologies in a networked operating environment.	Use current hardware and OS technologies and accepted best practices in network design to help solve business and industrial problems.	Communicate technical information relative to problems and solutions to professionals in the field.	Students will develop and clearly express complex ideas in written and oral presentations. (ILO)	Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem. (ILO)	Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. (ILO)	Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a problem, or achieving a goal. (ILO)
CSCI 103	I	I		I	I			I
CSCI 105	I					I	I	
CSCI 106	I		I					
CSCI 163			R	I	I	I		I
CSCI 211	I							
CSCI 221	I	I	R					
CSCI 248	R	I	R					
CSCI 263		R	I	R	I			R
CSCI 281		R	R			R		
CSCI 292	M A	M A	M A	M A	M A	M A	M A	M A
BUSN 121				I				
BUSN 231				R	R			

Key: "I"=Introduced; "R"=reinforced and opportunity to practice; "M"=mastery at the senior or exit level; "A"=assessment evidence collected

Note: Associates Degree

ILOs are also covered by University General Education Requirements. Items listed here supplement those topics and assessments.

Appendix Cover Sheet – Degree Audit

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**AS in Internet Network Specialist_F15.xlsx**
This documentation is relevant to Question number:	**Question 15– AS in Computer Networking**
Briefly summarize the content of the file and its value as evidence supporting program review:	**The requested current Degree Audit sheet (current as of Fall 2018) for the AS in Computer Networking.**

School of Mathematics & Computer Science

Fall 2015

Degree Audit: Associate Degree in Internet/Network Specialist

Name: ______________________ ID# ______________________

Advisor's Signature: ______________________ Chair Signature: ______________________

Graduation Date: ______________________ Date: ______________________

General Education Requirements

Communication (9 cr)

ENGL 110	3	________	___
ENGL 111	3	________	___
COMM 101	3	________	___

MATH 110 or higher (3 cr)

________	___	________	___

Gen Ed Electives (12 cr)

*BUSN 121	3	________	___
________	___	________	___
________	___	________	___
________	___	________	___

Free Electives (4 cr)

________	___	________	___
________	___	________	___

Departmental Requirements

Computer Science (28 cr)

CSCI 103	3	________	___
CSCI 105	3	________	___
CSCI 106	3	________	___
CSCI 163	3	________	___
CSCI 211	3	________	___
CSCI 221	3	________	___
CSCI 248	3	________	___
CSCI 263	3	________	___
CSCI 281	3	________	___
CSCI 292	4	________	___

Other Support Courses (6 cr)

BUSN 121	3	________	___
BUSN 231	3	________	___

________ At least 62 total credits

________ Residency (16 of last 20 credits at LSSU)

________ 2.0 Overall GPA

________ 2.0 GPA in Departmental Requirements

________ 2.0 GPA in General Education

Appendix Cover Sheet – Four Column Report

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**FourColumnASinCN.pdf**
This documentation is relevant to Question number:	**Question 13– AS in Computer Networking**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Four column report from TracDat.** **Note: First two objectives were not added by our school, they were added by administration and are not maintained by us. Mission Statement is also not ours, and was not put there by us.**

Assessment: Program Four Column

Computer Networking AS

Program (CoIS) - Internet/Network Specialist AS

Mission Statement: We equip our graduates for success through emphasis on rigorous programs, hands-on experiences, and interaction with highly-qualified faculty members who are centered on student success.
Assessment Contact: Dr. Evan Schemm

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Program Review - The Program provides evidence in support of Program Review in accordance with the Higher Learning Commission Criteria for Accreditation (4.A. The institution demonstrates responsibility for the quality of its educational programs. 1. The institution maintains a practice of regular program reviews.) **Goal Status:** Active **Goal Category:** Periodic Program Review	**Indirect - Report/Audit - Internal** - The Program conducts evidence-supported regular program review. The Program addresses the key components of the , incorporates feedback from assessment activities, and documents the impact of assessment findings and subsequent actions on student learning. **Criteria Target:** The Program Review will address the following criteria: 1. Contribution to LSSU Mission/Vision 2. Metrics of Productivity 3. Internal and External Program Demand 4. Program Quality 5. Program Assessment 6. Opportunity Analysis		
2.1 Program Enrollment - Strategy 2.1 The Program establishes realistic goals for program enrollment that are optimistic, realistic, achievable. **Goal Status:** Active **Goal Category:** Enrollment	**Regular, recurring** - The program sets goals for program enrollment which are time-based, progressive, achievable and quantitative. **Criteria Target:** Program Enrollment Growth Goal: ____________ by		

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
Installation - The students will be able to Install and maintain network systems according to specifications given to them. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.0 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year end evaluation of projects and presentations has aggregate score of 3.88 (1 to 5). (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 163 [Troubleshooting and Repair of Personal Computers], and CSCI 281 [Introduction to UNIX and Networking] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 248 [Network Operating Systems I], and CSCI 281 [Introduction to UNIX and Networking]shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Evaluate again during next program review. (05/29/2018)
Security and Monitoring - The students will be able to assist in the analysis of security monitoring, intrusion detection, and troubleshooting techniques and methodologies in a networked operating environment. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.0 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year end evaluation of projects and presentations has aggregate score of 3.75 (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 163 [Troubleshooting and Repair of Personal Computers], and CSCI 281 [Introduction to UNIX and Networking] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes	**Use of Result:** Evaluate again during next program review.

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	reporting data.	Aggregate grade data from CSCI 248 [Network Operating Systems I], and CSCI 281 [Introduction to UNIX and Networking] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	(05/29/2018)
Best Practices - The students will be able to use current hardware and OS technologies and accepted best practices in network design to help solve business and industrial problems. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.0 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year end evaluation of projects and presentations has aggregate score of 3.25 (1 to 5). (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 163 [Troubleshooting and Repair of Personal Computers], and CSCI 281 [Introduction to UNIX and Networking] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 248 [Network Operating Systems I], and CSCI 281 [Introduction to UNIX and Networking] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Evaluate again during next program review. (05/29/2018)
Communication - The students will be able to communicate technical information relative to problems and solutions to professionals in the field. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.0 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year end evaluation of projects and presentations has aggregate score of 3.13 (1 to 5). (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions,	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 163 [Troubleshooting and Repair of Personal Computers], and CSCI 281 [Introduction to UNIX and Networking] shows students successfully completing these classes were able to meet this goal at	**Use of Result:** Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts.

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
ideas in written and oral presentations. **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	(07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 248 [Network Operating Systems I], and CSCI 281 [Introduction to UNIX and Networking] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Evaluate again during next program review. (05/29/2018)

Appendix Cover Sheet - Sophomore Projects Samples

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**PosterPresentations.zip**
This documentation is relevant to Question number:	**Question 16- AS in Computer Science** **Question 16- AS in Internet Network Specialist**
Briefly summarize the content of the file and its value as evidence supporting program review:	**This zip file contains samples of student submissions as part of CSCI 291 and CSCI 292.**

CS 291/292/419
Client Signoff Cover Sheet

Student Evaluation form for: [redacted]

Instructor: [illegible] Smith

Please leave this sheet with the client when they signoff on your project.

When the students assigned to your project have completed the project in question, demonstrated it to your satisfaction, provided initial training in its use (as well as manuals for future training and reference). Please indicate that by signing the attached form. Also, please email the supervising instructor and answer the following questions about your experience with this student:
(If the project team assigned to you had multiple students, please send one email with answers for each student on the team).

Dr. Schemm elschemm@furball.schemm.lssu.edu
Dr. Smith csmith16@lssu.edu
Dr. Kalata kkalata@lssu.edu

1) How would you rate the professionalism and communications skills of this student on the team?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

[redacted] is very professional

2) How would you rate this student's technical skills / ability to serve your needs?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

Website looks awesome

3) How well did the team keep you involved in the development process? (Timely meetings, demonstrations of work to date, etc)?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

[redacted] - Kept me informed and up to date

4) How well has this student prepared you to use the finished product (provided training, manuals, etc)?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

Would of liked a little more training time but [illegible] did a good job in the time we had available.

5) Are you satisfied that the project is complete? If not, what still needs to be completed?

Our website looks amazing [redacted] did a wonderful job. For some reason when I pull up the site on my computer it is missing an update that we did but shows up when pulled up on another computer. [redacted] tried to give me things to do to try and correct it but these didn't work. Would of liked to figure out what is happening with my [illegible]

Thanks for your time and answers!

Pickford Community Library –
Client: Ann Marie Smith
Student: [redacted]

The Pickford Community Library has relatively poor wireless and internet connectivity. The library's director would like a student to evaluate the current infrastructure and make recommendations for improvements to the available networking. This may require working with the library's Internet Service Provider, pulling cable, configuring wired network adaptors, installing and configuring wired and wireless routers, and testing reliability and speed.

Sault Theatre Project –
Client: Abby Baker
Student: [redacted]

The Sault Theatre Project is looking to revamp their website and add functionality so customers could purchase tickets to events or pay tuition for theatre classes. The current webpage layout needs to be evaluated and suggestions made for updates to the website. The handling of credit card payments has already been contracted out to a clearing-house firm.

Chippewa County Historical Society –
Client: Virginia Cymbalist
Student: [redacted]

The Kemp Industrial Museum (which was originally the office of the Kemp Coal Dock) showcases the major industries that were in the Sault from about 1875 to the middle 1900's. At the present time the exhibits are largely comprised of large photographs with descriptions, written historical information, and items from these industries. Specifically we're hoping to have a touch screen (a mouse might work) program utilizing photos and video and voice clips that make our displays more interesting at both the adult and youth levels. We also hope to include charts and graphs that show the impact of these industries on the population and economy of the Sault.

Chippewa Ottawa Resource Authority –
Client: Deanna Bowen
Student: [redacted]

The Chippewa Ottawa Resource Authority requires a website to be developed.

Name: [redacted]

Self and Peer Evaluation

Answer the following questions (and be **specific.** You have a lot of room to write for a reason.):
What were the tasks you performed during your project(s)?

- Meeting with client
- Reading project-related resources, learning about noise
- Writing technical specification document
- Making a project schedule
- Learning to use Qt
- Learning to use version control
- Experimenting with pre-existing noise implementations + libraries
- Writing a C++ implementation of improved Perlin noise
- Testing and solving problems with my noise implementation
- Writing code to generate and display an mage
- Creating a simple user interface to display generated images
- Getting help at office hours to solve tiling issue
- Attempting to reduce directional artifacts
- Analyzing noise results to find issues
- Experimenting with how changing parameters affected results
- Writing up the results of the parameter experiments
- Cleaning up and re-organizing code for readability
- Attending weekly project meetings

Rate your overall performance on your project(s).

Very Poor		Poor		Average		Above Average		Excellent
1	2	3	4	5	6	$\boxed{7}$	8	9

Did you assist directly any other teams, including teams in another class? If "yes", which teams?

No

Was your team assisted directly by anyone from another team? If "yes", who, and how?

No.

Did your team utilize any other 'Human' Resources (other students, professors, etc)?
If "yes", who and how?

Yes, I asked Dr. Schemm for help with solving an issue that I was having a hard time figuring out

What was the biggest problem that you figured out on this project?

The biggest problem that I figured out on my own was a series of issues with my Perlin noise implementation. I solved it by figuring out which functions weren't working correctly, then comparing my version to working implementations to see what I was missing or doing wrong.

What was the biggest problem that you needed help figuring out on this project? How did you seek that help?

The biggest problem that I needed help with was my tiling issue. I sought help by going to office hours and asking about it.

What would you do differently next time?

Next time, I would ask for help sooner after running into problems. I would also come up with a more realistic and useful schedule for myself, and I would ask more questions in general to make sure I was on the right track

CS 291/292/419
Client Signoff Cover Sheet

Student Evaluation form for: [redacted]

Instructor: Dr. Smith

Please leave this sheet with the client when they signoff on your project.

When the students assigned to your project have completed the project in question, demonstrated it to your satisfaction, provided initial training in its use (as well as manuals for future training and reference). Please indicate that by signing the attached form. Also, please email the supervising instructor and answer the following questions about your experience with this student:
(If the project team assigned to you had multiple students, please send one email with answers for each student on the team).

Dr. Schemm elschemm@furball.schemm.lssu.edu
Dr. Smith csmith16@lssu.edu
Dr. Kalata kkalata@lssu.edu

1) How would you rate the professionalism and communications skills of this student on the team?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

2) How would you rate this student's technical skills / ability to serve your needs?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

3) How well did the team keep you involved in the development process? (Timely meetings, demonstrations of work to date, etc)?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

4) How well has this student prepared you to use the finished product (provided training, manuals, etc)?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

5) Are you satisfied that the project is complete? If not, what still needs to be completed?
We are very satisfied with the completed project. [redacted] created a program that we can easily adapt to meet our future needs but is very usable now.

Thanks for your time and answers.

CS 291/292/419
Client Signoff Sheet

Project: Kemp Industrial Museum Kiosk

Client: Chippewa County Historical Society

Student(s): [redacted]

Student(s):

Student(s):

Cooperating instructor: Dr. Smith

I have received from the CS Projects team all the software, manuals, and training outlined in the specifications document signed at the start of the term.

While we understand that long term maintenance of the results of this project are important to you, University policy requires that we give students a final grade for their work at the end of the semester, and can no longer require hours of work from them for this project after the end of the semester. If your questions are simple, and short, you may feel free to contact them up to the end of the semester.

If you are looking to have the project expanded on, please contact either Dr. Smith or Dr. Schemm with the details, and we can investigate the possibility of adding your fixes, additions, or other work to the next semesters projects class.

This form can either be delivered via the team assigned to your project, or scanned and emailed to the cooperating instructor.

Client Signoff: Virginia Cimbalick
Chippewa Co. Historical Society

Date: 4-26-2017

CS 291/292/419
Client Signoff Sheet

Project: PRC Clent Datab se

Client: Di e Pe ler Resour Center

Student(s): el i

Student(s): onnor tz

Student(s):

Cooperating instructor: Dr. Sc

I have received from the CS Projects team all the software, manuals, and training outlined in the specifications document signed at the start of the term.

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This form can either be delivered via the team assigned to your project, or scanned and emailed to the cooperating instructor.

Client Signoff:

Date: 5/21/18

CS 291/292/419
Client Signoff Cover Sheet

Student Evaluation form for: [redacted]

Instructor: Dr. Smith

Please leave this sheet with the client when they signoff on your project.

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website looks awesome

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[redacted] kept me informed and up to date

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Would of liked a little more training time but overall did a good job in the time we had available.

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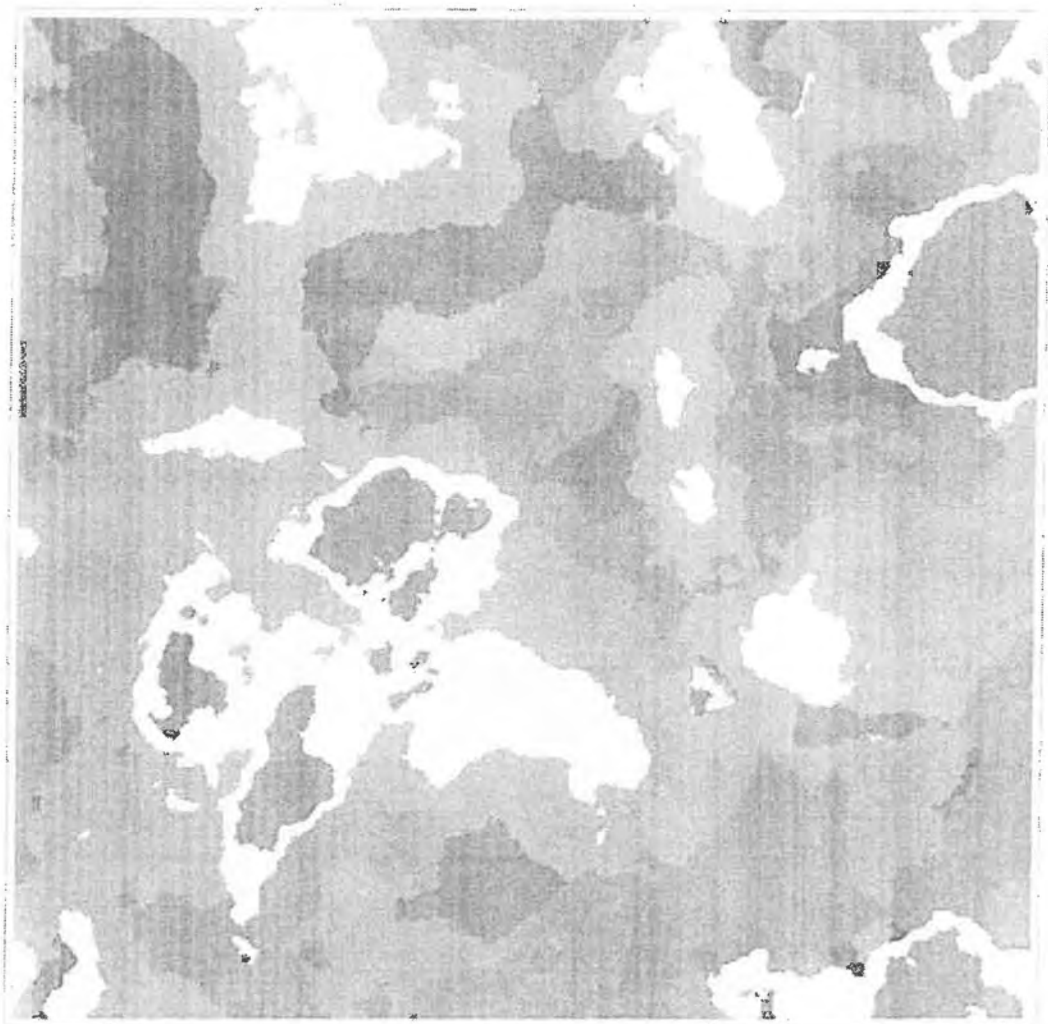
Thanks for your time and answers.

Terrain Generator



[redacted]

CSCI 291, Spring 2018

Introduction

Perlin noise is a form of coherent noise originally developed by Ken Perlin in 1983. In the years that followed, it has proved to be extremely useful for procedural content generation. It can be used to generate a variety of textures, as well as side-scrolling, 2D, and 3D terrain. For this project, I wrote a c++ implementation of Perlin's 2002 Improved Noise algorithm. This noise implementation was then used as the basis for a terrain generation system that creates 32x32 pixel chunks of 2D biomed terrain. This terrain tiles seamlessly, allowing the user to scroll in any direction for a seemingly endless amount of time.

Handling Directional Artifacts

In order to reduce the appearance of directional artifacts, I experimented with multiple possible solutions. The first involved an attempt to increase the number of gradient vectors used by the Perlin noise function. I hoped that by padding the number of gradients that the function has to choose from, I would be able to reduce the amount of directional bias in the end result. However, the results produced by this version of the project didn't seem to be any better or worse than the original implementation. The second attempt involved modifying the octave noise function in order to rotate each octave by a pseudorandom amount. This seemed to slightly improve the appearance of the terrain created by using a single noise instance in the early stages of the project, but didn't appear to have much of a positive effect on the biomed terrain created using multiple instances of the noise class. In the end, I decided that for finished product, Ken Perlin's original implementation seemed to produce the best looking results.

The use of multiple noise generator instances with different seeds turned out to be the most effective way of reducing artifacts. Strong directional bias is still present in the results produced by each individual noise generator, but using the values from each of these noise generators to assign a biome to the final terrain produced more natural looking results.

Terrain produced with one noise generator early in the project.

Terrain produced with multiple uniquely-seeded noise generators.

The noise class has two constructors: a default constructor that uses the current time to seed the random number generator, and a constructor that allows the user to pass in an integer seed value. Because the biome function relies on three unique noise arrays in order to produce the final result, using the default constructor for more than one instance is not recommended. If multiple random number generators are seeded with the same time, they will produce identical results, which will re-introduce obvious directional artifacts and lead to some undesirable behavior from the biome function. By default, each instance of the noise class used in the terrain generator's main window is seeded with a random number.

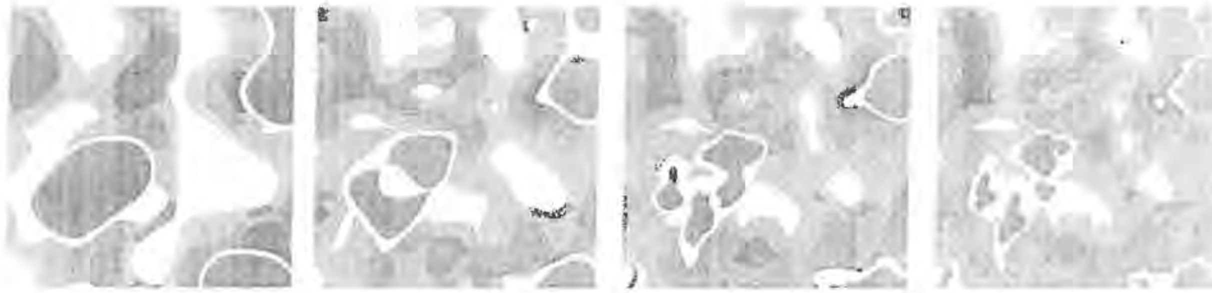
Terrain examples produced with identical seeds, with one unique seed, and with three unique seeds.

In the next four sections of this paper, I looked into the effects that changing certain parameters can have on the resulting terrain. For the sake of consistency and easy comparison, all of the example images were generated using the same three seed values: 985 for elevation, 3275 for temperature, and 29748 for moisture. These are the same seed values that were used to produce the large terrain image seen on the cover of this report.

Octaves

The octave parameter is used inside of the octavePerlin function, and determines how many octaves of noise will be combined into the final result. The default value is 8, but all integer values ranging from 1 to 15 are allowed.

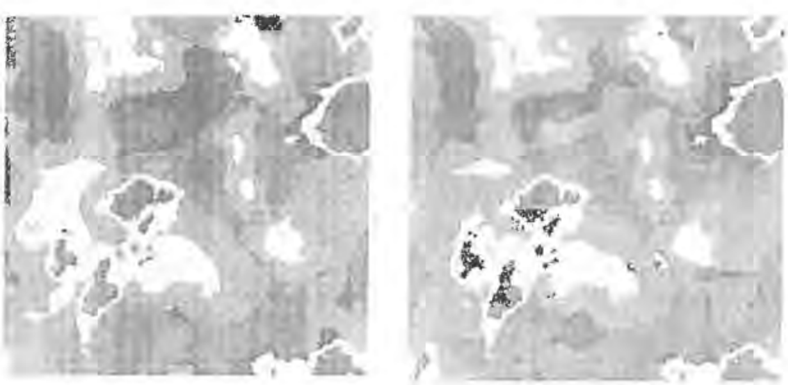
When each of the three generators is given a low octave value, the resulting terrain is smooth, terraced, and unnatural looking. This terracing effect is most severe with an octave value of 1. As octave values increase, the results become more natural looking. With an octave value of 4 for each generator, the terrain no longer appears terraced, but it still lacks the natural-looking fractal edges.



The results of using low octave values (from 1 to 4) for each noise generator.

The edges of the terrain will continue to become more natural looking as the octave value is increased up to the default value of 8. For values beyond 8, the amount of detail along the borders between biomes continues to increase. However, these increases in detail are small, and are barely noticeable at the highest allowed value of 15.

It's also possible to change the octave value for only one of the three noise generators. However, doing this did not produce very useful or natural looking results. Setting the octave parameter to a low value for one noise instance adds some of the terrace-like effects seen earlier. It also leads to some less organic looking intersections between biomes. The higher the octave value, the less obvious these effects become. With an octave value of 4 for one noise instance, the edges of some biomes are smooth compared to the fractal edges obtained with the default value, but this effect isn't pronounced enough to be easily noticed.



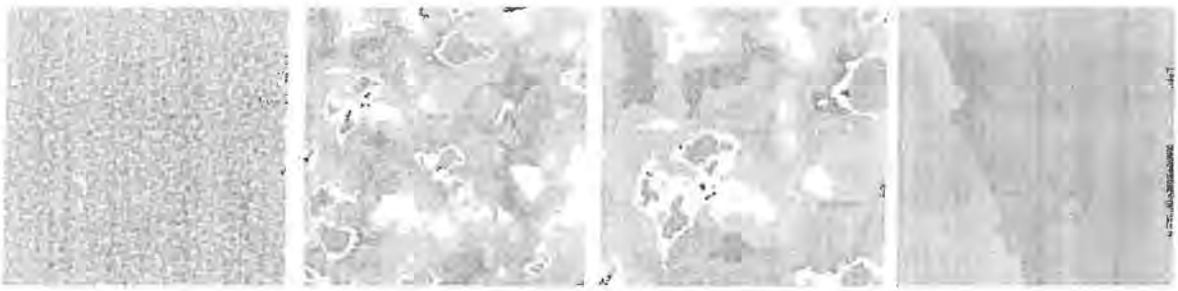
Terrain produced with an octave value of 1 for one noise instance, compared to the default terrain. Slightly different results are possible depending on which instance is changed.

Changing the octave value of the elevation noise instance to a low value is not recommended, as this leads to unnaturally round lakes and mountains that clash with the rest of the terrain.

Zoom

The zoom parameter is used inside of the getChunk function, and is responsible for how zoomed in/out the terrain appears to be. Larger values produce terrain that appears more zoomed out, while small values appear to be zoomed in. The default value is 0.005, and all values greater than 0 and less than or equal to 0.1 are allowed.

When a large zoom value is used for each noise instance, it becomes difficult to make out specific biomes in the resulting terrain. When using a small zoom value, the borders of biomes are easy to see, but users might spend quite a while scrolling through one biome before reaching the next one.

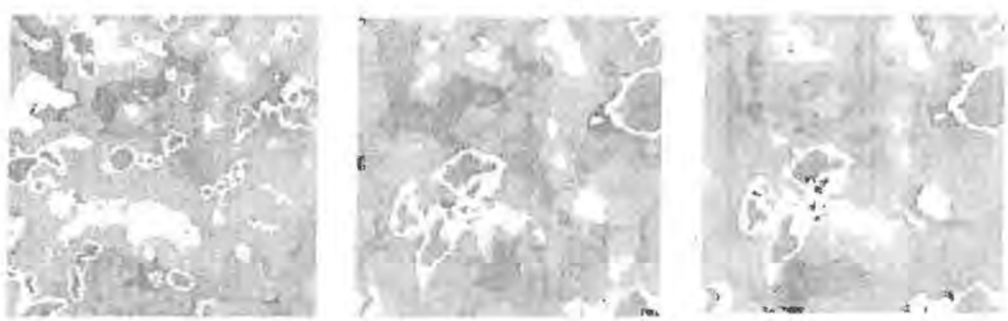


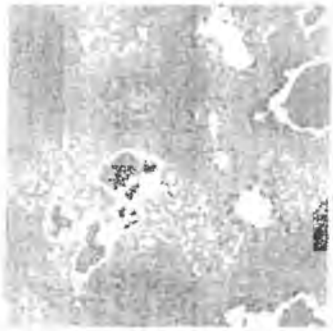
Terrain produced with zoom values of 0.1, 0.009, 0.005 (default), and 0.0005.

In order to test the effects of using different zoom values for each individual noise instance, a value of 0.01 was chosen to represent zoomed-out noise, while a value of 0.0009 was chosen to represent zoomed-in noise.

Changing the zoom value of the elevation instance to 0.01 produced results with a greater number of small lakes and mountains distributed throughout the terrain. Raising the zoom value to 0.01 for either temperature or moisture increased the amount of biome variation in the terrain by creating smaller areas of each non-lake and non-mountain biome. Areas that would've been made up of one continuous biome by default were broken up into multiple small areas of each biome instead.

Zoom values of 0.01 used for elevation, temperature, and moisture.

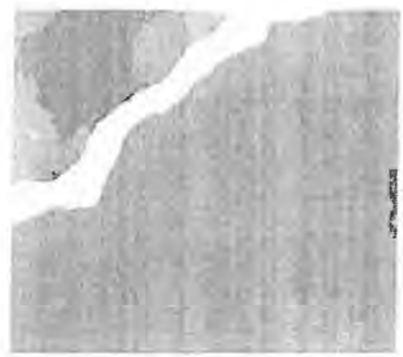





Using a zoom value for an individual noise instance that is too high can result in unnatural and undesirable results. In this case, 0.1 was used for temperature in the first example and elevation in the second.

Changing the zoom value for the elevation to 0.0009 appears to flatten the overall terrain. Lakes and mountains become far less common, but also increase greatly in size.

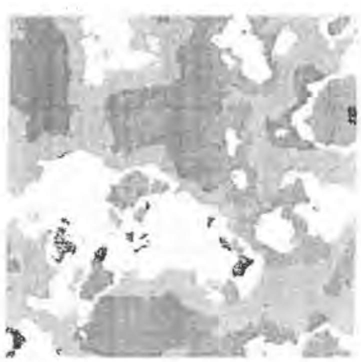
Terrain produced with an elevation zoom value of 0.0009.



A lake found while scrolling through the terrain from the previous image.

Changing the zoom of either temperature or moisture to 0.0009 alters the overall biome distribution. Large areas of the map become dominated by one of two distinct groups of biome types. The first group has large areas of desert, tropical rainforest, and boreal forest. Tundra is almost entirely taken over by boreal forest in this group. The second group has a larger amount of temperate rainforest, grassland, and woodland. These two groups appear whether you choose to alter the zoom for temperature or moisture, but their distribution around the overall map is different depending on which parameter was changed. These areas of altered distribution become larger as smaller zoom values are used.

Terrain produced with a zoom value of 0.0009 for the temperature noise generator



Terrain produced with a zoom value of 0.0009 for the moisture noise generator

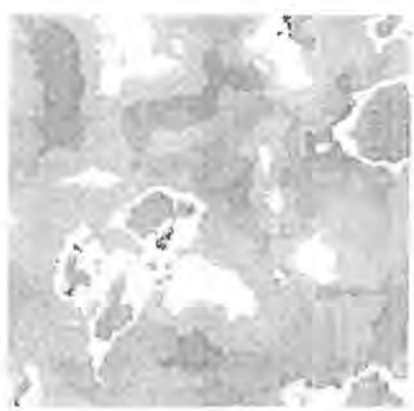
Persistence

Persistence is a parameter used in the octavePerlin function. It is used as a multiplier that decreases the amplitude value for each octave of noise. The default value is 0.5, and all values between -1 and 1 are allowed. However, values close to these cutoff points are unlikely to be useful, as using them produces

Using a persistence value of 0 for each of the three noise generator instances produces smooth-edged and terraced terrain, similar to the results from using a low number of octaves. As the values move away from this central point, the terrain becomes rougher, and eventually takes on a splotchy appearance. Negative values tend to move towards a large amount of the snow and water biomes, while positive values tend to move towards the "middle" biomes of grassland and forest.

-1 and 1, the extreme edge cases for persistence values. Both of these are unlikely to be useful for terrain generation, as they produce results where individual biomes are no longer distinguishable.

During my experiments, some of the most interesting results produced by changing any of the noise generation parameters came from using a persistence value of -0.5.



Terrain examples produced from identical seed values. The first example has a persistence of -0.5, while the second uses the default 0.5

Terrain generated while using this value for all three noise generation instances has increased amounts of water and snow, while still including smaller amounts of all the other biomes. The layout of this terrain is also significantly different from the terrain produced using the default persistence with the same seed values. This could provide a good way to generate terrain with larger bodies of water as needed. However, the amount of snow biome present in the resulting terrain might not be ideal for all situations.

In order to deal with this, I briefly changed one of the conditions near the end of the biome function. Normally, the last "else if" condition in this function is "else if(elevation < 0.7)". I temporarily changed this to value to 0.95 in an attempt to reduce the amount of high elevation terrain in the final results. This replaced a fair amount of the snow with tundra and boreal forest, producing a more balanced looking result. A second biome function with slightly different values could make altering the persistence more useful for generating different varieties of terrain.

Using persistence values above 0.5 for individual noise generator instances produced terrain where the edges of certain biomes were rougher and had more of the splotchy appearance seen when using the edge cases.

Setting the persistence to -0.5 for elevation alone produced results similar to using -0.5 for all three noise generators, but with a slightly different distribution of biomes. Using a persistence value of -0.5 for either moisture or temperature caused changes in biome distribution. The results of these changes were similar to the results of using a low zoom value for moisture or temperature, where biomes seemed to form two distinct groups. However, the effect seemed less pronounced.

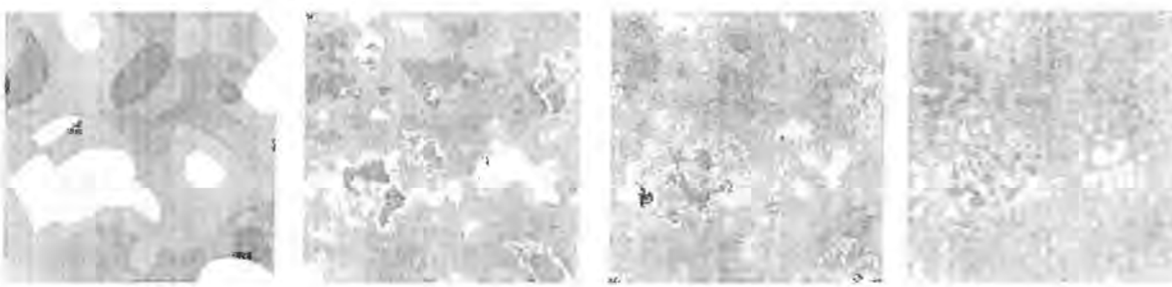
Terrain examples produced when using a persistence of -0.5 for elevation, temperature, and moisture.

Roughness

Roughness is a parameter used in the octavePerlin function. It is used as a multiplier which increases the frequency of the noise at each octave. The default value is 2, and all values between 0 and 10 are allowed by the setter function.

Using a roughness of 1 for each noise generator produces terrain that has the same smooth and unnaturally terraced appearance as terrain produced with a low number of octaves. If a roughness of 0 is used, the terrain generator produces an even more severely terraced result that has few to no lakes, plus a smaller amount of mountains and snow biomes.

As roughness values increase beyond the default, the edges between biomes become more jagged and splotchy. Values higher than 4 are unlikely to be useful for creating actual terrain, as the results they produce begin to look more and more unnatural.



Terrain examples produced with roughness values of 0, 3, 5, and 10.

When higher roughness values are used with one out of the three noise generator instances, the jagged edges appear on some (but not all) of the borders between different biomes.

Example terrain produced by using a roughness of 5 only on the elevation noise generator, then only on the moisture generator.

Project References

Biagioli, Adrian. "Understanding Perlin Noise." *Adrian's Soapbox*, 9 Aug. 2014, flafla2.github.io/2014/08/09/perlinnoise.html.

Patel, Amit. "Making Maps with Noise Functions." *Red Blob Games*, www.redblobgames.com/maps/terrain-from-noise/.

Perlin, Ken. " Improved Noise Reference Implementation ." *NYU Media Research Lab*, mrl.nyu.edu/~perlin/noise/.

Perlin, Ken. "Improving Noise." *ACM Transactions on Graphics*, vol. 21, no. 3, Jan. 2002, doi: 10.1145/566654.566636.

"Procedurally Generating Wrapping World Maps in Unity C# Part 4." *Jgallant*, 15 Jan. 2016, www.jgallant.com/procedurally-generating-wrapping-world-maps-in-unity-csharp-part-4/

Name: [redacted]

Self and Peer Evaluation

Answer the following questions (and be **specific**. You have a lot of room to write for a reason.):
What were the tasks you performed during your project(s)?

was respons r sig ing cl n
ram
client data ou interfac h
n l
Si i l
c
p
Flow through u and r
e prog.
I was also responsible creating a static
built of p so that cli wou no
need d l braries r.
I was r co
o y at
a.
A y,
u e
docu was
by myself, with ild by y
a e
presentation. y Final

Rate your overall performance on your project(s).

Very Poor		Poor		Average		Above Average		Excellent
1	2	3	4	5	6	7	8	9

For each teammate, answer the following:
What were the tasks your teammate(s) performed during your project(s)? Label each set of tasks with your teammate's name. (If you were on a one-person team, leave this page blank).

[redacted] :

- Sett u c syste
- ceing SQL Functionality into the existing GUI program
  - Adding clients to the daabase by racing data From QT texte
  - Querying the daabase an displayi based n se pn
    6.

How do you rate your teammate's overall performance on your project(s)?

Name

Very Poor		Poor		Average		Above Average		Excellent
1	2	3	4	5	6	7	8	9

Name

Very Poor		Poor		Average		Above Average		Excellent
1	2	3	4	5	6	7	8	9

Name

Very Poor		Poor		Average		Above Average		Excellent
1	2	3	4	5	6	7	8	9

Did you assist directly any other teams, including teams in another class? If "yes", which teams?

I cannot speak For my b did not t
y oth

Was your team assisted directly by anyone from another team? If "yes", who, and how?

I For but I was not assisted
by anyon From ano

Did your team utilize any other 'Human' Resources (other students, professors, etc)?
If "yes", who and how?

I. cannot spea my tea but I did not
utilize any other huma source.

What was the biggest problem that you figured out on this project?

I had 1
build For program. The documen tion For implementing
this on a Windows system was and it wa
time consuming process to Figure out n trouble hoot the
process.

What was the biggest problem that you needed help figuring out on this project?
How did you seek that help?

I did not he p For my in lve
in the pro; All probl experienced I wocs l
to Figure out through my own ab ty. IF I was
elp, would have First spoken Dr. Sche

What would you do differently next time?

I would communicate with he Client a y
more ave more involvem nt
portion of the application. h d ba

The database interFacing was more d c
than we expected and by the time mplica ions
arose, I was unab to help Connor significantly
since I was i o
he t o

Name: [redacted]

Self and Peer Evaluation

Answer the following questions (and be **specific**. You have a lot of room to write for a reason.):
What were the tasks you performed during your project(s)?

- Meeting with client
- Reading project-related resources, learning about noise
- Writing technical specification document
- Making a project schedule
- Learning to use Qt
- Learning to use version control
- Experimenting with pre-existing noise implementations + libraries
- Writing a C++ implementation of improved Perlin noise
- Testing and solving problems with my noise implementation
- Writing code to generate and display an image
- Creating a simple user interface to display generated images
- Getting help at office hours to solve tiling issue
- Attempting to reduce directional artifacts
- Analyzing noise results to find issues
- Experimenting with how changing parameters affected results
- Writing up the results of the parameter experiments
- Cleaning up and re-organizing code for readability
- Attending weekly project meetings

Rate your overall performance on your project(s).

Very Poor		Poor		Average		Above Average		Excellent
1	2	3	4	5	6	$\boxed{7}$	8	9

Did you assist directly any other teams, including teams in another class? If "yes", which teams?

No

Was your team assisted directly by anyone from another team? If "yes", who, and how?

No.

Did your team utilize any other 'Human' Resources (other students, professors, etc)?
If "yes", who and how?

Yes, I asked Dr. Schemm for help with solving an issue that I was having a hard time figuring out

What was the biggest problem that you figured out on this project?

The biggest Problem that I figured out on my own was a series of issues with my Perlin noise implementation. I solved it by Figuring out which functions weren't working correctly, then comparing my version to working implementations to see what I was missing or doing wrong.

What was the biggest problem that you needed help figuring out on this project? How did you seek that help?

The biggest problem that I needed help with was my tiling issue. I sought help by going to office hours and asking about it.

What would you do differently next time?

Next time, I would ask for help sooner after running into problems. I would also come up with a more realistic and useful schedule for myself, and I would ask more questions in general to make sure I was on the right track

Pickford Community Library –
Client: Ann Marie Smith
Student: [redacted]

The Pickford Community Library has relatively poor wireless and internet connectivity. The library's director would like a student to evaluate the current infrastructure and make recommendations for improvements to the available networking. This may require working with the library's Internet Service Provider, pulling cable, configuring wired network adaptors, installing and configuring wired and wireless routers, and testing reliability and speed.

Sault Theatre Project –
Client: Abby Baker
Student: [redacted]

The Sault Theatre Project is looking to revamp their website and add functionality so customers could purchase tickets to events or pay tuition for theatre classes. The current webpage layout needs to be evaluated and suggestions made for updates to the website. The handling of credit card payments has already been contracted out to a clearing-house firm.

Chippewa County Historical Society –
Client: Virginia Cymbalist
Student: [redacted]

The Kemp Industrial Museum (which was originally the office of the Kemp Coal Dock) showcases the major industries that were in the Sault from about 1875 to the middle 1900's. At the present time the exhibits are largely comprised of large photographs with descriptions, written historical information, and items from these industries. Specifically we're hoping to have a touch screen (a mouse might work) program utilizing photos and video and voice clips that make our displays more interesting at both the adult and youth levels. We also hope to include charts and graphs that show the impact of these industries on the population and economy of the Sault.

Chippewa Ottawa Resource Authority –
Client: Deanna Bowen
Student: [redacted]

The Chippewa Ottawa Resource Authority requires a website to be developed.

PART 2: Degree-Level Review

Degree Program: Associates in Computer Science

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

13. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

    See included document FourColumnASinCS.pdf.

Degree assessment for this program is handled in two ways. First, the capstone course for this program is the Computer Networking Project (CSCI 292). As part of the evaluation of student projects, faculty in the Computer Science and Computer Networking areas meet to discuss student performance, as well as evaluation success of the students on our four program level outcomes.

The second method used to assesses the program level outcomes is to look at the aggregate of course level assessment for courses taught that semester that are tied to each of the four program level objectives. These aggregate level assessments indicate that in general, we are reaching our goals. Specific places where we have trouble (students do not meet the goals) are usually related to a specific class, and are commented on, and tweaked at the course level. Years ago, our school adopted an end-of-semester reporting form for course assessment that (among other things) specifically addresses things that did not go well in a course, as well as proposed changes to address that. Please see the numerous examples in TracDat of such data.

14. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

During the last couple annual meetings (since the introduction of ENGL 306 as a course in the Bachelors Degree version of this degree), we have noted the difference in communication ability between Senior Projects (capstone for the Bachelors Degree in the same area) and Computer Networking Project (the sophomore capstone for this degree). Because the degree is a two year degree, we do not (at this time) anticipate adding ENGL 306 as a part of this degree because it would delay completion of the degree by at least one semester for students that do not take their regular English sequence during their freshman year. Instead, we have pulled some of the formalized documentation that is used in the senior project class, and required students to use them in this class. This has not only standardized the communications requirements for the students (each instructor was using their own instrument), but better prepares those who are going on for the Bachelors Degree.

In order to ensure that projects are of a sufficient difficulty level (without being too difficult for Sophomores) we changed how projects are admitted to the project pool 3 years ago. Prior to that point, projects were found by individual instructors of the three projects classes (CSCI 291, CSCI 292, and CSCI 418) and students had the opportunity to choose one of their instructors projects or suggest their own (which would then be approved or not by their instructor). We found that there was enough variation year to year, both with the caliber of projects available as well as the criteria used to evaluate the projects difficulty level, that we needed to standardize things better.

To facilitate that, we created a CS projects working group (consisting of all current CS / CN faculty) that evaluates all projects that are submitted for a year. Combined, they evaluate the difficulty of the assignment (Sophomore or Senior), the category of the project (primary knowledge areas required to complete), as well as fitness for this type of course (we have, for example, determined not to accept any more projects from commercial clients for a variety of reasons). This change allows a more meaningful standard for comparing student performance on projects.

As an example of the use of aggregate data, we have been looking at student performance coming out of CSCI 121 and CSCI 201. For this degree in particular, passing CSCI 201 seems to be a far bigger hurdle than is intended. We have been looking at a number of possible reasons for that, including instructional methods in both the pre-req courses, (CSCI 105, CSCI 121) as well as for this class (CSCI 201). In comparison with topics and delivery methods at other institutions, we find little difference between our topics and methods. We do, however, note significant differences between our topics and methods when compared to institutions that only offer a two year program. Our current hypothesis is that students are having difficulty making the transition from the lab oriented CSCI 105, and the more explicitly laid out assignments of of the pre-req classes to the less rigid CSCI 201 which requires more insight in the design and layout of the programs (where that is given in the assignment for CSCI 105 and CSCI 121). We are investigating ways that we can smooth out that transition.

An interesting datum that has come about recently has come from advising. In the last couple of semesters, we have had an increase in the number of students just pursuing the Associates in Computer Science. These students have found the final class required (CSCI 415) to be out of reach for a two year program. The students do have an alternative of CSCI 163, but recently that has moved to an alternate year offering. CSCI 163 really isn't an equivalent to CSCI 415, but we were pressured to make an alternative for an alternate year offering, and additionally Teacher Ed needed a class in there they could count as a 'hardware class'. Since CS certification in Computer Science is no longer offered, we are looking to fix all the problems with this by simply allowing students to take one of several of our alternate year upper level offerings. This would give them a bit of depth in one area, the freedom to choose that area (if not under a time-crunch) or the ability to pick the next offered one (if under a time crunch).

Quality, Resources and Support (CC 3.A)

15. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

For basic information, please see the attached degree audit (document AS Computer Science_F17.xlsx) and curricular map (document AS_CS_CurricularMap2018.xls) for this program. The degree audit was specifically requested, and represents the current course completion required to earn this degree. The curricular map shows how each of these courses relate to the four program level outcomes for the degree program (the first four columns), as well as the Institutional Level Outcomes (ILOs).

The Program Level Objectives were updated in 2018 to make them easier to assess and measure. We also decided at the same time to show the relationship of our courses to the university ILOs at the same time, as these ideas are core to the profession of Computer Science. Almost all jobs in this field revolve around taking the needs of clients, industry accepted standards (security for example), which often are not understood or even valued by clients and producing a unique system to meet the needs of those clients. The inclusion of the University ILOs allow us to focus on both the technical aspects of the field (our program learning outcomes) as well as the service aspect that most jobs in this area have (university ILOs). While almost all our courses touch on the ILOs in some way, courses tagged as related to the ILOs have a higher level of relation to them.

Intellectual Inquiry (CC 3.B).

16. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

Almost every course in this degree involves the analyzing of needs for a computer networking system, as well as setting it up to work with the actual users of the system (communication). Any of the programming or scripting classes (CSCI 105, CSCI 121, CSCI 201, CSCI 415, etc) involve the input (collecting), processing (analyzing), as well as output (communication) of information.

Unlike our Senior Projects class, Sophomore Computer Science Projects students are not required to participate in the Senior Symposium Poster presentation. They are required give an oral presentation on their material, but are not required to use slides to do so. Please see some examples of various student hand-ins and other project related materials in the Appendix labeled Sophomore Projects Samples.

Appendix Cover Sheet – Curriculum Map

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**AS_CS_CurricularMap2018.xls**
This documentation is relevant to Question number:	**Question 15– AS in Computer Science**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Revised Curriculum Map for our new program objectives as of Spring 2018. Includes courses that also map to the University ILOs.**

LSSU A.S. Computer Science - Program Objectives

After successful completion of our degree requirements, the student will be able to:

	Design and develop computer programs to meet specifications given to them.	Assist in analyzing, implementing, and integrating appropriate solutions for networking, database, and coding to applications and systems frameworks.	Use current software technologies and accepted best practices in software and systems design to help solve business and industrial problems.	Communicate technical information relative to problems and solutions to professionals in the field.	Students will develop and clearly express complex ideas in written and oral presentations. (ILO)	Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem. (ILO)	Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. (ILO)	Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a problem, or achieving a goal. (ILO)
CSCI 103				I	I			I
CSCI 105		I				I	I	
CSCI 121	I	r						
CSCI 201		R						
CSCI 211	I		I					
CSCI 221	I		I					
CSCI 291	M A	M A	M A	M A	M A	M A	M A	M A
CSCI 415		M	M					
MATH 111				R		R		
MATH 207				R		R		
BUSN 121				I				

Key: "I"=Introduced; "R"=reinforced and opportunity to practice; "M"=mastery at the senior or exit level; "A"=assessment evidence collected

(Note: Associates Program)

ILOs are also covered by University General Education Requirements. Items listed here supplement those topics and assessments.

Appendix Cover Sheet – Degree Audit

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**AS in Computer Science_F17.xlsx**
This documentation is relevant to Question number:	**Question 15– AS in Computer Science**
Briefly summarize the content of the file and its value as evidence supporting program review:	**The requested current Degree Audit sheet (current as of Fall 2018) for the AS in Computer Science.**

School of Mathematics & Computer Science — Fall 2017

Degree Audit: Associates in Computer Science

Name: ____________________ ID # ____________________

Advisor's Signature: ____________________ Chair's Signature: ____________________

General Education

Communication (9 cr)			Grade
ENGL 110	3	______	___
ENGL 111	3	______	___
COMM 101	3	______	___

Gen Ed. Electives (12cr)			
* BUSN 121	3	______	___
* MATH 207	3	______	___
* Required in degree program			
______	___	______	___
______	___	______	___

Free Electives (11 cr)			
______	___	______	___
______	___	______	___
______	___	______	___
______	___	______	___
______	___	______	___

Departmental Requirements (33 cr)

Computer Science (27 cr)			Grade
CSCI 103	3	______	___
CSCI 105	3	______	___
CSCI 121	4	______	___
CSCI 201	4	______	___
CSCI 163 or CSCI 415	3	______	___
CSCI 211	3	______	___
CSCI 221	3	______	___
CSCI 291	4	______	___

Mathematics (6 cr)			
MATH 111	3	______	___
MATH 207	3	______	___

Other Requirements (3 cr)			
BUSN 121	3	______	___

______ At least 62 total credits

______ At least 16 of last 32 credits earned at LSSU

______ 2.0 Overall GPA

______ 2.5 GPA in School Requirements

Appendix Cover Sheet – Four Column Report

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**FourColumnASinCS.pdf**
This documentation is relevant to Question number:	**Question 13– AS in Computer Science**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Four column report from TracDat.** **Note: First two objectives were not added by our school, they were added by administration and are not maintained by us. Mission Statement is also not ours, and was not put there by us.**

Assessment: Program Four Column

Computer Science AS

Program (CoIS) - Computer Science AS

Assessment Contact: Dr. Christopher Smith
Mission Statement: We equip our graduates for success through emphasis on rigorous programs, hands-on experiences, and interaction with highly-qualified faculty members who are centered on student success.

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Program Review - The Program provides evidence in support of Program Review in accordance with the Higher Learning Commission Criteria for Accreditation (4.A. The institution demonstrates responsibility for the quality of its educational programs. 1. The institution maintains a practice of regular program reviews.) **Goal Status:** Active **Goal Category:** Periodic Program Review	**Indirect - Report/Audit - Internal** - The Program conducts evidence-supported regular program review. The Program addresses the key components of the , incorporates feedback from assessment activities, and documents the impact of assessment findings and subsequent actions on student learning. **Criteria Target:** The Program Review will address the following criteria: 1. Contribution to LSSU Mission/Vision 2. Metrics of Productivity 3. Internal and External Program Demand 4. Program Quality 5. Program Assessment 6. Opportunity Analysis		
2.1 Program Enrollment - Strategy 2.1 The Program establishes realistic goals for program enrollment that are optimistic, realistic, achievable. **Goal Status:** Active **Goal Category:** Enrollment	**Regular, recurring** - The program sets goals for program enrollment which are time-based, progressive, achievable and quantitative. **Criteria Target:** Program Enrollment Growth Goal: ___________ by		

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Design - The Students will be able to design and develop computer programs to meet specifications given to them. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.0 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year End evaluation of projects and presentations has aggregate score of 3.14 (1 to 5). Includes 3 non-performing teams. (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 103 [Survey of Computer Science], and CSCI 121 [Principles of Programming] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Data from CSCI 121 has prompted investigations into how to increase student use of office hours, as well as methods that might be used to increase student attempts of homework assignment. Failure in the class is almost universally attributable to turning in less than 33% of assignments. Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 201 [Data Structures and Algorithms], and CSCI 291 [Computer Science Project] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Evaluate again during next program review. (05/29/2018)
Implementation - The students will be able to assist in analyzing, implementing, and integrating appropriate solutions for networking, database, and coding to applications and systems frameworks. **Goal Status:** Active	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.0 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** No Year End evaluation of projects and presentations has aggregate score of 2.86 (1 to 5). Includes 3 non-performing teams. Three teams of 7 with non-performance (project not completed), drops us below target. (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Goal Category: Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Exam/Quiz - within the course** - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 103 [Survey of Computer Science], and CSCI 121 [Principles of Programming] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Data from CSCI 121 has prompted investigations into how to increase student use of office hours, as well as methods that might be used to increase student attempts of homework assignment. Failure in the class is almost universally attributable to turning in less than 33% of assignments. Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Aggregate grade data from CSCI 201 [Data Structures and Algorithms], and CSCI 291 [Computer Science Project] shows students successfully completing these classes were able to meet this goal at least 70% of the time. (05/29/2018)	**Use of Result:** Evaluation again during next program review. (05/29/2018)
Best Practices - The students will be able to use current software technologies and accepted best practices in software and systems design to help solve business and industrial problems. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) [Bloom] **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.0 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Year end evaluation of projects and presentations has aggregate score of 3.07 (1 to 5). Includes 3 non-performing teams. (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 103 [Survey of Computer Science], and CSCI 121 [Principles of Programming] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Data from CSCI 121 has prompted investigations into how to increase student use of office hours, as well as methods that might be used to increase student attempts of homework assignment. Failure in the class is almost universally attributable to turning in less than 33% of

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
	patterns. The specific courses used will be indicated for each set of reporting data.		assignments. Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)
Communication - The students will be able to communicate technical information relative to problems and solutions to professionals in the field. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2018 **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex ideas in written and oral presentations. **Revision Notes:** We revised all program goals in 2018 to make them more measurable and applicable.	**Direct - Capstone Project - including undergraduate research** - Year End Project Review **Criteria Target:** Score of 3.0 or higher for at least 70% of students	**Finding Reporting Year:** 2017-2018 **Goal met:** No Year End evaluation of projects and presentations has aggregate score of 2.79 (1 to 5). Includes 3 non-performing teams. Three non-performing teams (projects not completed) of 7 drops us below threshold. (05/30/2018)	**Use of Result:** Evaluate again after next years projects. (05/30/2018)
	Direct - Exam/Quiz - within the course - Year End Aggregate Course Data **Criteria Target:** 70% of students earn at least 70% of the possible points on objective related exam questions, lab tasks, or homework assignments. **Schedule/Notes:** Courses used each year may vary due to course offering patterns. The specific courses used will be indicated for each set of reporting data.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Aggregate grade data from CSCI 103 [Survey of Computer Science], and CSCI 121 [Principles of Programming] shows students successfully completing these classes were able to meet this goal at least 70% of the time. [Retroactively added based on prior data to new department objectives for 2018] (07/30/2018)	**Use of Result:** Data from CSCI 121 has prompted investigations into how to increase student use of office hours, as well as methods that might be used to increase student attempts of homework assignment. Failure in the class is almost universally attributable to turning in less than 33% of assignments. Result added retroactively to new 2018 program objectives. Data from 2016-2017 had already been used for 2017-2018 classes, as well as ongoing curricular update efforts. (07/30/2018)

Appendix Cover Sheet - Sophomore Projects Samples

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**PosterPresentations.zip**
This documentation is relevant to Question number:	**Question 16- AS in Computer Science** **Question 16- AS in Internet Network Specialist**
Briefly summarize the content of the file and its value as evidence supporting program review:	**This zip file contains samples of student submissions as part of CSCI 291 and CSCI 292.**

CS 291/292/419
Client Signoff Cover Sheet

Student Evaluation form for: [redacted]

Instructor: Dr. Smith

Please leave this sheet with the client when they signoff on your project.

When the students assigned to your project have completed the project in question, demonstrated it to your satisfaction, provided initial training in its use (as well as manuals for future training and reference). Please indicate that by signing the attached form. Also, please email the supervising instructor and answer the following questions about your experience with this student:
(If the project team assigned to you had multiple students, please send one email with answers for each student on the team).

Dr. Schemm elschemm@furball.schemm.lssu.edu
Dr. Smith csmith16@lssu.edu
Dr. Kalata kkalata@lssu.edu

1) How would you rate the professionalism and communications skills of this student on the team?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

[redacted] is very professional

2) How would you rate this student's technical skills / ability to serve your needs?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

website looks awesome

3) How well did the team keep you involved in the development process? (Timely meetings, demonstrations of work to date, etc)?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

[redacted] kept me informed and up to date

4) How well has this student prepared you to use the finished product (provided training, manuals, etc)?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

Would of liked a little more training time but they did a good job in the time we had available.

5) Are you satisfied that the project is complete? If not, what still needs to be completed?

Our Website Looks amazing. [redacted] did a wonderful [illegible]
For some reason when I pull up the site on my computer it is missing an update that we did but shows up when pulled up on another computer. [redacted] tried to give me things to do to try and correct it but these didn't work, I would of liked to figure out what is happening with my website

Thanks for your time and answers.

Pickford Community Library –
Client: Ann Marie Smith
Student: [redacted]

The Pickford Community Library has relatively poor wireless and internet connectivity. The library's director would like a student to evaluate the current infrastructure and make recommendations for improvements to the available networking. This may require working with the library's Internet Service Provider, pulling cable, configuring wired network adaptors, installing and configuring wired and wireless routers, and testing reliability and speed.

Sault Theatre Project –
Client: Abby Baker
Student: [redacted]

The Sault Theatre Project is looking to revamp their website and add functionality so customers could purchase tickets to events or pay tuition for theatre classes. The current webpage layout needs to be evaluated and suggestions made for updates to the website. The handling of credit card payments has already been contracted out to a clearing-house firm.

Chippewa County Historical Society –
Client: Virginia Cymbalist
Student: [redacted]

The Kemp Industrial Museum (which was originally the office of the Kemp Coal Dock) showcases the major industries that were in the Sault from about 1875 to the middle 1900's. At the present time the exhibits are largely comprised of large photographs with descriptions, written historical information, and items from these industries. Specifically we're hoping to have a touch screen (a mouse might work) program utilizing photos and video and voice clips that make our displays more interesting at both the adult and youth levels. We also hope to include charts and graphs that show the impact of these industries on the population and economy of the Sault.

Chippewa Ottawa Resource Authority –
Client: Deanna Bowen
Student: [redacted]

The Chippewa Ottawa Resource Authority requires a website to be developed.

Name: [redacted]

Self and Peer Evaluation

Answer the following questions (and be **specific**. You have a lot of room to write for a reason.):
What were the tasks you performed during your project(s)?

- Meeting with client
- Reading project-related resources, learning about noise
- Writing technical specification document
- Making a project schedule
- Learning to use Qt
- Learning to use version control
- Experimenting with pre-existing noise implementations + libraries
- Writing a C++ implementation of improved Perlin noise
- Testing and solving problems with my noise implementation
- Writing code to generate and display an image
- Creating a simple user interface to display generated images
- Getting help at office hours to solve tiling issue
- Attempting to reduce directional artifacts
- Analyzing noise results to find issues
- Experimenting with how changing parameters affected results
- Writing up the results of the parameter experiments
- Cleaning up and re-organizing code for readability
- Attending weekly project meetings

Rate your overall performance on your project(s).

Very Poor		Poor		Average		Above Average		Excellent
1	2	3	4	5	6	$\boxed{7}$	8	9

Did you assist directly any other teams, including teams in another class? If "yes", which teams?

No

Was your team assisted directly by anyone from another team? If "yes", who, and how?

No.

Did your team utilize any other 'Human' Resources (other students, professors, etc)?
If "yes", who and how?

Yes, I asked Dr. Schemm for help with solving an issue that I was having a hard time figuring out

What was the biggest problem that you figured out on this project?

The biggest problem that I figured out on my own was a series of issues with my Perlin noise implementation. I solved it by figuring out which functions weren't working correctly, then comparing my version to working implementations to see what I was missing or doing wrong.

What was the biggest problem that you needed help figuring out on this project? How did you seek that help?

The biggest problem that I needed help with was my tiling issue. I sought help by going to office hours and asking about it.

What would you do differently next time?

Next time, I would ask for help sooner after running into problems. I would also come up with a more realistic and useful schedule for myself, and I would ask more questions in general to make sure I was on the right track.

CS 291/292/419
Client Signoff Cover Sheet

Student Evaluation form for: [redacted]

Instructor: Dr. Smith

Please leave this sheet with the client when they signoff on your project.

When the students assigned to your project have completed the project in question, demonstrated it to your satisfaction, provided initial training in its use (as well as manuals for future training and reference). Please indicate that by signing the attached form. Also, please email the supervising instructor and answer the following questions about your experience with this student:
(If the project team assigned to you had multiple students, please send one email with answers for each student on the team).

Dr. Schemm elschemm@furball.schemm.lssu.edu
Dr. Smith csmith16@lssu.edu
Dr. Kalata kkalata@lssu.edu

1) How would you rate the professionalism and communications skills of this student on the team?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

2) How would you rate this student's technical skills / ability to serve your needs?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

3) How well did the team keep you involved in the development process? (Timely meetings, demonstrations of work to date, etc)?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

4) How well has this student prepared you to use the finished product (provided training, manuals, etc)?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

5) Are you satisfied that the project is complete? If not, what still needs to be completed?
We are very satisfied with the completed project. [redacted] created a program that we can easily adapt to meet our future needs but is very usable now.

Thanks for your time and answers.

CS 291/292/419
Client Signoff Sheet

Project: Kemp Industrial Museum Kiosk

Client: Chippewa County Historical Society

Student(s): [redacted]

Student(s):

Student(s):

Cooperating instructor: Dr. Smith

I have received from the CS Projects team all the software, manuals, and training outlined in the specifications document signed at the start of the term.

While we understand that long term maintenance of the results of this project are important to you, University policy requires that we give students a final grade for their work at the end of the semester, and can no longer require hours of work from them for this project after the end of the semester. If your questions are simple, and short, you may feel free to contact them up to the end of the semester.

If you are looking to have the project expanded on, please contact either Dr. Smith or Dr. Schemm with the details, and we can investigate the possibility of adding your fixes, additions, or other work to the next semesters projects class.

This form can either be delivered via the team assigned to your project, or scanned and emailed to the cooperating instructor.

Client Signoff: Virginia Cimbalick
Chippewa Co. Historical Society

Date: 4-26-2017

CS 291/292/419
Client Signoff Sheet

Project: PRC Clent Datab se

Client: Di e Pe ler Resour Center

Student(s): el

Student(s): [redacted]

Student(s):

Cooperating instructor: Dr. Sc

I have received from the CS Projects team all the software, manuals, and training outlined in the specifications document signed at the start of the term.

While we understand that long term maintenance of the results of this project are important to you, University policy requires that we give students a final grade for their work at the end of the semester, and can no longer require hours of work from them for this project after the end of the semester. If your questions are simple, and short, you may feel free to contact them up to the end of the semester.

If you are looking to have the project expanded on, please contact either Dr. Smith or Dr. Schemm with the details, and we can investigate the possibility of adding your fixes, additions, or other work to the next semesters projects class.

This form can either be delivered via the team assigned to your project, or scanned and emailed to the cooperating instructor.

Client Signoff:

Date: 6/21/18

CS 291/292/419
Client Signoff Cover Sheet

Student Evaluation form for: [redacted]

Instructor: Dr. Smith

Please leave this sheet with the client when they signoff on your project.

When the students assigned to your project have completed the project in question, demonstrated it to your satisfaction, provided initial training in its use (as well as manuals for future training and reference). Please indicate that by signing the attached form. Also, please email the supervising instructor and answer the following questions about your experience with this student:
(If the project team assigned to you had multiple students, please send one email with answers for each student on the team).

Dr. Schemm elschemm@furball.schemm.lssu.edu
Dr. Smith csmith16@lssu.edu
Dr. Kalata kkalata@lssu.edu

1) How would you rate the professionalism and communications skills of this student on the team?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

[redacted] is very professional

2) How would you rate this student's technical skills - ability to serve your needs?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

website looks awesome

3) How well did the team keep you involved in the development process? (Timely meetings, demonstrations of work to date, etc)?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

[redacted] kept me informed and up to date

4) How well has this student prepared you to use the finished product (provided training, manuals, etc)?
5-Excellent 4-Very good 3-Average 2-Below Average 1-Weak

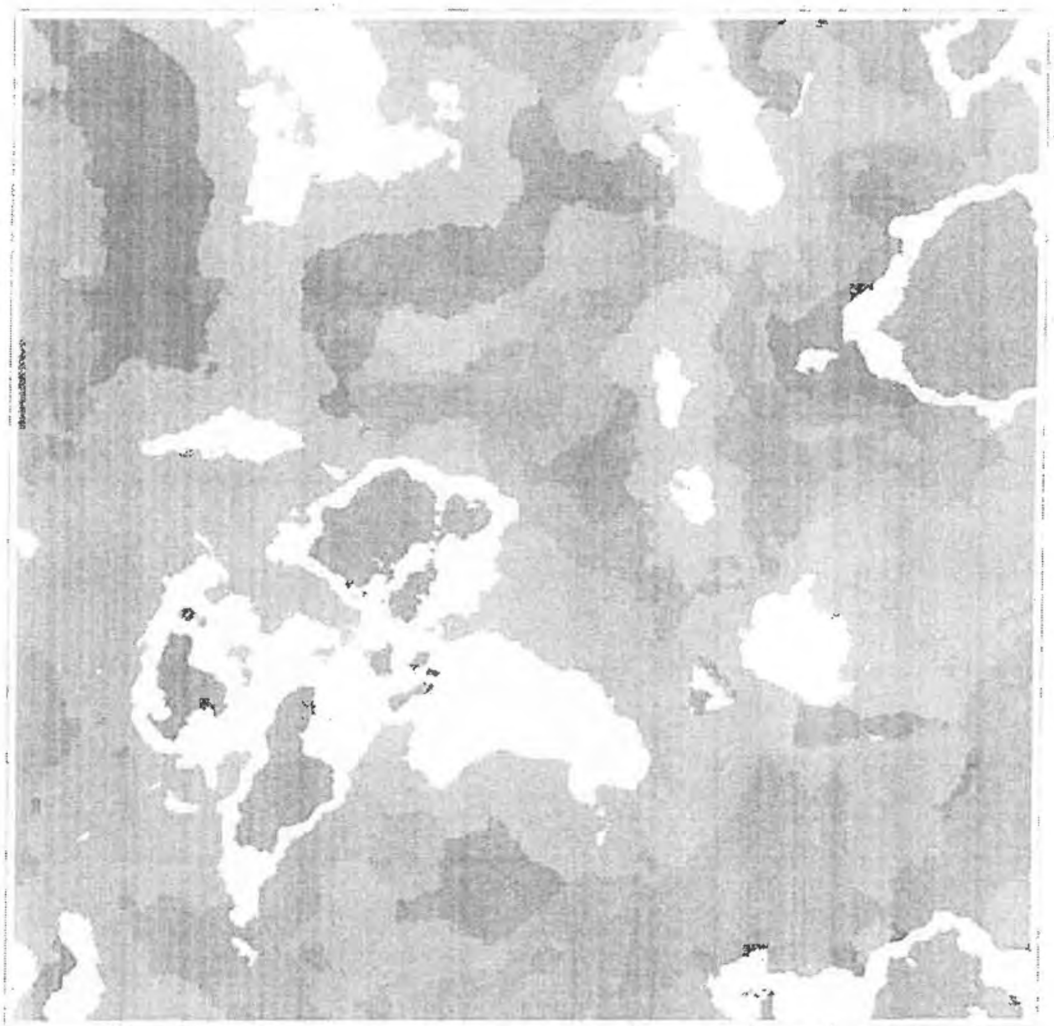
Would of liked a little more training time but [redacted] did a good job in the time we had available.

5) Are you satisfied that the project is complete? If not, what still needs to be completed?

Our website looks amazing. [redacted] did a wonderful job. For some reason when I pull up the site on my computer it is missing an update that we did but it doesn't when pulled up on another computer. [redacted] tried to give me things to do to try and correct it but those didn't work. Would of liked to figure out what is happening with my computer.

Thanks for your time and answers.

Terrain Generator



[redacted]

CSCI 291, Spring 2018

Introduction

Perlin noise is a form of coherent noise originally developed by Ken Perlin in 1983. In the years that followed, it has proved to be extremely useful for procedural content generation. It can be used to generate a variety of textures, as well as side-scrolling, 2D, and 3D terrain. For this project, I wrote a c++ implementation of Perlin's 2002 Improved Noise algorithm. This noise implementation was then used as the basis for a terrain generation system that creates 32x32 pixel chunks of 2D biomed terrain. This terrain tiles seamlessly, allowing the user to scroll in any direction for a seemingly endless amount of time.

Handling Directional Artifacts

In order to reduce the appearance of directional artifacts, I experimented with multiple possible solutions. The first involved an attempt to increase the number of gradient vectors used by the Perlin noise function. I hoped that by padding the number of gradients that the function has to choose from, I would be able to reduce the amount of directional bias in the end result. However, the results produced by this version of the project didn't seem to be any better or worse than the original implementation. The second attempt involved modifying the octave noise function in order to rotate each octave by a pseudorandom amount. This seemed to slightly improve the appearance of the terrain created by using a single noise instance in the early stages of the project, but didn't appear to have much of a positive effect on the biomed terrain created using multiple instances of the noise class. In the end, I decided that for finished product, Ken Perlin's original implementation seemed to produce the best looking results.

The use of multiple noise generator instances with different seeds turned out to be the most effective way of reducing artifacts. Strong directional bias is still present in the results produced by each individual noise generator, but using the values from each of these noise generators to assign a biome to the final terrain produced more natural looking results.

Terrain produced with one noise generator early in the project.

Terrain produced with multiple uniquely-seeded noise generators.

The noise class has two constructors: a default constructor that uses the current time to seed the random number generator, and a constructor that allows the user to pass in an integer seed value. Because the biome function relies on three unique noise arrays in order to produce the final result, using the default constructor for more than one instance is not recommended. If multiple random number generators are seeded with the same time, they will produce identical results, which will re-introduce obvious directional artifacts and lead to some undesirable behavior from the biome function. By default, each instance of the noise class used in the terrain generator's main window is seeded with a random number.

Terrain examples produced with identical seeds, with one unique seed, and with three unique seeds.

In the next four sections of this paper, I looked into the effects that changing certain parameters can have on the resulting terrain. For the sake of consistency and easy comparison, all of the example images were generated using the same three seed values: 985 for elevation, 3275 for temperature, and 29748 for moisture. These are the same seed values that were used to produce the large terrain image seen on the cover of this report.

Octaves

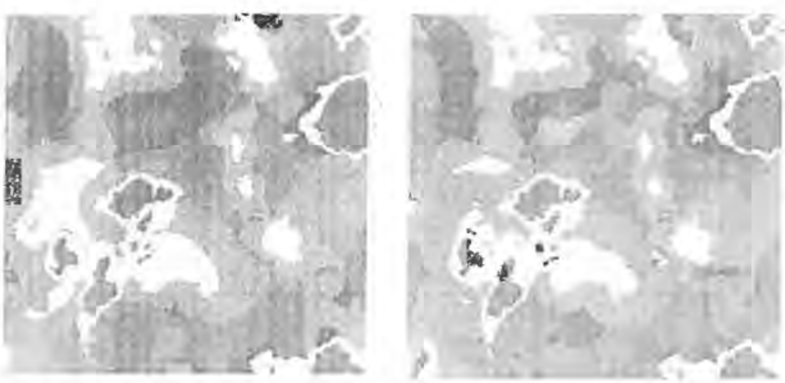
The octave parameter is used inside of the octavePerlin function, and determines how many octaves of noise will be combined into the final result. The default value is 8, but all integer values ranging from 1 to 15 are allowed.

When each of the three generators is given a low octave value, the resulting terrain is smooth, terraced, and unnatural looking. This terracing effect is most severe with an octave value of 1. As octave values increase, the results become more natural looking. With an octave value of 4 for each generator, the terrain no longer appears terraced, but it still lacks the natural-looking fractal edges.

The results of using low octave values (from 1 to 4) for each noise generator.

The edges of the terrain will continue to become more natural looking as the octave value is increased up to the default value of 8. For values beyond 8, the amount of detail along the borders between biomes continues to increase. However, these increases in detail are small, and are barely noticeable at the highest allowed value of 15.

It's also possible to change the octave value for only one of the three noise generators. However, doing this did not produce very useful or natural looking results. Setting the octave parameter to a low value for one noise instance adds some of the terrace-like effects seen earlier. It also leads to some less organic looking intersections between biomes. The higher the octave value, the less obvious these effects become. With an octave value of 4 for one noise instance, the edges of some biomes are smooth compared to the fractal edges obtained with the default value, but this effect isn't pronounced enough to be easily noticed.



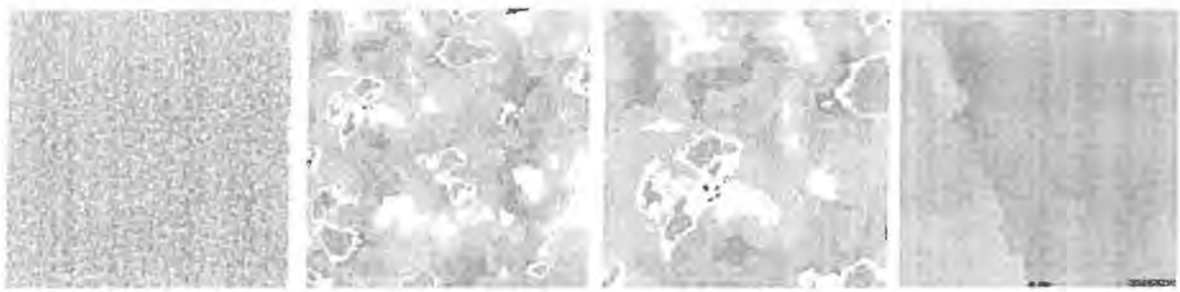
Terrain produced with an octave value of 1 for one noise instance, compared to the default terrain. Slightly different results are possible depending on which instance is changed.

Changing the octave value of the elevation noise instance to a low value is not recommended, as this leads to unnaturally round lakes and mountains that clash with the rest of the terrain.

Zoom

The zoom parameter is used inside of the getChunk function, and is responsible for how zoomed in/out the terrain appears to be. Larger values produce terrain that appears more zoomed out, while small values appear to be zoomed in. The default value is 0.005, and all values greater than 0 and less than or equal to 0.1 are allowed.

When a large zoom value is used for each noise instance, it becomes difficult to make out specific biomes in the resulting terrain. When using a small zoom value, the borders of biomes are easy to see, but users might spend quite a while scrolling through one biome before reaching the next one.

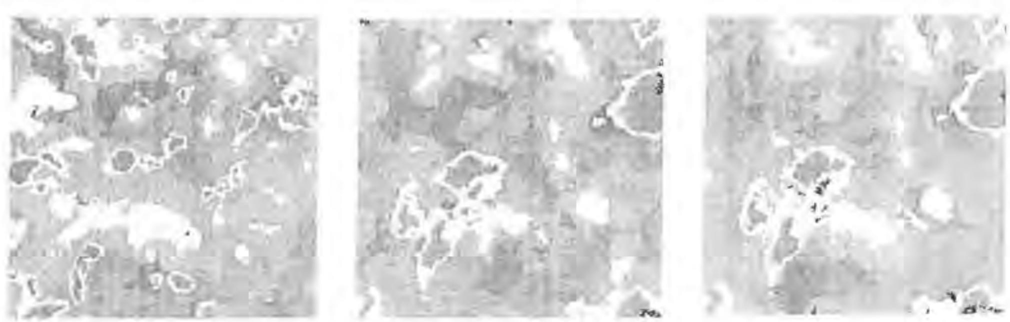


Terrain produced with zoom values of 0.1, 0.009, 0.005 (default), and 0.0005.

In order to test the effects of using different zoom values for each individual noise instance, a value of 0.01 was chosen to represent zoomed-out noise, while a value of 0.0009 was chosen to represent zoomed-in noise.

Changing the zoom value of the elevation instance to 0.01 produced results with a greater number of small lakes and mountains distributed throughout the terrain. Raising the zoom value to 0.01 for either temperature or moisture increased the amount of biome variation in the terrain by creating smaller areas of each non-lake and non-mountain biome. Areas that would've been made up of one continuous biome by default were broken up into multiple small areas of each biome instead.

Zoom values of 0.01 used for elevation, temperature, and moisture.




Using a zoom value for an individual noise instance that is too high can result in unnatural and undesirable results. In this case, 0.1 was used for temperature in the first example and elevation in the second.

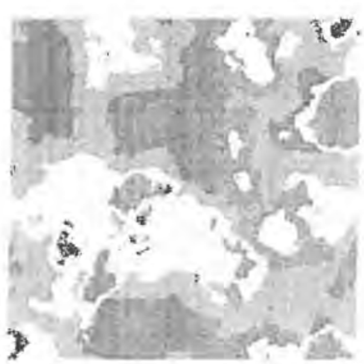
Changing the zoom value for the elevation to 0.0009 appears to flatten the overall terrain. Lakes and mountains become far less common, but also increase greatly in size.

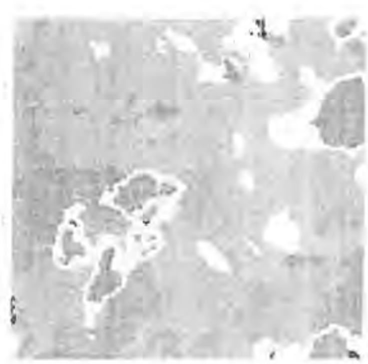
Terrain produced with an elevation zoom value of 0.0009.

A lake found while scrolling through the terrain from the previous image.

Changing the zoom of either temperature or moisture to 0.0009 alters the overall biome distribution. Large areas of the map become dominated by one of two distinct groups of biome types. The first group has large areas of desert, tropical rainforest, and boreal forest. Tundra is almost entirely taken over by boreal forest in this group. The second group has a larger amount of temperate rainforest, grassland, and woodland. These two groups appear whether you choose to alter the zoom for temperature or moisture, but their distribution around the overall map is different depending on which parameter was changed. These areas of altered distribution become larger as smaller zoom values are used.

Terrain produced with a zoom value of 0.0009 for the temperature noise generator





Terrain produced with a zoom value of 0.0009 for the moisture noise generator

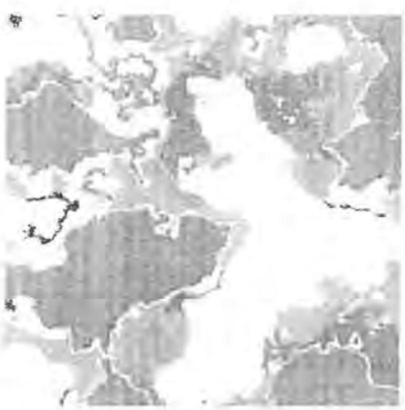
Persistence

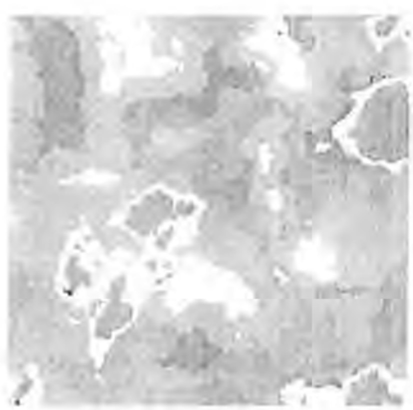
Persistence is a parameter used in the octavePerlin function. It is used as a multiplier that decreases the amplitude value for each octave of noise. The default value is 0.5, and all values between -1 and 1 are allowed. However, values close to these cutoff points are unlikely to be useful, as using them produces

Using a persistence value of 0 for each of the three noise generator instances produces smooth-edged and terraced terrain, similar to the results from using a low number of octaves. As the values move away from this central point, the terrain becomes rougher, and eventually takes on a splotchy appearance. Negative values tend to move towards a large amount of the snow and water biomes, while positive values tend to move towards the "middle" biomes of grassland and forest.

-1 and 1, the extreme edge cases for persistence values. Both of these are unlikely to be useful for terrain generation, as they produce results where individual biomes are no longer distinguishable.

During my experiments, some of the most interesting results produced by changing any of the noise generation parameters came from using a persistence value of -0.5.

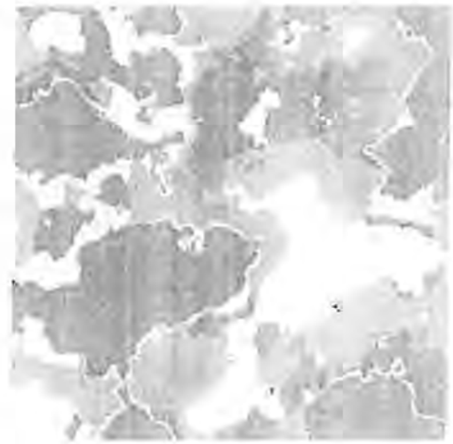




Terrain examples produced from identical seed values. The first example has a persistence of -0.5, while the second uses the default 0.5

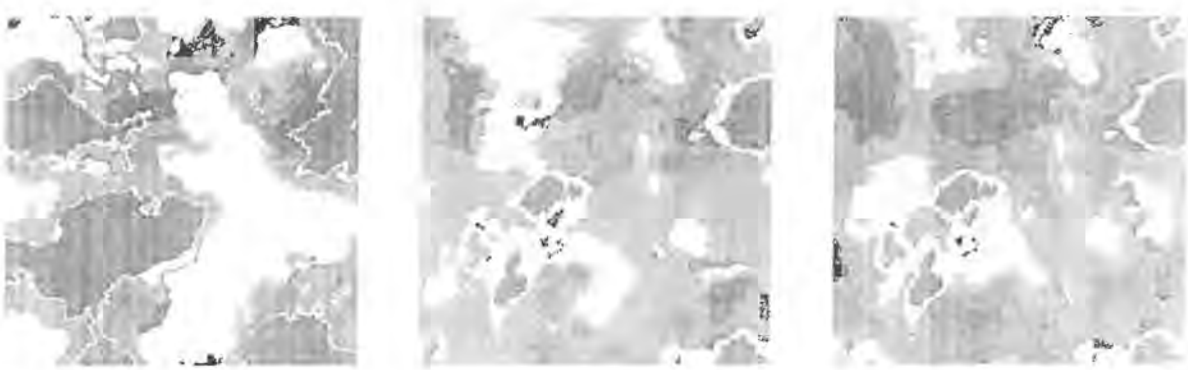
Terrain generated while using this value for all three noise generation instances has increased amounts of water and snow, while still including smaller amounts of all the other biomes. The layout of this terrain is also significantly different from the terrain produced using the default persistence with the same seed values. This could provide a good way to generate terrain with larger bodies of water as needed. However, the amount of snow biome present in the resulting terrain might not be ideal for all situations.

In order to deal with this, I briefly changed one of the conditions near the end of the biome function. Normally, the last "else if" condition in this function is "else if(elevation < 0.7)". I temporarily changed this to value to 0.95 in an attempt to reduce the amount of high elevation terrain in the final results. This replaced a fair amount of the snow with tundra and boreal forest, producing a more balanced looking result. A second biome function with slightly different values could make altering the persistence more useful for generating different varieties of terrain.



Using persistence values above 0.5 for individual noise generator instances produced terrain where the edges of certain biomes were rougher and had more of the splotchy appearance seen when using the edge cases.

Setting the persistence to -0.5 for elevation alone produced results similar to using -0.5 for all three noise generators, but with a slightly different distribution of biomes. Using a persistence value of -0.5 for either moisture or temperature caused changes in biome distribution. The results of these changes were similar to the results of using a low zoom value for moisture or temperature, where biomes seemed to form two distinct groups. However, the effect seemed less pronounced.



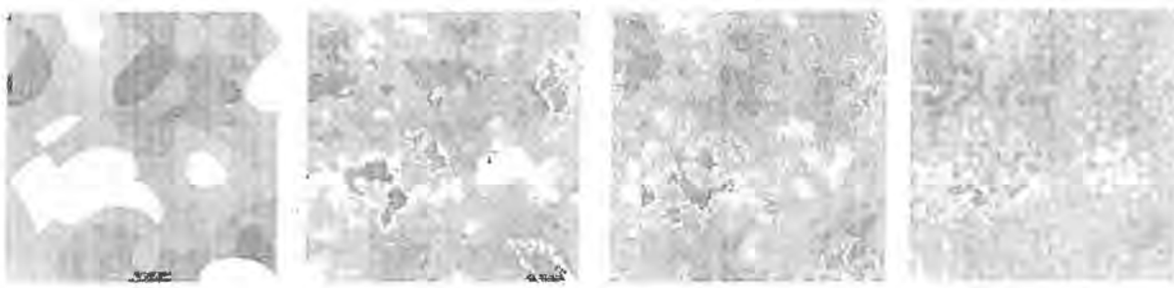
Terrain examples produced when using a persistence of -0.5 for elevation, temperature, and moisture.

Roughness

Roughness is a parameter used in the octavePerlin function. It is used as a multiplier which increases the frequency of the noise at each octave. The default value is 2, and all values between 0 and 10 are allowed by the setter function.

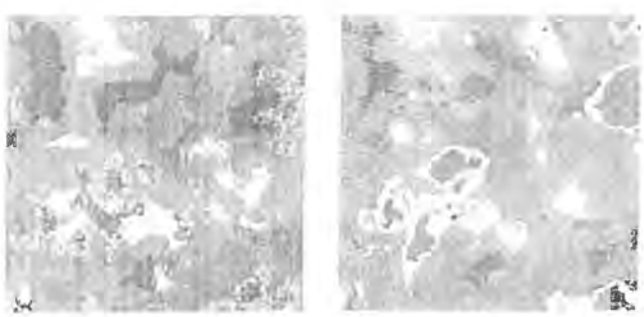
Using a roughness of 1 for each noise generator produces terrain that has the same smooth and unnaturally terraced appearance as terrain produced with a low number of octaves. If a roughness of 0 is used, the terrain generator produces an even more severely terraced result that has few to no lakes, plus a smaller amount of mountains and snow biomes.

As roughness values increase beyond the default, the edges between biomes become more jagged and splotchy. Values higher than 4 are unlikely to be useful for creating actual terrain, as the results they produce begin to look more and more unnatural.



Terrain examples produced with roughness values of 0, 3, 5, and 10.

When higher roughness values are used with one out of the three noise generator instances, the jagged edges appear on some (but not all) of the borders between different biomes.



Example terrain produced by using a roughness of 5 only on the elevation noise generator, then only on the moisture generator.

Project References

Biagioli, Adrian. "Understanding Perlin Noise." *Adrian's Soapbox*, 9 Aug. 2014, flafla2.github.io/2014/08/09/perlinnoise.html.

Patel, Amit. "Making Maps with Noise Functions." *Red Blob Games*, www.redblobgames.com/maps/terrain-from-noise/.

Perlin, Ken. " Improved Noise Reference Implementation ." *NYU Media Research Lab*, mrl.nyu.edu/~perlin/noise/.

Perlin, Ken. "Improving Noise." *ACM Transactions on Graphics*, vol. 21, no. 3, Jan. 2002, doi: 10.1145/566654.566636.

"Procedurally Generating Wrapping World Maps in Unity C# – Part 4." *Jgallant*, 15 Jan. 2016, www.jgallant.com/procedurally-generating-wrapping-world-maps-in-unity-csharp-part-4/

PART 2: Degree-Level Review

Degree Program: **B.S. Mathematics Secondary Teaching**

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

13. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

The 4-Column Program Assessment Report is attached as a related document.

14. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

In 2016, upon completion of Program Review for this major, it was noticed that even though our majors passed overall at a rate of 100%, Measurement and Geometry was often the lowest sub-section of the MTTC exam. The study guide located at https://www.mttc.nesinc.com/Content/STUDYGUIDE/MI_SG_OBJ_022.htm was reviewed as well as the practice exam at https://www.mttc.nesinc.com/Content/STUDYGUIDE/MI_SG_SRI_022.htm . The instructor of MATH 325 College Geometry placed more emphasis on transformations and restructured the lesson on inscribed angles to contain circumscribed angles. While not statistically conclusive, both students who took the exam after this change were successful in this sub-area.

The University as a whole assessed Freshmen retention and found that students who took a university success seminar were more likely to be successful in their freshman year. While we had suggested students in this program take EDUC 101, it had not been required. As a result of that assessment, we now require students in this program to take EDUC 101.

In CSCI 105 Introduction to Computer Programming in 2017-2018, the ability to Acquire Data and the ability to Present and Display Data failed to meet expectations. This outcome is also reflected in the Student Learning Outcomes for the overall CSCI 105 course. As a result, both the outcomes related to the School of Education and the outcomes related directly to this course indicate a potential disconnect in the course. The students performed well on Transform Data using a Mathematical Calculation. This does not reflect the core competency in the topic of the course: programming. For the Fall 2018 semester, a new textbook was selected to strengthen the emphasis upon programming and data processing. This change was not driven just from this particular assessment, but also the SLO assessment from past offerings of the course.

Quality, Resources and Support (CC 3.A)

15. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

    There are many things that contribute to ensuring that the program-level and course-level learning outcomes are at an appropriate level.

    A) Prerequisite Structure

    Mathematics by its nature has a natural prerequisite structure. Each course must be rigorous enough to prepare students for courses which use it as a prerequisite.

    B) Historical

    Much of the early content in mathematics is inherited from a historical structure and must be easily transferred from one school to another. Many high school students take our MATH 151 and MATH 152 courses and transfer them to other schools including University of Michigan, so the content must be somewhat standardized.

    C) Standards and Guidelines

    We review our degree content against several standards. For our mathematics degrees, we review the Curriculum Guide to Majors in Mathematical Sciences, published by the Mathematical Association of America's Committee on Undergraduate Programs in Mathematics (CUPM). It can be found at:
    https://docs.google.com/viewer?url=https%3A%2F%2Fwww.maa.org%2Fsites%2Fdefault%2Ffiles%2Fpdf%2FCUPM%2Fpdf%2FCUPMguide_print.pdf.
    For the Mathematics Secondary Teaching degree we review the Michigan Department of Education Standards for the Preparation of Teachers of Mathematics–Secondary (EX) found at:
    https://docs.google.com/viewer?url=http%3A%2F%2Fwww.michigan.gov%2Fdocuments%2Fmde%2FMath_Standards_554574_7.pdf
    Additionally, for the two education degrees we use The Mathematical Education of Teachers II, (METII) published by the Conference Board of Mathematical Sciences in 2012. It can be found at:
    https://docs.google.com/viewer?url=https%3A%2F%2Fwww.cbmsweb.org%2Farchive%2FMET2%2Fmet2.pdf

The Lumina Foundation's Degree Qualification Profile (DQP) is suggested as a resource for answering the questions about what students should know and be able to do at each degree level:
http://degreeprofile.org/wp-content/uploads/2017/03/DQP-grid-download-reference-points-FINAL.pdf

Intellectual Inquiry (CC 3.B).

16. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

Students in this program complete many projects throughout their studies culminating in a capstone student-teaching experience.

A) **MATH 325 College Geometry Project and Portfolio**

Students complete a geometry project in Geometer's Sketchpad using what they learned in an independent lesson on symmetry. Examples of some past projects are attached. The projects must include concepts of symmetry and transformational geometry. Students also complete a portfolio that includes their best proofs and constructions and reflects on the learning process. An example of a student portfolio is attached.

B) **MATH 207 Statistics Project and Paper**

Students are required to do a project and paper where they collect data, use inferential statistics and write a final report. The project description, rubric, and some examples of student work are attached.

C) **MATH 401 Project, Paper and Presentation**

Students are asked to do a mathematical modeling project, working in groups. They present their work to the class and write a paper. Examples from two groups are included as attachments.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Mathematics Secondary Ed BS 4-column report**
This documentation is relevant to Question number:	**13.**
Briefly summarize the content of the file and its value as evidence supporting program review:	**It shows that the four column report was completed.**

Assessment: Program Four Column

Program (CoIS) - Mathematics Secondary Ed BS

Assessment Contact: Dr. Brian Snyder
Mission Statement: We equip our graduates for success through emphasis on rigorous programs, hands-on experiences, and interaction with highly-qualified faculty members who are centered on student success.

Student Learning Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Mathematical Processes and Number Concepts - Candidates will be able to use mathematical processes, axiomatic systems, computing, algorithms, and logical reasoning to solve problems and communicate mathematical ideas. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex ideas in written and oral presentations., ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. **Revision Notes:** Alignment to Standards: InTASC: Standards 4 and 5 MDE Mathematics Secondary: 1.1,	**Direct - Exam/Quiz - Standardized -** The Mathematical Processes and Number Concepts subarea scores on the MTTC Mathematics (EX) Subject Test will be analyzed. **Criteria Target:** 80% of students will score 3 or higher on the subarea score.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes No testers took the Mathematics Secondary Subject Test in 2017-2018. (08/13/2018)	**Use of Result:** In the Fall of 2018, the faculty of the School of Mathematics and Computer Science are developing new plans for recruitment into this program. These plans will be recorded in the School minutes and implemented as soon as possible. Multiple regional ISDs are in need of math teachers and have contacted LSSU to recruit our students. (08/28/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** No 50% of students scored 3 or higher. (08/13/2017)	**Use of Result:** Only 2 students took the exam this year. One made a 3 and the other a 2. In the last 4 academic years, all but one student has scored 3 or higher. We will continue to monitor this outcome. (08/13/2017)
	Direct - Exam/Quiz - within the course - Candidates in MATH 325 College Geometry are asked to define undefined terms, axioms and theorems in geometry, describe their role in axiomatic systems and	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes 100% of the students scored 7 or above. (05/05/2017)	**Use of Result:** There are no concerns at this time. We will assess again in the Spring of 2019. (05/10/2017)

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
1.2, 1.3, 1.5.1, 1.5.9, 1.5.12, 1.6, 2.2	to provide an example of each. **Criteria Target:** 80% of students will score 7 or more points on the scoring guide. **Schedule/Notes:** MATH 325 is an alternate year course. **Related Documents:** MATH 325 Undefined Terms Axioms Theorems Scoring Guide.docx		
	Direct - Group project, collaborative learning - Students in MATH 401 Mathematical Modeling will complete a a modeling project and write a report about their results. **Criteria Target:** A score of 6 or higher out of 9 possible points. **Schedule/Notes:** MATH 401 is an alternate year course. **High Impact Program Practices 1:** Collaborative Assignments, Projects **Related Documents:** MATH 401 Project Rubric.pdf	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of the Mathematics Secondary Education majors scored a 6 or higher. (08/27/2018)	**Use of Result:** These students, working together in a group, did a strong job motivating and deriving their mathematical models. Though still worthy of full marks (2/2) student analysis of the model was perhaps the weakest area. In the rubric, items (b) and (c) are difficult to distinguish and should be merged into a single bullet worth four points. Also, in future projects it may be wise to have students working in groups to self-assess their group's functionality during progress reports. (08/27/2018)
	Direct - Exam/Quiz - within the course - Candidates in CSCI 105 Introduction to Computer Programming will be able to acquire data and then transform that data using mathematical calculations. **Criteria Target:** 70% of the students will score 70% or above.	**Finding Reporting Year:** 2017-2018 **Goal met:** No 60.9% of the students were able to acquire the data and 78.5% of the students were able to transform the data using mathematical calculations with a score of 70% or above. (05/01/2018)	**Use of Result:** The ability to Acquire Data failed to meet expectations. This outcome is also reflected in the Student Learning Outcomes for the overall CSCI 105 course. As a result, both the outcomes related to the School of Education and the outcomes related directly to this course indicate a potential disconnect in the course. The students performed well on Transform Data using a Mathematical Calculation. This does not reflect

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
			the core competency in the topic of the course: programming. For the Fall 2018 semester, a new textbook will be selected to strengthen the emphasis upon programming and data processing. This change is driven not just from this particular assessment, but also the SLO assessment from past offerings of the course. (06/15/2018)
Patterns, Algebraic Relationships, and Functions - Candidates will be able to describe, analyze, and generalize patterns, algebraic relationships and functions using the tools of algebra and calculus. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. **Revision Notes:** Alignment to Standards: InTASC: Standards 4 and 5 MDE Mathematics Secondary: 1.1, 1.2, 1.3, 1.5.3, 1.5.4, 1.5.5, 1.5.9	**Direct - Exam/Quiz - Standardized -** The Patterns, Algebraic Relationships, and Functions subarea scores on the MTTC Mathematics (EX) Subject Test will be analyzed. **Criteria Target:** 80% of students will score 3 or higher on this subarea.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes No testers took the Mathematics Secondary Subject Test in 2017-2018. (08/13/2018)	**Use of Result:** In the Fall of 2018, the faculty of the School of Mathematics and Computer Science are developing new plans for recruitment into this program. These plans will be recorded in the School minutes and implemented as soon as possible. Multiple regional ISDs are in need of math teachers and have contacted LSSU to recruit our students. (08/28/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of students scored 3 or higher. (08/13/2017)	**Use of Result:** 100% of students in the last 3 years have scored a 4 in this area. (08/13/2017)
	Direct - Exam/Quiz - within the course - Candidates in MATH 151 Calculus I are asked to create a function that models a given verbal description, then use calculus to find an optimal solution to a problem. **Criteria Target:** 70% of students will score 4 or higher on the scoring guide. **Related Documents:** Candidates in MATH 151 Calculus I	**Finding Reporting Year:** 2017-2018 **Goal met:** No 68% of the students earned a 4 or higher. (06/01/2018)	**Use of Result:** A majority of the students were able to find the correct model and locate the extrema, though many of these did not put units on their answers. For those who were not success, the biggest issue was going from a multivariable equation to a single variable function. In the Fall of 2018, we will emphasize model creation in the lecture, give a

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	Modeling Scoring Guide.docx		formative assessment quiz over the section and provide the students with the rubric before the summative assessment. (06/01/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 71% of students scored 4 or more. (05/05/2017)	**Use of Result:** The goal was met. We will monitor again in the Fall of 2017. (08/27/2018)
	Direct - Exam/Quiz - within the course - Candidates in MATH 152 Calculus II are asked to find the interval and radius of converge for a power series. **Criteria Target:** At least 70% of students will score 5 or higher on the scoring guide. **Related Documents:** MATH 152 Calculus II Power Series Scoring Guide.docx	**Finding Reporting Year:** 2017-2018 **Goal met:** No 64% of the students made 5 or higher. (05/10/2018)	**Use of Result:** There was only one secondary education major in the class and this student scored 7 out of 7. The largest area of difficulty was solving absolute value inequalities algebraically. In the Fall of 2018, faculty will provide an extra algebra review over solving absolute value inequalities and see if this improves student performance. (08/27/2018)
	Candidates in MATH 341 Abstract Algebra will be able to solve problems using groups and their properties. **Criteria Target:** 70% of students will score 70% or above on this objective. **Schedule/Notes:** MATH 341 is an alternate year course.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes 100% of students were successful (01/01/2017)	**Use of Result:** If expectations were at 80%, there would be 3/4 students meeting condition. Because of small population, 70/70 or 80/80 may not be met due to 1 student not meeting expectations. Care must be used during future assessment cycles. (01/01/2017)
Measurement and Geometry - Candidates will be able to apply geometric principles in Euclidean, analytic, transformational and vector geometry to analyze geometric objects, form conjectures, solve problems and prove theorems. **Goal Status:** Active **Goal Category:** Student Learning	**Direct - Exam/Quiz - Standardized -** The Measurement and Geometry subarea scores on the MTTC Mathematics (EX) Subject Test will be analyzed. **Criteria Target:** 80% of students will score 3 or higher on this subarea.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes No testers took the Mathematics Secondary Subject Test in 2017-2018. (08/13/2018)	**Use of Result:** See comment above about recruitment. (08/28/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of students scored a 3 or higher in this area (08/13/2017)	**Use of Result:** No concerns at this time. The average over the last 3 year period in this subarea is 3.4, with 100% of students scoring 3 or

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
Goal Level (Bloom/Webb): High-Level (Creating/Evaluating) [Bloom] **Institutional Learning:** ILO2 - Use of Evidence - Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem., ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. **Revision Notes:** Alignment to Standards: InTASC: Standards 4 and 5 MDE Mathematics Secondary: 1.1, 1.2, 1.3, 1.5.3, 1.5.4, 1.5.5, 1.5.9	**Direct - Exam/Quiz - within the course** - Candidates in MATH 325 College Geometry are asked to construct a geometric object, form a conjecture about the object and then prove their conjectures. **Criteria Target:** 80% of students will score 3 or higher on the scoring **Schedule/Notes:** MATH 325 is an alternate year course. **Related Documents:** MATH 325 Construction Conjecture Proof Scoring Guide.docx	**Finding Reporting Year:** 2016-2017 **Goal met:** No 50% of students earned 3 or more points on a problem in Euclidean geometry. 100% of students earned 3 or more points on a problem in coordinate geometry. (08/28/2018)	higher. (08/13/2017) **Use of Result:** The students met expectations in coordinate geometry. There were only 4 people in the course. On the problem in Euclidean geometry, two of the students made a false conjecture and were thus unable to prove it. They were more successful correcting the problem outside of class when time wasn't an issue. In the Spring of 2019, we will seek to address this issue by helping students further develop strategies for testing their conjectures before writing proofs. (06/01/2017)
	Direct - Exam/Quiz - within the course - Candidates in MATH 305 Linear Algebra will be able to find eigenvalues, eigenvectors for a linear transformation. **Criteria Target:** 70% of students will 7 out of the 10 possible points. **Schedule/Notes:** Available Points: Students are able to find the eigenvalues: 4 points Students are able to find an eigenvector: 3 points Students are able to find the other eigenvector: 3 points MATH 305 is an alternate year course.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 73% of students scored 70% or above. (01/05/2018)	**Use of Result:** No concerns at this time. We will assess again in the Fall of 2019. (05/01/2018)
	Direct - Exam/Quiz - within the course - Candidates in MATH 152 will be able to apply integration methods to find area.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 88% of students scored 70% or higher. (05/10/2018)	**Use of Result:** 21 out of 33 students earned a perfect score on this objective, so there are no

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	Criteria Target: 70% of students will score 70% or higher. **Related Documents:** MATH 152 Calculus II Area.docx		major concerns. (07/23/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 86% of students scored 70% or higher. (05/02/2017)	**Use of Result:** There are no concerns with this objective. (08/28/2018)
Data Analysis, Statistics, Probability, and Discrete Mathematics - Candidates will be able to organize, analyze and interpret data, sets and relations using the tools of statistics, probability and discrete mathematics. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO2 - Use of Evidence - Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem., ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. **Revision Notes:** Alignment to Standards: InTASC: Standards 4 and 5 MDE Mathematics Secondary: 1.1, 1.2, 1.3, 1.4, 1.5.6, 1.5.7, 1.5.11, 1.5.12, 2.2	**Direct - Exam/Quiz - Standardized -** The Data Analysis, Statistics, Probability and Discrete Mathematics subarea scores on the MTTC Mathematics (EX) Subject Test will be analyzed. **Criteria Target:** 80% of students will score a 3 or higher on this subarea.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes No testers took the Mathematics Secondary Subject Test in 2017-2018. (08/13/2018)	**Use of Result:** In the Fall of 2018, the faculty of the School of Mathematics and Computer Science are developing new plans for recruitment into this program. These plans will be recorded in the School minutes and implemented as soon as possible. Multiple regional ISDs are in need of math teachers and have contacted LSSU to recruit our students. (08/29/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of students scored 3 or higher in this subarea. (08/13/2017)	**Use of Result:** No concerns at this time. The average over the last 3 year period in this subarea is 3.4, with 100% of students scoring 3 or higher. (08/13/2017)
	Direct - Exam/Quiz - within the course - Candidates in CSCI 105 Introduction to Computer Programming will be able to present and display data and then document and describe the results. **Criteria Target:** 70% of students will score 70% or above.	**Finding Reporting Year:** 2017-2018 **Goal met:** No 56.5% on Present and Display Data 73.1% on Document and Describe Data (05/01/2018)	**Use of Result:** The ability to Present or Display Data failed to meet expectations. This outcome is also reflected in the Student Learning Outcomes for the overall CSCI 105 course. As a result, both the outcomes related to the School of Education and the outcomes related directly to this course indicate a potential disconnect in the course. The students met the expectations for Document or Describe the Results. This does not reflect the core competency in the topic of the course: programming. For the Fall

Student Learning Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
			2018 semester, a new textbook will be selected to strengthen the emphasis upon programming and data processing. This change is driven not just from this particular assessment, but also the SLO assessment from past offerings of the course. (06/10/2018)
	Direct - Exam/Quiz - within the course - Candidates in MATH 207 Principles of Statistical methods will be able to calculate empirical probabilities given data. **Criteria Target:** 70% of students will score 7 or higher on a 10 point scale.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 73.8% score 7 or above. (08/29/2018)	**Use of Result:** There are no concerns. (08/29/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 79.8% scored 7 or above. (08/29/2017)	**Use of Result:** There are no concerns. (08/29/2017)
	Direct - Group project, collaborative learning - Students in MATH 207 Principles of Statistical Methods will complete a descriptive statistics project. **Criteria Target:** 70% of students scored 70% or above. **Related Documents:** Descriptive Statistics Rubric(2).pdf	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 77.5% scored 70% or above. (08/29/2018)	**Use of Result:** There are no major concerns. In the Fall 2018, there are plans to have at least three meetings with each group to discuss their progress. (08/29/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 90.8% scored 70% or above. (08/29/2017)	**Use of Result:** There are no concerns. (08/29/2018)
	Students in MATH 216 Discrete Mathematics will state and apply the Pigeonhole Principle to prove various combinatorial statements. **Criteria Target:** 70% of students will score 70% or higher **Schedule/Notes:** MATH 216 is an alternate year course.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 83% of students scored 70% or higher. (05/01/2018)	**Use of Result:** We will reassess in the Spring of 2020. (05/01/2018)
Instructional Choices - Candidates make instructional choices that reflect the integrated nature of mathematical concepts and mathematical practices within and	Students in EDUC442 [Math Methods for Secondary Teachers] or EDUC 452 [Directed Study in Math Methods for Secondary Teachers] will complete a unit plan.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes 100% of students scored 3 or 4 on each of the subareas of the Unit Plan Rubric. (08/31/2018) **Related Documents:**	**Use of Result:** See the related document on the Unit Plan assessment. The assessment focuses on the content knowledge needed to structure unit plans and

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
among the mathematical domains. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) [Bloom] **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex ideas in written and oral presentations., ILO2 - Use of Evidence - Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem., ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. , ILO4 - Professional Responsibility - Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a problem, or achieving a goal. **Revision Notes:** Alignment with Standards: InTASC: Standards 6,7,8 MDE Mathematics Secondary: 2.2, 2.4, 2.5, 3.1	**Criteria Target:** At least 80% of students will score a 3 or higher on each subsection of the Unit Plan Rubric. **Related Documents:** Unit Plan Assessment.docx	Claim 1. Unit Plan Key Assessment EDUC452 year 2016-17.docx	develop student leaning. This allows the instructor to perceive the strength of the teacher candidates' knowledge of the content to be taught. There are no concerns at this time. (05/01/2017)

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Bachelor of Science in Mathematics Secondary Teaching and Bachelor of Science in Mathematics Elementary Teaching Program Review**
This documentation is relevant to Question number:	**14 and 15**
Briefly summarize the content of the file and its value as evidence supporting program review:	**It shows assessment and narrative related to program assessment and it shows alignment with standards.**

Bachelor of Science in Mathematics Secondary Teaching and Bachelor of Science in Mathematics Elementary Teaching Program Reviews

Submitted By: Dr. Kimberly Muller, Chair, School of Mathematics and Computer Science

Date Submitted: August 9, 2016

1. Mission/Vision

The Bachelor of Science in Mathematics Secondary Teaching and the Bachelor of Science in Mathematics Elementary Teaching are programs of the School of Mathematics and Computer Science. Throughout this document we will refer to the Bachelor of Science in Mathematics Secondary Teaching degree as M-ST and the Bachelor of Science in Mathematics Elementary Teaching degree as M-ET. The M-ST and M-ET programs have been in place since 1994. Historically, LSSU had a similar program to the M-ST program from 1971 to 1981. You can find a partial history of the program up to 2004 (with some additional narrative and revisions made in 2006) at http://math.lssu.edu/prpe. In addition, this webpage has information on the content standards, pass rates of the accreditation examination up until 2004 and a detailed program philosophy.

An attempt was made initially to create two separate program reviews for these two programs, but after writing several pages of each, it was found that programs were so similar that the two documents were in many sections nearly identical. After the Chair's consultations with Associate Provost Myton and Dean Fiebelkorn on June 20, 2016, it was decided to create one document. Where there are large differences, these will be noted. If a difference is minor a subscript of ST or ET will be used.

The current program objectives for the two programs were developed in 2009 under the leadership of Professor Sherry Duesing. The objectives for the two programs are identical.

Program Objectives

Upon completion of a Bachelor of Science degree in mathematics: secondary teaching (or elementary teaching), from Lake Superior State University, students will be able to:

1. Demonstrate a fundamental and foundational knowledge of mathematics by developing quantitative and abstract reasoning skills in order to build a conceptual understanding of logical structures and axiomatic systems.
2. Demonstrate technical mathematical skills in the areas of algebra, geometry, calculus, and statistics for solving problems.
3. Use their knowledge of the historical background of mathematics in enriching their own lives and the lives of their future students.
4. Use software and other technology to solve problems.
5. Use their acquired skills in the pursuit of a job and/or graduate school.
6. Create mathematical models and use their mathematical and analytical skills to solve real-world problems.
7. Continue to acquire new knowledge for life-long learning in pursuit of their professional and personal goals.
8. Communicate mathematically in their profession and the broader community.
9. Make connections of mathematical ideas to other ideas both inside of and outside of mathematics.

The similarity between the two degrees is largely due to the similarity to the "Content Guidelines/Standards" matrices for the two certification programs that were instituted by the Michigan State Board of Education in 2000. The State of Michigan guidelines can be found at http://www.michigan.gov/mde/0,4615,7-140-5683_6368-24835--,00.html while our specific program matrices can be found on the website http://math.lssu.edu/prpe. The course mappings in the matrices were created by professors, Sherry Duesing, Lorraine Gregory and Brian Snyder in 2006. There are very few differences between the K-8 and 7-12 Mathematics subject areas and both lead to the Mathematics (EX) endorsement. The test objectives for the certification exams (Michigan Test for Teacher Certification – MTTC) can be found at http://www.mttc.nesinc.com/MI_viewFW_opener.asp. There are some specific content differences due to the grade level of the students.

LSSU Mission Statement

Our mission at Lake Superior State University is to help students develop their full potential. We launch students on paths to rewarding careers and productive, satisfying lives. We serve the regional, state, national and global communities by contributing to the growth, dissemination, and application of knowledge.

Our mathematics programs for future elementary and secondary teachers introduce students to a broad range of both pure and applied mathematics, as well as both continuous and discrete, throughout their four years of study. The M-ET degree

also provides those students with the foundational knowledge required of all elementary education majors. The topics are aligned with the Michigan State Board of Education content guidelines as illustrated by the Program Review done in 2006. In the M-ST degree we've had a 100% placement rate for students in this program over the last five years. In the last two years we've had students who graduated in December obtain mid-year full-time employment in the field. For the M-ET, degree we've had very few students over the last five years, but those who graduated had immediate career placement. (For more information see sections 3 and 4 on "Demand" and "Quality".) Because of our emphasis very early in MATH 103_{ET}, MATH 104_{ET}, MATH 215 and MATH 216_{ST} on inquiry-based, student-centered learning and our requirement of passing the licensure exam (MTTC) and student teaching before graduation, our graduates exit LSSU with the ability to both think independently and communicate their ideas effectively. As teachers, our graduates join a workforce that has dissemination as its primary goal.

LSSU Vision Statement

Our programs grow and evolve in ways that keep our graduates at the cutting edge of technological and societal advances. As such, we will be viewed by our constituents as:

- The preferred regional choice for students who seek a quality education which provides a competitive edge in an evolving job market.
- An institution where relevant concepts are taught by quality faculty, and are paired with practical real world experience to provide a well-rounded education.
- An institution which capitalizes on its location to instill graduates with an understanding of environmental issues and an overarching desire to be responsible stewards of the environment.
- A University that is highly student centered and empowers all students to realize their highest individual potential.

Our program also supports the University Vision in several different ways. One of our program outcomes is that graduates should be able to "use software and other technology to solve problems". Several of our classes support this outcome including Elementary Statistics, Linear Algebra, College Geometry, Mathematical Modeling and Principles of Programming. As for quality faculty, except in rare cases, all of our program courses are taught by faculty who hold a doctorate in a field of pure or applied mathematics, statistics or mathematics education. The rare exceptions include courses where there is a co-teacher with a terminal degree in a related field, such as engineering. All of these faculty members have publications in their respective fields, one had a previous successful career at a tier one university, one has had prior K-12 experience, one has had more than 50 publications since coming to LSSU, two have received teaching awards, and one has co-authored a textbook in his field. Another program outcome is for successful graduates to "create mathematical models and use their mathematical and analytical skills to solve real-world problems." Many of our courses have course objectives tied to this program outcome, including MATH 103_{ET}, 104_{ET}, 151, 152, 207, 251_{ST}, 310_{ST}, and 401_{ST}. In particular, in the M-ST program, MATH 401 has a class project where the students work together to solve a current problem. In 2016 their class project was to design a mathematical model that would specifically help LSSU. One of our greatest areas of strength is the individual attention that our students receive. All of our classes are small with 30 or fewer students. When one compares this with larger state universities, which have large lecture classes for first year students, we are able to provide a uniquely student-centered atmosphere in the classroom. Our introductory proof sequence has 15 or fewer students and is typically taught using inquiry based learning. This is a very student-centered approach where students present the material to each other. In MATH 325, the students work in groups though activities both in the classroom and in the computer lab to form conjectures and build their own axiomatic system. For the elementary education students, MATH103 and 104 are taught using problem-based learning rather than direct instruction. Our program was the preferred regional choice in M-ST for many years. In fact, a large percentage of the area middle school and high school mathematics teachers are LSSU graduates. In 2011-2012, the teacher education programs at LSSU were placed on probation by the Michigan Department of Education. At the time our M-ST and M-ET pass rates had been between 89% (due to one student) and 100% for many years, but our programs took a large hit in enrollment that year and saw continued declines. While we don't think we can claim the status of preferred regional choice currently, our students have had an outstanding record on the certification exam and in job placement for many years. This would be an excellent area to promote as a program of distinction.

Several areas of the Strategic Plan are supported by our program. Some of these are emerging and others are more established.

2.1 LSSU will increase enrollment. For the last two years we have offered a Field Day experience for area high school students where we introduced students to topics in mathematics and computer science using hands-on activities. We also contacted admitted students after they were accepted, made new brochures and power point slides for our programs, increased the visibility of our Pi Day activities and saw a large increase in admitted students for this program. Last year there were 10 admits to these programs compared to 0 the year before and one the previous year. Sadly, this year we have seen a reversal of that trend.

2.5 LSSU will graduate students who have had an exceptionally good university experience. The one-on-one attention that our graduates receive gives them a chance to exceed beyond expectations. Students learn from instructors with a variety of experiences, including K-12 teaching experience and others involved in teacher professional development. They become involved in the content using inquiry based learning and problem solving, not just listening to lectures. Students are prepared for the classroom by extensive field experience and student teaching opportunities.
4.1 LSSU will increase high-impact educational experiences in BS/BA degree programs. Our students learn using inquiry-based learning and problem solving. Our students complete projects in MATH 207, MATH 321, MATH 325, MATH 341_{ST}. They have several hands-on classroom experiences, as well as student teaching.
4.3 LSSU will improve the tracking process of graduate success. We have been tracking our graduates' placements three months after graduation since 2012 and have increased efforts to track them later.
4.5 LSSU will prepare graduates who are ready for professional certifications or licensure. Our students are prepared to take MTTC certification exam since the course work required in the programs correlates to the objectives for the licensure exams (MTTC). The current pass-rate for the secondary and elementary exam in 100% for those majoring (not minoring) in these areas.
4.6 LSSU will increase the number of students participating in professional conferences and workshops. Several of our students have attended Math Teachers' Circle meetings. Three students attended the Michigan Council of Teachers of Mathematics conference July 2015.
6.1 LSSU will define assessment and engage in meaningful, institutionalized assessment activities. Our school has been doing course assessment with well-established objectives for many years. Our program assessment has improved greatly over the last four years.
6.2 LSSU will utilize appropriate and developing technology to facilitate effective and enriched learning experiences across the campus community. This is an area in which we excel. In fact we purchased and used many technologies such as i-Pads, tablets and document cameras before they were more widely available across campus. We also use many educational and commercial software packages in our courses to enhance student understanding of difficult mathematical concepts.

There are several areas that distinguish these programs from our main competitors in the state. One is the small class size, especially at the calculus level. A second is the number of courses that have opportunities for the students to present the material that they are learning to their peers, giving them ample opportunities to practice communicating mathematics before they begin their student teaching. Also, the fact that our program is housed in the mathematics department (as opposed to education) provides a level of mathematical rigor that facilitates a deeper understanding of the core content areas.

2. Productivity

The faculty and adjuncts in mathematics teach a large percentage of classes that are not required by our majors. Because all of the faculty teach courses that are both in the program and out of the program, gauging productivity can be difficult. Because of this we have tried to use several different measures. First, we will take a look at instructional load for courses with the MATH prefix. This includes developmental courses (MATH 087, MATH 088, MATH 102) and general education courses (MATH 110, MATH 111, MATH 131, MATH 207). Of these general education courses only MATH 207 is required in these programs. There is also a course that is taught as service to business and science (MATH 112), courses only required by the Elementary Education and M-ET programs (MATH 103 and MATH 104) and courses that are filled by a variety of majors including Mathematics, M-ET, M-ST, Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering and Physical Science (MATH 151, MATH 152, MATH 251_{ST}, MATH 310_{ST}). The only courses in these programs under review that are not included in other non-teaching programs are MATH 321 and MATH 325. Using data from two consecutive academic years (2014-2015 and 2015-2016) the mathematics faculty load can be broken down as follows:

- Developmental—25.7%
- General Education—36.1%
- Service to business and science—7.3%
- Courses only required for all Elementary Education majors and **M-ET**—3.0%
- **M-ST and M-ET Only**—1.4%
- **M-ST and M-ET** with Heavy Service—18.6%
- B.S. in Mathematics and **M-ST** Only—2.7%
- B.S. in Mathematics, **M-ET and M-ST**—2.1%
- B.S. in Mathematics Only—3.2%

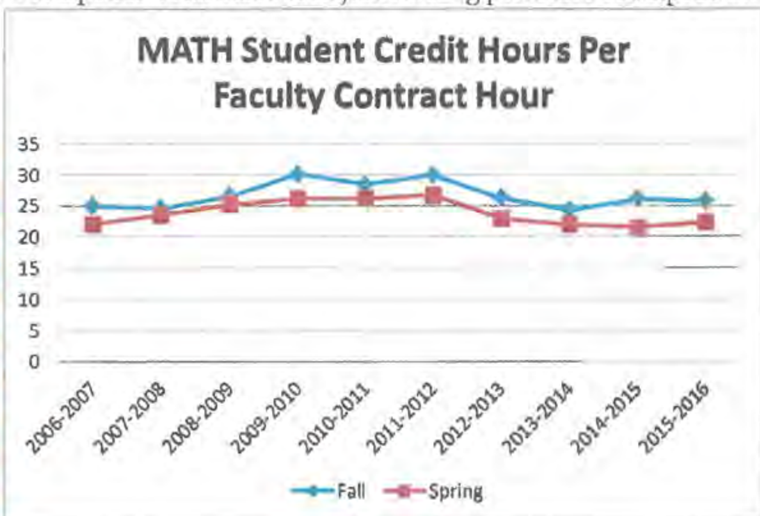
Only 1.4% of our mathematics faculty instructional load is used exclusively for these two programs. That is approximately 3.2 load hours per year. Additionally, only 4.8% of the load is used by this program without also being required for general education or engineering which significantly increases the student credit hour/load hour ratio for those courses. This represents 10.5 load hours per year for these programs, along with the B.S in Mathematics. (This file is in tracdat.) Note

that none of the courses used for the M-ET program are exclusive to that program. In correspondence with Dean Fiebelkorn about whether or not this program should be deleted for low enrollment, one of the reasons she gave for keeping this program was, "Provided we keep the elementary math minor, the elementary education program period, and the secondary math major, then there are no unique courses that are offered only for the elementary math major."

A second measure of productivity is from Professor Collette Coullard's Spring 2015-2016 Cost-Revenue Analysis. In her analysis, based on classroom discussions with Associate Provost David Myton and Interim Vice President of Finance Morrie Walworth, she took into consideration tuition, state funding, the tuition plateau, discounted tuition, State of Michigan Contributions, auxiliary funds, faculty salary, faculty benefits and 50% overhead. The Cost-Revenue analysis for those instructors who predominantly teach mathematics courses was a net revenue of $951,887 and for the department as a whole was $1,111,013. In the discussions during Professor Coullard's presentation of her class's research, President Pleger mentioned that one measure of cost effectiveness would be whether or not each faculty member's revenue from student credit hours to instructional load (taking into consideration all of the above variables) made a profit. Each mathematics faculty member does so according to this analysis.

Along those same lines, a third measure of productivity would be the ratio of student credit hours to faculty contract hour. The following table tracks data from 2006-2016. The numbers in blue represent the ratio of student credit hours to faculty contract hours in the Fall and the numbers highlighted in red are from Spring. The average of the Fall ratios is 26.6 with a standard deviation of 2.0 and the average of the Spring ratios is 23.9 with a standard deviation of 1.9. Even though there has been some fluctuation, an attempt has been made to adjust offering patterns to compensate for enrollment declines.

Term	Student Credit Hours	Faculty Contract Hours	Student Credit Hours Per Faculty Contract Hour
Fall 2006	2881	115.66	24.91
Spring 2007	2091	94.66	22.09
Fall 2007	2893	117.66	24.59
Spring 2008	2294	97.66	23.49
Fall 2008	3173	119.66	26.52
Spring 2009	2612	103.66	25.20
Fall 2009	3202	106.70	30.01
Spring 2010	2406	91.96	26.16
Fall 2010	3263	114.96	28.38
Spring 2011	2671	101.96	26.20
Fall 2011	3301	110.66	29.83
Spring 2012	2691	100.63	26.74
Fall 2012	2974	113.63	26.17
Spring 2013	2324	101.23	22.96
Fall 2013	2845	117.26	24.26
Spring 2014	2143	97.63	21.95
Fall 2014	2747	105.63	26.01
Spring 2015	2182	101.13	21.58
Fall 2015	2659	103.33	25.73
Spring 2016	1997	89.63	22.28



Divisions (As Defined in the Load Report Summary)	Instructional Load	Total Contract Hours	Student Credit Hours	Student Credit Hours per Instructional Load	Rank of SCH per ILH	Student Credit Hour per Contract Hour	Rank of SCH per CH
Business Fall	158.36	163.364	2870				
Business Spring	149.09	155.091	2951	18.933	4	18.279	4
CIFS Fall	108.844	109.8439	2459				
CIFS Spring	111.426	108.844	**2718.59**	23.506	2	23.676	2
Education Fall	60.197	72.1967	635				
Education Spring	64.906	72.6561	532	9.3283	11	8.0565	11
Engineering Fall	128.455	136.475	**1413.55**				
Engineering Spring	152.003	154.39	1306.44	9.6984	10	9.3514	9
EMS Fall	20.488	20.488	290				
EMS Spring	26	26	205	10.648	8	10.648	8
A & L Fall	233.676	251.671	4181				
A & L Spring	201.95	218.952	3135	16.794	5	15.545	5
Lib Arts Fall	5.333	12.0033	56				
Career Develop Spring	3.6667	11.9967	20	8.4447	12	3.1667	12
MathCS Fall	155.67	159.333	3537				
MathCS Spring	141.9	144.9	2638	20.735	3	20.281	3
Nursing Fall	210.1	228.067	1913.61				
Nursing Spring	126.23	144.227	1454.6	10.015	9	9.0472	10
PS_CBS Fall	163.7	166.704	4672.9				
PS_CBS Spring	184.45	187.445	5291	28.62	1	28.135	1
RSES Fall	97.1627	106.1597	1150				
RSES Spring	99.198	108.198	1146	11.693	7	10.711	7
Sciences Fall	309.11	338.109	3870				
Sciences Spring	327.38	354.38	5217.66	14.278	6	13.123	6

A fourth measure is the next comparison, to the left, with other academic areas (as separated by the load report summary on the O:\ drive). It was made using the summary for 2015-2016. Because of our heavy service load our ratio of student credit hours per faculty instructional load hours is the 3rd highest division on campus and our ratio of student credit hour per faculty contract hour is also the 3rd highest division on campus. (Instructional load does not include release time and Faculty Contract Hours do. Some areas receive a larger percentage of release time than others.) This data deals with instructional load.

A shortcoming of the above measures is that they show that the faculty members who teach courses in these programs are productive, but they don't show specifically what is happening in the program courses. The next table is an attempt to track course enrollment numbers for the program courses. The courses with bold yellow font have undergone changes to their course offering pattern in the last few years in order to either save money or make the course load easier on students taking multiple mathematics courses.

	Total Enrollment in Courses								
M-ET or M-ST	COURSE	TITLE	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
M-ET	MATH103	Number Sys/Prob Solv Elem Teac	32	20	12	12	24		9
M-ET	MATH104	Geometry/Measurement Elem Teac	32	29	18	18	12	8	8
M-ET, M-ST	MATH151	Calculus I	83	92	97	103	89	59	69
M-ET, M-ST	MATH152	Calculus II	46	54	57	57	67	59	61
M-ET, M-ST	MATH207	Prin of Statistical Methods	220	253	295	268	243	197	192
M-ET, M-ST	MATH215	Fund Concepts of Mathematics	18	25	19	20	19	6	7
M-ST	MATH216	Discrete Math/Problem Solving	14	8	11	11	6	5	5
M-ST	MATH251	Calculus III	39	31	42	24	24	44	47
M-ET, M-ST	MATH305	Linear Algebra	22		9		7		12
M-ST	MATH310	Differential Equations	37	35	38	23	30	39	30
M-ET, M-ST	**MATH321**	**History of Mathematics**	**13**	**20**	**13**	**5**	**9**	**5**	
M-ET, M-ST	**MATH325**	**College Geometry**	**9**		**7**		**5**	**7**	
M-ST	MATH341	Abstract Algebra I		15		8		10	
M-ST	**MATH401**	**Mathematical Modeling**		**16**		**14**	**8**		**8**
M-ET, M-ST	EDSE301	Intro to Special Education				5	9	4	8
M-ET, M-ST (Prior to Fall 2012)	EDUC150	Reflections Learning Teaching	55	64	48				
M-ET, M-ST	EDUC250	Student Diversity and Schools	50	61	43	17	21	17	15
M-ET, M-ST	EDUC301	Educ Psych & Learning Theory	40	42	20	22	15	11	10
M-ET	EDUC330	Reading Elementary Classroom	27	19	13	9	10	4	8
M-ET, M-ST	EDUC350	Int Tech 21st Century Lrn Env					0	11	9
M-ET	EDUC410	Corrective Reading Classroom	28	23	13	6	11	3	7
M-ET	EDUC411	Elem Lang Arts/Literacy Skills	21	26	13	11	14	4	5
M-ST	EDUC415	General Instructional Methods						11	8
M-ET	EDUC420	Math Methods Elem Teachers	27	24	17	6	12	3	7
M-ET	EDUC421	Science Methods Elem Teachers	26	26	15	7	9		8
M-ET	EDUC422	Soc Studies Meth Elem Teachers	27	28	12	9	5	2	5
M-ET	EDUC423	Art Methods-Classroom Teachers				13	15	11	13
M-ET	EDUC424	Hlth/Phy Ed Meth Cl Room Teach				9	12	5	10
M-ST	EDUC431	The Secondary Learner	18	15	20	7			
M-ST	EDUC440	Reading in the Content Area	19	21	22	7	8	6	3
M-ST	**EDUC442**	**Math Methods Secondary Teache**	**10**	**0**	**11**				
M-ST	**EDUC452**	**Dir St Math Meth Sec Teachers**					**1**	**4**	**1**
M-ST	EDUC460	Classroom Management						6	8
M-ET, M-ST	EDUC480	Directed Teaching Seminar	37	28	35	34	17	15	6
M-ET, M-ST	EDUC492	Directed Teaching	37	28	35	34	17	15	6

M-ET and B.S. in Elementary Education	64	49	30	30	36	8	17
M-ET, M-ST, Service and General Education	220	253	295	268	243	197	192
M-ET and M-ST Only	32	20	31	5	15	16	1
M-ET and/or MST with Large Service Component	205	212	234	207	210	201	207
M-ST and/or M-ET, with B.S. in Mathematics	54	64	39	53	40	21	32
M-ST and/or M-ET, with other Education Degree:	412	405	306	196	175	128	136

The other enrollment numbers come from the following general education or program requirements. The following courses are specifically required by other majors (than M-ET or M-ST).

MATH 103 & MATH 104—Elementary Education

MATH 207—General Education, Athletic Training, Biochemistry, Computer Networking, Computer Science, Criminal Justice (Corrections, Criminalistics, Generalist, Homeland Security, Law Enforcement, Loss Control, Public Safety), Electrical Engineering Technology, Environmental Science, Exercise Science, Fire Science, Forensic Chemistry, Geology, Industrial Technology, Manufacturing Engineering Technology, Medical Laboratory Science, Nursing, Parks and Recreation, Physical Science

MATH 151 & MATH 152—Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mathematics, Mechanical Engineering, Physical Science

MATH 251, MATH 310—Computer Engineering, Electrical Engineering, Mathematics, Mechanical Engineering

Other than the courses in dark green, all other courses serve students in multiple majors. For those courses in dark green, two of them are alternate year offerings. This is only 6.3333 load hours over a two year period. Students have a choice between EDUC 442 and EDUC 452, but only EDUC 452 has been offered in recent years because it can be prorated. Our programs have very few expenses that are program specific. The needed software licenses, computers, instructional technologies and paper usage are more than covered by our course fees. It would seem the costs to the university are minimal, especially considering our large service role.

The following table shows the 10-year enrollment data for these two programs. Also included are the enrollments in the Bachelor of Science in Mathematics degree because 10 of the required courses for that program are also in the M-ST program.) We have included the minors because these students contribute to the enrollment in the courses.

	Bachelor of Science in Mathematics Elementary Teaching	Bachelor of Science in Mathematics Secondary Teaching	Bachelor of Science in Mathematics	Minor in Mathematics Elementary Teaching	Minor in Mathematics Secondary Teaching	Minors in Mathematics
Fall 2006	1	13	10	25	3	13
Fall 2007	0	13	8	17	2	11
Fall 2008	3	14	8	15	4	6
Fall 2009	3	12	9	13	3	7
Fall 2010	3	16	13	17	2	5
Fall 2011	0	19	11	14	2	4
Fall 2012	2	12	14	23	6	8
Fall 2013	0	9	12	12	8	14
Fall 2014	1	9	11	9	4	8
Fall 2015	2	10	11	2	3	15

As you can see by looking at the "Fall 2012" line, the fact that the education programs at LSSU were put on probation in 2012 impacted the enrollment in our programs and we have yet to recover. It is concerning that the majors dropped precipitously, but it is equally concerning that the Minor in Mathematics Elementary Teaching did as well. Since most of the courses overlap, our course enrollment and course offering patterns have been impacted. As noted earlier, prior to that year, these were regional programs of choice. We should consider ways that we can return the numbers to their prior levels. We believe that one of the best ways would be to advertise our high pass rates on the MTTC exam.

To be consistent with last year's B.S. in Mathematics program review an attempt was made to use the Ipeds database from the National Center for Educational Statistics to compare our enrollment with the 15 public universities in Michigan but in Ipeds, the data for all education majors was combined in one total and we were unable to separate by discipline.

The table to the right shows degree conferral. The table contains M-ET, M-ST and the B.S. in Mathematics because before 2009, the institutional data was combined for some of these programs. We've separated out the data in those years using Anchor Access and commencement programs, but if you do your own report in Argos, it will combine some of the data.

Academic Year	Bachelor of Science in Mathematics Elementary Teaching	Bachelor of Science in Mathematics Secondary Teaching	Bachelor of Science in Mathematics	Total
2006-2007		2	4	6
2007-2008		3	3	6
2008-2009	1	3	3	7
2009-2010		1	1	2
2010-2011	1	1	4	6
2011-2012		5	2	7
2012-2013		3	3	6
2013-2014			2	2
2014-2015		2	3	5
2015-2016		2	1	3

On a national level, data is collected every decade. According to the Conference Board of Mathematical Sciences 2010 survey at http://www.ams.org/profession/data/cbms-survey/cbms2010, there were a total of 3,614 degrees in mathematics education awarded in 2009-2010. (This is the last year that data is available.) There were 2774 four-year institutions in that

year, giving an **average of 1.3 related mathematics education degrees per four year institution**. (One commercial website seems to indicate that only around 1700 of these have programs in mathematics education bringing the ratio to 2.1, but we were not able to verify this number on a more dependable public site.) Our total degrees awarded for those programs is typically around 2, making us only slightly higher (or lower) than average.

Using Argos to estimate the terms to graduation for these two programs, the average was 9.09 terms for majors in this program over the period from 2009-2014 and 8.30 for LSSU graduates as a whole (more recent data appears to be unavailable in Argos). Since these students need student teaching in order to graduate, this difference is not surprising. In a 2014 report from Al Case in Admissions, the overall FTIC retention rate from Fall 2010-2014 at LSSU was 70.40% and for the M-ST degree it was 83.30%. (No number was provided for M-ET and this report is not available in Argos. We made an attempt to obtain more recent numbers from Annette Hackbarth-Onson in Admissions who referred us to Vice President Morrie Walworth. At the time of this writing, no new data has been made available.)

3. Internal and External Program Demand

External Demand:

Mathematics is a high need area for high school and middle school math teachers. According to the Occupational Outlook Handbook of the Bureau of Labor Statistics there will be a growth of 6% in the demand for high school and middle school teachers from 2014-2024.

According to the National Center for Educational Statistics, 15% of secondary level teachers are Mathematics teachers. Just less than 2% of elementary teachers focus on mathematics while 62% teach several subjects, including mathematics. (Source: https://nces.ed.gov/programs/digest/d13/tables/dt13_209.10.asp, accessed June 28, 2016). The Occupational Outlook Handbook (OOH), issued by the Bureau of Labor and Statistics, projects the job outlook for teachers in all disciplines to "grow about as fast as the average" between 2008 and 2018, an estimated 13% in ten years. Across the country, public interest in the school system is on the rise and the federal government has increased spending for education. The need for highly qualified teachers continues to expand.

A table published by the National Center for Educational Statistics provided information regarding the percentage distribution of public elementary and secondary schools with a teaching vacancy in selected teaching fields, by the school's reported level of difficulty in filling the vacancy, teaching field, and locale: 2011-12. The information regarding mathematics teachers was that the percentage of schools with vacancies was 20% nationwide of which 1.1% could not be filled 2012-13. This was the fourth highest vacancy rate listed. Source: http://nces.ed.gov/surveys/ruraled/tables/c.1.c.-1.asp

Both programs are approved by Michigan Department of Education (MDE) and are two of four possible majors available at LSSU for prospective teachers. In addition, the success of the mathematical education students has consistently remained good. We feel that the decline in enrollment has more to do with the problems caused by probation in 2011-2012 and less to do with demand. The students who have graduated in recent years have all either been employed immediately or had employment offers, but chose to pursue other opportunities.

Internal Demand:

Refer back to page 5 for programs that require the M-ST or M-ET program courses. The largest constituents outside of mathematics are:

- MATH 151 & MATH 152—Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering, Physical Science
- MATH 251, MATH 310—Computer Engineering, Electrical Engineering, Mechanical Engineering

The table and lists on that page best represent internal demand. Another indication of demand is the enrollment of minors in these areas. All students must now take mathematics as part of their general education classes. As a result of this and other programs' requirements, most of the students enrolled in mathematics courses are not students majoring in M-ST, M-ET or the Bachelor of Science in Mathematics.

4. Program Quality

Mathematics introduces students to formal reasoning and, as a result, contributes to development of qualitative and quantitative analytic skills. The math department in its service role, as well as a major department, is proud to have promoted, to continue to promote, and to improve those indispensable skills for the entire LSSU community and all LSSU

graduates. Over the years the department has recruited and retained strong mathematicians and mathematics educators as witnessed by their recent scientific and pedagogical output:

- Dr. Grace Ngunkeng has published 3 refereed articles in the past 3 years, has presented her work at the 2013 Joint Mathematics Meetings, and has attended 6 conferences in the past 3 years.
- Dr. Kimberly Muller has published 4 refereed articles and has presented her scholarly work at 15 meetings or workshops in the past 10 years.
- Dr. Lorraine Gregory has made 6 conference presentations in the past 10 years.
- Dr. Brian Snyder has coauthored a textbook, published 1 refereed article, and attended 9 conferences in the past 10 years.
- Dr. Collette Coullard has published 5 refereed articles and made 2 conference presentations in the past 10 years.
- Dr. George Voutsadakis has published 44 research articles and participated in 6 conferences in the past 10 years.

It has developed a regional reputation and has strongly contributed to outreach activities promoting mathematics and mathematics education and, thus, increased the University's visibility and service in the community. Some examples of our state and regional involvement are:

- Dr. Brian Snyder just finished a year as chair of the Michigan Section of the Mathematical Association of America,
- Dr. Collette Coullard, Dr. Lorraine Gregory and Dr. Kimberly Muller, serve on the Eastern Upper Peninsula Math and Science Center Advisory Board,
- Dr. Collette Coullard and Dr. Kimberly Muller serve on the planning committee for the Eastern Upper Peninsula Math Teachers' Circle,
- The School of Mathematics and Computer Science hosted the Michigan Section of the Mathematical Association of America's annual meeting in 2013,
- Dr. Lorraine Gregory, Dr. Kimberly Muller and Dr. Brian Snyder have taught professional development workshops in 4 different regions across the state,
- Dr. Lorraine Gregory has been involved in several professional development activities for K-12 teachers in the Upper Peninsula, and the state, the most recent being two preconference professional development for MCTM, July 2015,
- Dr. Lorraine Gregory has served as the VP for 4 year colleges for the Michigan Council of Teachers of Mathematics,
- The School of Mathematics and Computer Science has held two Field Day experiences for area high school students, an event we hope to repeat as an annual recruiting effort,
- The School of Mathematics and Computer Science holds an annual Pi Day and math bowl for area middle school and high school students.

Moreover, some of our majors have been among the highest GPA graduates and have been awarded University-wide distinctions, many with regular placement on the Dean's list and graduating cum laude, magna com laude or summa cum laude. Of the program's graduates over the last seven years, 42.9% graduated cum laude, 14.3% graduated magna cum laude, and 14.3% graduated summa cum laude. The average GPA was 3.56. Two have been awarded Faculty Association university-wide scholarships based on overall academic excellence.

Several graduates have established and continue to distinguish themselves in their professions. We are providing three examples below. In addition to the quotes that we have included, we are grateful to these graduates for providing valuable feedback that can be used to strengthen our programs. Please note that two of these graduates received mid-year placement when a district was in a bind to fill a vacant position. However, they were both asked to return the following year to the same placement because of their excellent work.

The first example is Andrew Doerr who graduated in December of 2014. Mr. Doerr was able to obtain a mid-year placement as a mathematics teacher and golf coach at Sacred Heart Academy in Mount Pleasant. When asked about his time here, he replied, "LSSU's Math Education program prepared me to teach a variety of classes. Going in to LSSU, I was not nearly as confident with the material that I was going to be teaching as I am now. The professors were there for me in and out of the classroom, and were always available for when I needed extra assistance. I am very appreciative of the professors and the people that I met at LSSU, and they definitely have had an impact on who I am today."

Chris Ogren, who graduated from the M-ST program in 2013, worked at Kalamzoo Central High School as a 9th grade math teacher from October 2013-August 2015. In the Fall of 2015 he returned to his hometown to teach at Escanaba High School as a Geometry and AP Statistics teacher. When asked about his time here, Mr. Ogren said "I feel that at Lake

Superior State, I received an education that taught me all of the math I will need for being a teacher. I learned to not only memorize the necessary math skills, but also to think like a mathematician. I believe that the math faculty at LSSU did a great job of breaking math down to its fundamentals, and then building up to the more complex ideas. The program had a great balance of classes that challenged me on multiple levels. I especially look back and appreciate the things I learned in Math 215, College Geometry, History of Math, and Math Modeling. Most of my math classes were helpful, but those 4 are the classes I find myself referencing to students in my everyday teaching."

One of our most recent graduates, Jessica Keilholtz, accepted a mid-year placement at the middle school in Cedarville after graduating in December of 2015. They asked her to return next fall and she has accepted the position. Ms. Keilholtz said, "my content knowledge was strong enough that my only worry was classroom management and I had enough people to have my back that I made it through alright." She also indicated that her student teaching position in Brimley taught her to "handle a lot of situations so I felt well prepared." She said that, "The class that helped me the most would be the college geometry class. Being able to define shapes and show how to create them using technology was very useful."

Through feedback from these students, one area where we could support them more is outside of the mathematical content area. For example Ms. Keilholtz relied on her new colleagues to teach her where to find educational resources. Finding new approaches to teaching difficult topics was sometimes a challenge for her. There are many websites that provide these educational resources and/or tips. This could perhaps be added to the Methods course or to a series of seminars.

The Mathematics Education program was originally approved by the Michigan Department of Education in 1998. It was reapproved in 2006. In 2012, 6 programs in education were suspended by the state of Michigan and others were discontinued. Mathematics was not one of these programs. While the pass rate for the suspended programs on the state licensure exams was low, the pass rate for mathematics has remained high, typically above 90% for secondary education and recently, 100%. This compares to the state pass rate for secondary mathematics of 96.5%. There have been too few elementary mathematics majors taking the test (3 or fewer). More specific data is in the Program Assessment section. Following the suspension of programs in 2012, the School of Education sought out and completed accreditation by the national accrediting body for schools of education – The Council for the Accreditation of Educator Preparation (CAEP). This was successfully granted in October 2013. The School of Education continues to succeed, with recent ratings from the Department of Education being among the highest in the state. (http://www.lssu.edu/education/ accessed June 29, 2016)

Our programs compare favorably in its depth and quality to other peer mathematics programs. Two important documents for comparing our programs to those of others are the **Curriculum Guide to Majors in Mathematical Sciences**, published in 2015 by the Mathematical Association of America's Committee on Undergraduate Programs in Mathematics (CUPM) and **The Mathematical Education of Teachers II, (METII)** published by the Conference Board of Mathematical Sciences in 2012.

In 2015 the CUPM released its new **Curriculum Guide to Majors in the Mathematical Sciences**. It has four cognitive recommendations and nine content recommendations for programs in mathematics. Since these recommendations are brand new, we were impressed with how well our programs already fit. We will list those goals and briefly explain how we meet them. In some cases, for the sake of brevity, the recommendations are linked to our program outcomes. The first set of recommendations is for general mathematics programs, but we highlight them in order to support our earlier claim, that the placement of our programs within the department of mathematics is an added strength to the quality and rigor of our program.

Cognitive Recommendation 1: Students should develop effective thinking and communication skills. Program Outcome 8.

Cognitive Recommendation 2: Students should learn to link applications and theory. Program Outcome 6.

Cognitive Recommendation 3: Students should learn to use technological tools. Program Outcome 4.

Cognitive Recommendation 4: Students should develop mathematical independence and experience open-ended inquiry. Program Outcome 7. Specifically our use of inquiry-based learning in multiple mathematics courses and our student teaching experience.

Content Recommendation 1: Mathematical sciences major programs should include concepts and methods from calculus and linear algebra. MATH 151, MATH 152, MATH 251_{ST}, MATH 305, MATH 310_{ST}, MATH 401_{ST}

Content Recommendation 2: Students majoring in the mathematical sciences should learn to read, understand, analyze, and produce proofs at increasing depth as they progress through a major. MATH 103_{ET}, MATH 104_{ET}, MATH 215, MATH 216, MATH 321, MATH 325, MATH 341

Content Recommendation 3: Mathematical sciences major programs should include concepts and methods from data analysis, computing, and mathematical modeling. MATH 103_{ET}, MATH 104_{ET}, MATH 207, MATH 305, MATH 401_{ST}, CSCI 103_{ET}, CSCI 105, CSCI 121_{ST}

Content Recommendation 4: Mathematical sciences major programs should present key ideas and concepts from a variety of perspectives to demonstrate the breadth of mathematics. Our program has a mixture of theoretical and applied topics.

Content Recommendation 5: Students majoring in the mathematical sciences should experience mathematics from the perspective of another discipline. CSCI 105, PHYS 221_{ST}, CHEM 115_{ST}, NSCI 101_{ET}.

Content Recommendation 6: Mathematical sciences major programs should present key ideas from complementary points of view: continuous and discrete; algebraic and geometric; deterministic and stochastic; exact and approximate.

Continuous: The majority of the calculus sequence
Discrete: MATH 216_{ST}, parts of MATH 152, parts of MATH 401_{ST}
Algebraic: MATH 103_{ET} , MATH 305, MATH 341_{ST}
Geometric: MATH 104_{ET}, some topics in the calculus sequence, some topics in MATH 305, MATH 321, MATH 325 and MATH 401_{ST}
Deterministic: MATH 310_{ST}, some topics in MATH 401_{ST}
Stochastic: MATH 207, some topics in MATH 401_{ST}
Exact: Most of the calculus sequence
Approximate: Some topics in the calculus sequence, some topics in MATH 401_{ST}

Content Recommendation 7: Mathematical sciences major programs should require the study of at least one mathematical area in depth, with a sequence of upper-level courses. We don't require this.

Content Recommendation 8: Students majoring in the mathematical sciences should work, independently or in a small group, on a substantial mathematical project that involves techniques and concepts beyond the typical content of a single course. MATH 321, MATH 325, MATH 401_{ST}

Content Recommendation 9: Mathematical sciences major programs should offer their students an orientation to careers in mathematics. Students in this area are typically only interested in teaching. However, this is an area that could use improvement.

Coursework is important for the formation of a successful teacher. However, "upper-division courses typical of a mathematics major have minimal impact on the quality of a teacher's instruction, as measured by student performance." (MET II p. 53) MET II recommends that courses for prospective teachers should provide teachers with opportunities for the full range of mathematical experiences. These recommendations are as follows:

Recommendation 1: Prospective teachers need mathematics courses that develop a solid understanding of the mathematics they will teach. The list of courses outlined above illustrate the depth of knowledge required of students. However, not all of the courses examine the mathematics from a teacher's perspective. Notable exceptions are MATH 103_{ET} , MATH 104_{ET}, MATH321, MATH325 and the methods courses, in the context of preparing lessons and learning activities.

Recommendation 2: Coursework that allows time to engage in reasoning, explaining, and making sense of the mathematics that prospective teachers will teach is needed to produce well-started beginning teachers. Although the quality of mathematical preparation is more important than the quantity, the following recommendations are made for the amount of mathematics coursework for prospective teachers.

i) ***Prospective elementary teachers should be required to complete at least 12 semester-hours on fundamental ideas of elementary mathematics, their early childhood precursors, and middle school successors.*** MATH 103_{ET} , MATH 104_{ET} provide 10 contact hours (8 credits) of elementary and middle school mathematics content. In addition, MATH 325 reviews many definitions used in elementary mathematics, then builds on to those concepts quickly. MATH 215 and MATH 216_{ST} covers counting and the properties of integers and rational numbers.

ii) ***Prospective middle grades (5–8) teachers of mathematics should be required to complete at least 24 semester-hours of mathematics that includes at least 15 semester-hours on fundamental ideas of school mathematics appropriate for middle grades teachers.*** MATH 103_{ET} , MATH 104_{ET} provide 10 contact hours (8 credits) of elementary and middle school mathematics content. In addition, MATH 305 and MATH 325 review many definitions used in middle school mathematics, then builds on to those concepts quickly. MATH 215 and MATH 216_{ST} covers counting and the properties of integers and rational numbers.

iii) ***Prospective high school teachers of mathematics should be required to complete the equivalent of an undergraduate major in mathematics that includes three courses with a primary focus on high school mathematics from an advanced viewpoint.*** These courses include the MATH 151, MATH 152, MATH 207, MATH 215, MATH 216_{ST}, MATH 251_{ST}, MATH 305, MATH 310_{ST}, MATH 341_{ST} and MATH325.

Recommendation 3: Throughout their careers, teachers need opportunities for continued professional growth in their mathematical knowledge. Our students are prepared to begin teaching, and our faculty members are actively involved with professional development locally and in various locations in the State. Through our roles as advisors for the region's Math and Science Center, we know that there are many opportunities for teachers in the state to continue their professional development.

Recommendation 4. All courses and professional development experiences for mathematics teachers should develop the habits of mind of a mathematical thinker and problem-solver, such as reasoning and explaining, modeling, seeing structure, and generalizing. Courses should also use the flexible, interactive styles of teaching that will enable teachers to develop these habits of mind in their students. The authors of MAT II cite the Standards for Mathematical Practice included with the Common Core State Standards (CCSS-M), notably problem solving, reasoning and modeling mathematics. As described earlier in this document, our students have multiple opportunities to observe these Practices in their classrooms, especially when inquiry, proof and problem solving form a basis for the instruction.

Recommendation 5. At institutions that prepare teachers or offer professional development, teacher education must be recognized as an important part of a mathematics department's mission and should be undertaken in collaboration with mathematics education faculty. More mathematics faculty need to become deeply involved in PreK–12 mathematics education by participating in preparation and professional development for teachers and becoming involved with local schools or districts. The number of faculty who have or are currently involved in Professional Development indicates the level of importance placed on mathematics education PreK to college level. Moreover, one faculty member, Dr. Lorraine Gregory, has experience teaching in elementary and high schools, has a Doctorate in Education, and is actively involved in the School of Education as well as the mathematics department.

Recommendation 6. Mathematicians should recognize the need for improving mathematics teaching at all levels. Mathematics education, including the mathematical education of teachers, can be greatly strengthened by the growth of a mathematics education

community that includes mathematicians as one of many constituencies committed to working together to improve mathematics instruction at all levels and to raise professional standards in teaching. All faculty in the Mathematics Department are involved in the education of our students and the development of the mathematics education degree program. In addition, our faculty, with cooperation from the EUPISD and the EUP Math and Science Center, began a Math Teachers' Circle in 2013. A Math Teachers' Circle is a professional development community of middle school and high school math teachers, together with mathematicians in higher education and industry who get together to do math.

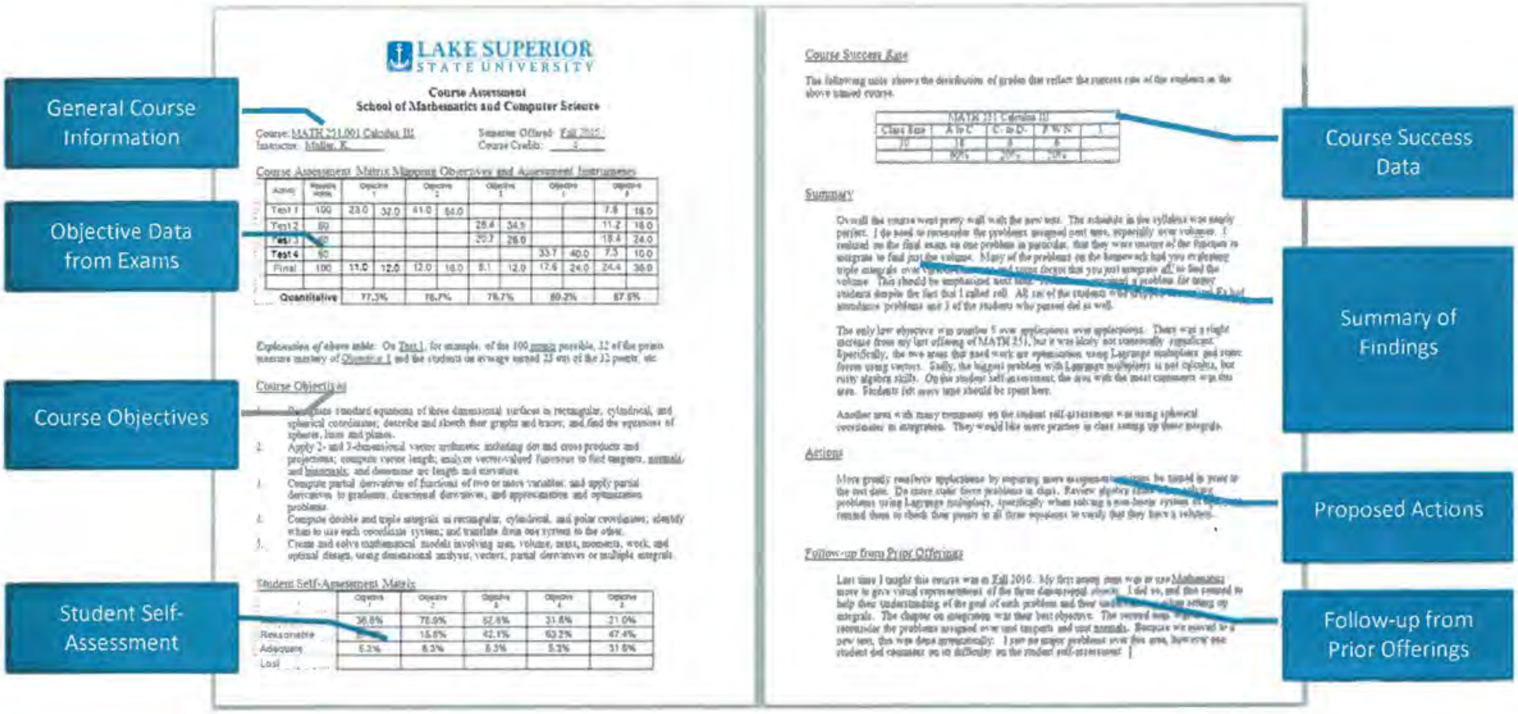
Finally, many of our classes are using technology in state-of-the-art classrooms and labs. Our School purchased many of these technologies for CAS 119, CAS 205, CAS 207, CAS 209A, CAS 210 and CAS 303 before they were more widely available on campus. Document cameras have been available for several years now, before they appeared in all classrooms across campus, and are used for a variety of purposes including displaying the content currently being discussed, student work on problems, student presentations, etc. TI84 calculators are extensively used in several classes, especially MATH207. Software specifically for educational purposes is available such as Geometer's Sketchpad. Besides technology, the department maintains a large collection of manipulatives such as place-value blocks, Algeblocks, tiles, geoboards, 2 and 3 dimensional shapes, etc. to assure that future teachers are aware of the place of these items in a rich mathematics educational experience.

5. Assessment

Our School has a well-established assessment strategy for all of its programs which began in 2008 with the establishment of a School Assessment Committee under the leadership of now Professor Emeritus Sherry Duesing. The Assessment Committee formed subcommittees by discipline and created measurable outcomes for all courses and programs by 2009 and created a mapping by 2010. All of these objectives are located on the N: drive, though some have been edited in Tracdat since that time. Those objectives were then reviewed by Professor Duesing and Dr. Gregory to ensure that the outcomes were properly worded using established terminology in the field of Education.

Course Assessment

In 2009, we created a two-page template for course objective assessment which recorded our data and a summary of how we planned to use this data to strengthen our courses, which would of course strengthen our programs as well. You can locate these old reports, beginning with assessment from 2009, on the N: drive under Assessment. Before Tracdat, we had a well-established routine of completing our course assessment documents and steadily improving our courses. We feel our progress in this regard was well-ahead of the University as a whole. Course proposals were sent to the Curriculum Committee making changes to MATH 310 and MATH 325. In the summer of 2015, in preparation for writing a previous program review the chair of the School of Mathematics and Computer Science reviewed the School's assessment on the N: drive and in Tracdat and found that many of the faculty had continued under the old process while also entering data into Tracdat. These faculty upload the School document into Tracdat as evidence using "related document". Some faculty only completed the School document, but did not enter their data into Tracdat. Some faculty entered assessment data into Tracdat, but no longer completed the School document. In the Fall of 2015, with the endorsement of Dr. David Myton, Associate Provost, the School voted to return to using the School's assessment template, with improvements that were more in line with the information that Tracdat usually required, such as a section that specifically requests "Actions" and a section for "Follow-up" on prior actions to complete the assessment loop.



On January 22, 2016, after Dr. Myton made some changes in Tracdat to align with our assessment template, Dr. Myton wrote, "Please thank your faculty for their assessment work. Your School is now the campus leader in terms of green checks and absence of red flags - congratulations!" In addition to Tracdat, many assessment reports can be found on the School's N: drive for easier viewing.

Program Assessment

The School has mapped course objectives to the program objectives. In most cases these course objectives are used to measure the program objectives. In one case the objective is measured by student placement after graduation. For those objectives where course outcome data is used, the numbers were calculated using the last semester/year of offering during the last two year cycle. Except for a few select cases of alternate year offerings, we used the data from 2015-2016. As you can see from the next table, in most cases the targeted threshold for the objective is met. Those boxes are green. There are three objectives where the numbers are lower that the target of 90%. Those boxes are red. To provide more context for how these numbers were calculated, inside the 6 courses in the M-ET program that have course outcomes aligned with Program Objective 1, there were 24 outcomes mapped to that objective. Of those 24 outcomes, 21 of the 24 were assessed as meeting the desired success rate during course assessment, giving an 87.5% percentage of course outcomes meeting the desired standard. If one more objective had met the desired standard, the objective overall would have met its 90% threshold. (Although the table shows that there is possibly some room for improvement, a quick look back at prior offerings shows that many of the course outcomes that did not meet the desired standard for this last offering, have met that standard recently. If we had chosen to do so, we could have used the "best" data instead of the most recent.) One should also note that the large majority of the objectives that did not meet the desired standard are in courses that are largely populated by students who are not majors in mathematics, M-ET or M-ST, so these numbers are likely not representative of our majors.

	Program Objectives	M-ET Courses	M-ST Courses	Targeted Threshold	Percentage of M-ET Course Objectives that Met Target	Percentage of M-ST Course Objectives that Met Target
1	Demonstrate a fundamental and foundational knowledge of mathematics by developing quantitative and abstract reasoning skills in order to build a conceptual understanding of logical structures and axiomatic systems.	MATH 103, MATH 104, MATH 215, MATH 305, MATH 321, MATH 325	MATH 215, MATH 216, MATH 305, MATH 341, MATH 321, MATH 325, MATH 401	90% of related objectives to hit targeted threshold	37.5%	85.7%
2	Demonstrate technical mathematical skills in the areas of algebra, geometry, calculus, and statistics for solving problems.	MATH 103, MATH 104, MATH 151, MATH 152, MATH 207, MATH 305, MATH 321, MATH 325	MATH 151, MATH 152, MATH 207, MATH 251, MATH 305, MATH 310, MATH 321, MATH 325	90% of related objectives to hit targeted threshold	34.5%	76.5%
3	Use their knowledge of the historical background of mathematics in enriching their own lives and the lives of their future students.	MATH 103, MATH 104, MATH 321	MATH 321	90% of related objectives to hit targeted threshold	100.0%	100.0%
4	Use software and other technology to solve problems.	MATH 103, MATH 104, MATH 207, MATH 305	MATH 207, MATH 305, MATH 401	90% of related objectives to hit targeted threshold	100.0%	100.0%
5	Use their acquired skills in the pursuit of a job and/or graduate school.			At least 80% of the respondents should be employed or in graduate school within a year of graduation.	100.0%	100.0%
6	Create mathematical models and use their mathematical and analytical skills to solve real-world problems.	MATH 103, MATH 104, MATH 207, MATH 151, MATH 152	MATH 151, MATH 152, MATH 251, MATH 310, MATH 401	90% of related objectives to hit targeted threshold	95.3%	80.4%
7	Continue to acquire new knowledge for life-long learning in pursuit of their professional and personal goals.	MATH 215, EDUC 480, EDUC 492	MATH 215, MATH 216, MATH 341, MATH 401, EDUC 480, EDUC 492	90% of related objectives to hit targeted threshold	100.0%	100.0%
8	Communicate mathematically in their profession and the broader community.	MATH 103, MATH 104, MATH 215, MATH 321, MATH 325	MATH 215, MATH 321, MATH 325, MATH 341	90% of related objectives to hit targeted threshold	100.0%	100.0%
9	Make connections of mathematical ideas to other ideas both inside of and outside of mathematics.	MATH 103, MATH 104, MATH 207	MATH 207, MATH 151, MATH 152, MATH 401	90% of related objectives to hit targeted threshold	100.0%	100.0%

All education students must pass the MTTC licensure exam prior to student teaching. This is perhaps a better measure of whether or not these targeted graduates are meeting program outcomes. Secondary education mathematics majors take the secondary mathematics exam. Our pass rate has remained high with 100% of the M-ST majors attempting the exam passing it from 2012-2015. On the other hand, elementary mathematics majors need to first pass the elementary education exam, and may become highly qualified without taking/passing the elementary mathematics exam. Currently, the pass rate for the M-ET majors is also 100%. The same exam is taken both by students majoring in mathematics as those minoring in mathematics, so some of the students included in the table below are minors, who take many of the same courses as those who are majoring in mathematics. The majors are in blue. All but one of the minors in the secondary program were still successful, but there is less success among the minors in elementary education.

	Test Code 22 - Secondary 89 - Elementary		Test Date	Result	Score (provided only for Fail; cut score is 220)	Subareas			
						Mathematical Processes and Number Concepts	Patterns, Algebraic Relationships, and Functions	Measurement and Geometry	Data Analysis, Statistics, Probability, and Discrete Mathematics
Tester 1	22	major	10/13/2012	P		2	4	2	2
Tester 2	22	minor	10/13/2012	P		4	3	4	4
Tester 3	22	minor	1/5/2013	P		3	4	3	3
Tester 4	22	minor	4/13/2013	F	202	1	2	2	3
Tester 5	22	major	4/13/2013	P		4	4	3	4
Tester 6	22	minor	7/13/2013	P		2	4	2	4
Tester 7	22	minor	10/5/2013	P		4	4	3	3
Tester 8	22	major	1/4/2014	P		2	3	2	4
Tester 9	22	major	10/11/2014	P		4	4	4	4
Tester 10	22	major	11/22/2014	P		3	2	3	3
Tester 11	22	major	4/18/2015	P		4	4	4	4
Tester 12	22	major	7/11/2015	P		3	4	3	3
Tester 13	89	minor	4/14/2012	P		4	4	4	4
Tester 14	89	minor	4/14/2012	F	189	3	1	2	1
Tester 15	89	minor	7/14/2012	F	192	3	1	1	2
Tester 16	89	minor	7/14/2012	P		4	4	4	4
Tester 17	89	minor	7/14/2012	F	213	2	2	2	3
Tester 18	89	major	4/13/2013	P		4	3	3	2
Tester 19	89	minor	4/13/2013	P		4	3	3	2
Tester 20	89	minor	4/12/2014	P		4	2	2	3
Tester 21	89	minor	4/12/2014	F	206	3	2	2	1
Tester 22	89	minor	10/10/2015	P		4	4	4	4

1 = Examinee answered few or none of the questions correctly (scaled subarea score of 100-179)
2 = Examinee answered some of the questions correctly (scaled subarea score of 180-219)
3 = Examinee answered many of the questions correctly (scaled subarea score of 220-259)
4 = Examinee answered most or all of the questions correctly (scaled subarea score of 260-300)

6. Opportunity Analysis

Recruitment

Our School developed several new initiatives to increase enrollment in the past year including a **Mathematics and Computer Science Field Day** for area high school students, calling and writing potential students, developing new pamphlets and power point presentations on our programs and increasing our presence on social media. We expected it to take several years to see any increase based on our efforts, but our school shows a remarkable 58.1% increase in admits already in 2015 (the largest increase shown in the data compiled by Joe Barrs at that time). We did not see the same increases this year for these two programs. While we no longer have access to reports from Joe Barrs, we are basing this on the number of students attending orientation. From the data pre-2011, we have a market for these two degrees in the region. We need to find new ways to market our students' overwhelming success from these two programs both on the certification exams and in job placement. A major STEM recruitment push makes perfect sense right now, and we believe our school is poised to attract those attentive to the job predictions. Note that our programs are much less expensive to run than many other programs, and we have the capacity to substantially increase enrollment with little or no marginal cost. We have requested changes to the tour guide notes for admissions that highlight our programs. While it seems these changes have not yet be made, we have seen other positive changes since the arrival of Annette Hackbarth-Onson and are hopeful that our programs will be highlighted in the future. We will continue to increase our efforts in recruitment, and we will continue to point out this opportunity for non-academic departments to support our efforts.

Facilities

Our facilities requirements are minimal. We share a lab with computer science and the computers are updated on a five year rotation using course fees. The course fees for MATH103 and 104 contribute to the collection of manipulatives used in those courses.

Potential

We have streamlined our course offerings so that courses exclusively for these programs are offered only every 2 years. We also changed the course offering pattern so that students would be less likely to need several of intensive mathematics courses at once. Still, these courses typically run with an enrollment of 5-10 students, which leaves room to recruit up to 20 additional students, at no marginal cost to LSSU. We would also like to see an increase in the number of minors for these two areas.

7. Optional

While our program is not zero-cost it does pay for itself as evidenced in other sections. Most mathematics programs across the U.S. are small when compared with overall offerings because it takes a comparatively rare gift for a student to succeed in such a program. Please do not underestimate the value of our strong ties to the K-12 community. Through our joint work with area teachers we have many opportunities to interact with regional teachers and students to promote LSSU and what we have to offer. Through workshops, advisory boards, projects, we interact with teachers regularly. The school district comes to us when they have a teaching vacancy to ask for recommendations. This is a tie to the people who interact daily with our potential students that is both priceless and only costs us time. Usually this time is spent disseminating knowledge on a subject that we love.

Appendix Cover Sheet

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Degree Audit**
This documentation is relevant to Question number:	**15**
Briefly summarize the content of the file and its value as evidence supporting program review:	**It shows the current curriculum for the degree.**

LAKE SUPERIOR STATE UNIVERSITY

B.S. Mathematics Secondary Teaching (EX endorsement)

Name____________ **ID#**____________ **Advisor**____________

Expected Date of Graduation____________ **Advisor Review** ____________

Enter semester (e.g F17) and grade (e.g B) for each class at LSSU. for transfer credits enter BOTH: 'TR' and the grade. The Certification GPA for the MATH major and PES will include all grades from all institutions.

Secondary Math Major [min. grade=C, min. GPA=2.70, credit=42]	**Grade/Sem.**
MATH151 Calculus I 4	____ __
MATH152 Calculus II 4	____ __
MATH207 Prin Statistical Methods 3	____ __
MATH215 Fund Concepts of Math 3	____ __
MATH216 Discrete Math Prob Solv 3	____ __
MATH251 Calculus III 4	____ __
MATH305 Linear Algebra 3	____ __
MATH310 Differential Equations 3	____ __
MATH321 History of Math 3	____ __
MATH325 College Geometry 3	____ __
MATH341 Abstract Algebra 3	____ __
MATH401 Mathematical Model 3	____ __
Complete one methods course from following two:	
EDUC442 Second Math Methods 3	____ __
EDUC452 Dir St Math Methods 3	____ __

Cognate

CSCI105 Intro to Computer Prog 3	____ __
or	
CSCI121 Prin of Computer Prog 3	____ __

General Education Requirements (36-42)

☐ *Check if MACRAO or GE-Cert completed*

ENGL110 First year composition I 3	____ __
ENGL111 First year composition II 3	____ __
Communication (COMM101 rec) 3	____ __
Humanities elective 3-4	____ __
Humanities elective 3-4	____ __
Social Science elective 3-4	____ __
Social Science elective 3-4	____ __
*Diversity elec 3-4 (e.g. EDUC250)	____ __
Natural Sci elect 3-4	____ __
Natural Sci elect 4	____ __
*Math elec 3-5 (e.g. MATH151)	____ __

Professional Education Sequence [PES] [min. grade = B- incl. transfer; max cr = 35]	**Grade/Sem.**
EDUC250 Student Div. & Schools 4	____ __
EDUC301 Educ Psych Learning Theory 3	____ __
Must be Admit. to Ed. Prior to EDUC350	
EDUC350 Integrating Tech Learning 3	____ __
EDSE301 Intro to Special Education 3	____ __
EDUC415 Gen Instructional Methods 2	____ __
EDUC 440 Reading Content Area 3	____ __
Complete one methods course from following two:	
*EDUC442 Math Methods Secon. 3	____ __
*EDUC452 Dir Study Math Methods 3	____ __
EDUC460 Classroom Management 2	____ __
Admission to Student Teaching required for following:	
EDUC480 Directed Teaching: Seminar 2	____ __
EDUC492 Directed Teaching 10	____ __

Education Cognate (4 credits)

*MATH207 Princ Statistical Method 3	____ __
EDUC101 Self as Learner 1	____ __

Minor

An approved teaching minor is recommended, but not required. Indicate choice below:

- ☐ **Teaching minor**: ____________
  (attach minor audit sheet, 2.7 GPA min, min grade of C)
- ☐ **Non-teaching minor** ____________
  (attach minor audit sheet)
- ☐ **No minor**

Graduation Criteria include:

- ☐ Residency: 50% of 300/400 courses earned at LSSU
- ☐ Total credits in excess of 124
- ☐ GPA overall and in major minimum of 2.70 (B-)
- ☐ No courses in major below a "C" (2.00)
- ☐ No education course below "B-" (2.70) in PES

Certification requires a passing grade on the MTTC Secondary Math exam (test #022)

Education Dean____________

*A course in another component of the program may be used to meet this requirement

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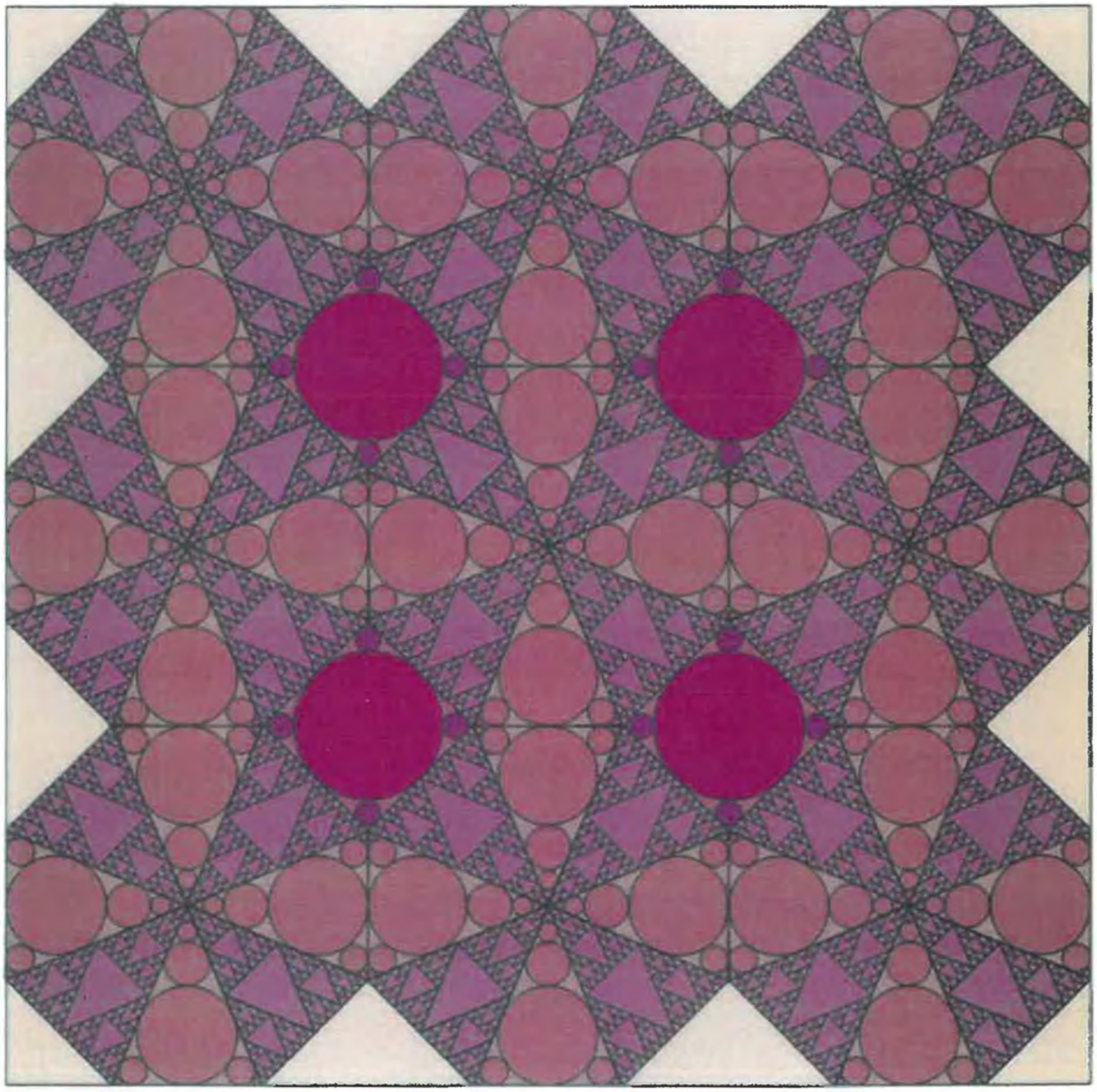
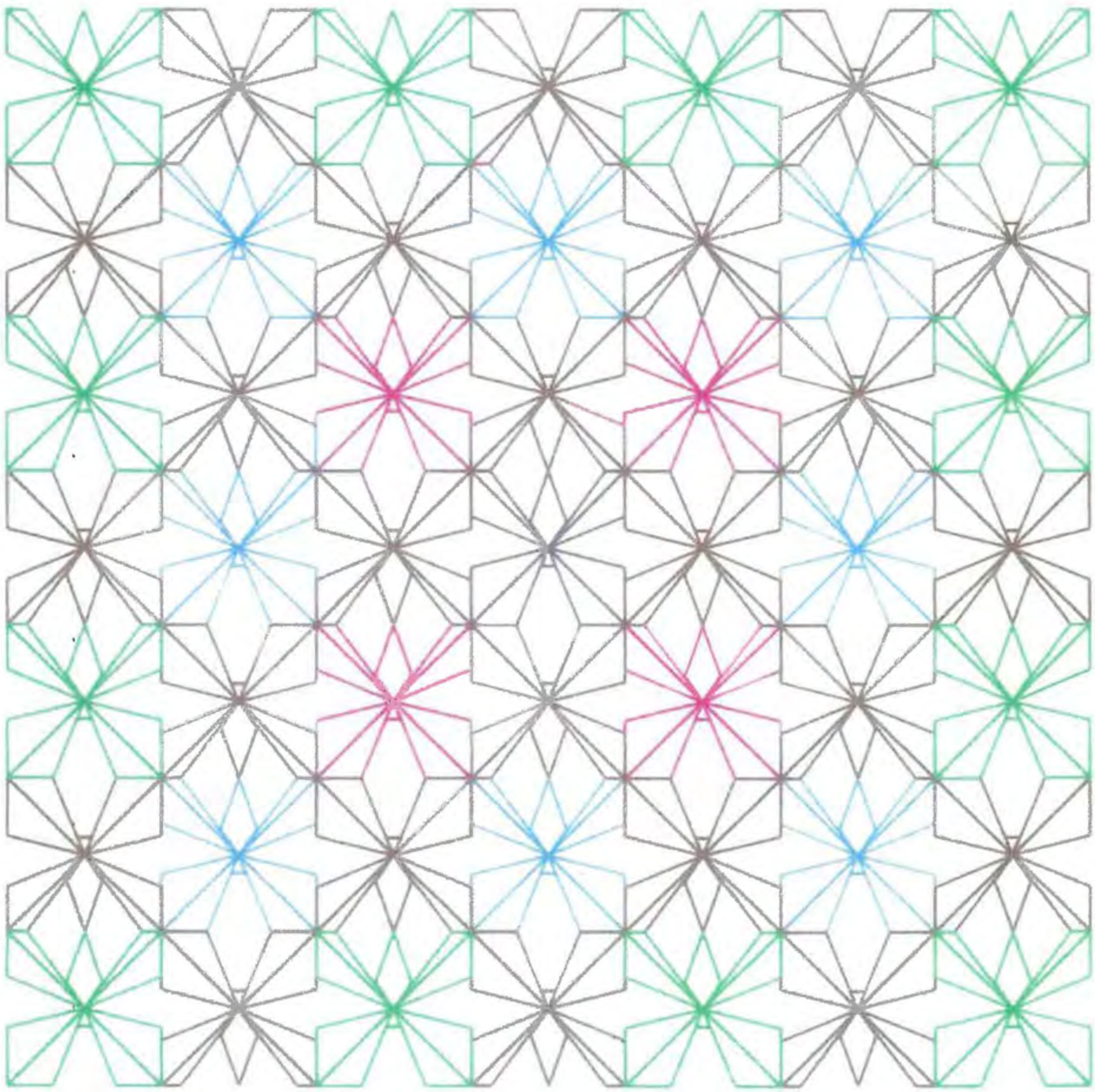
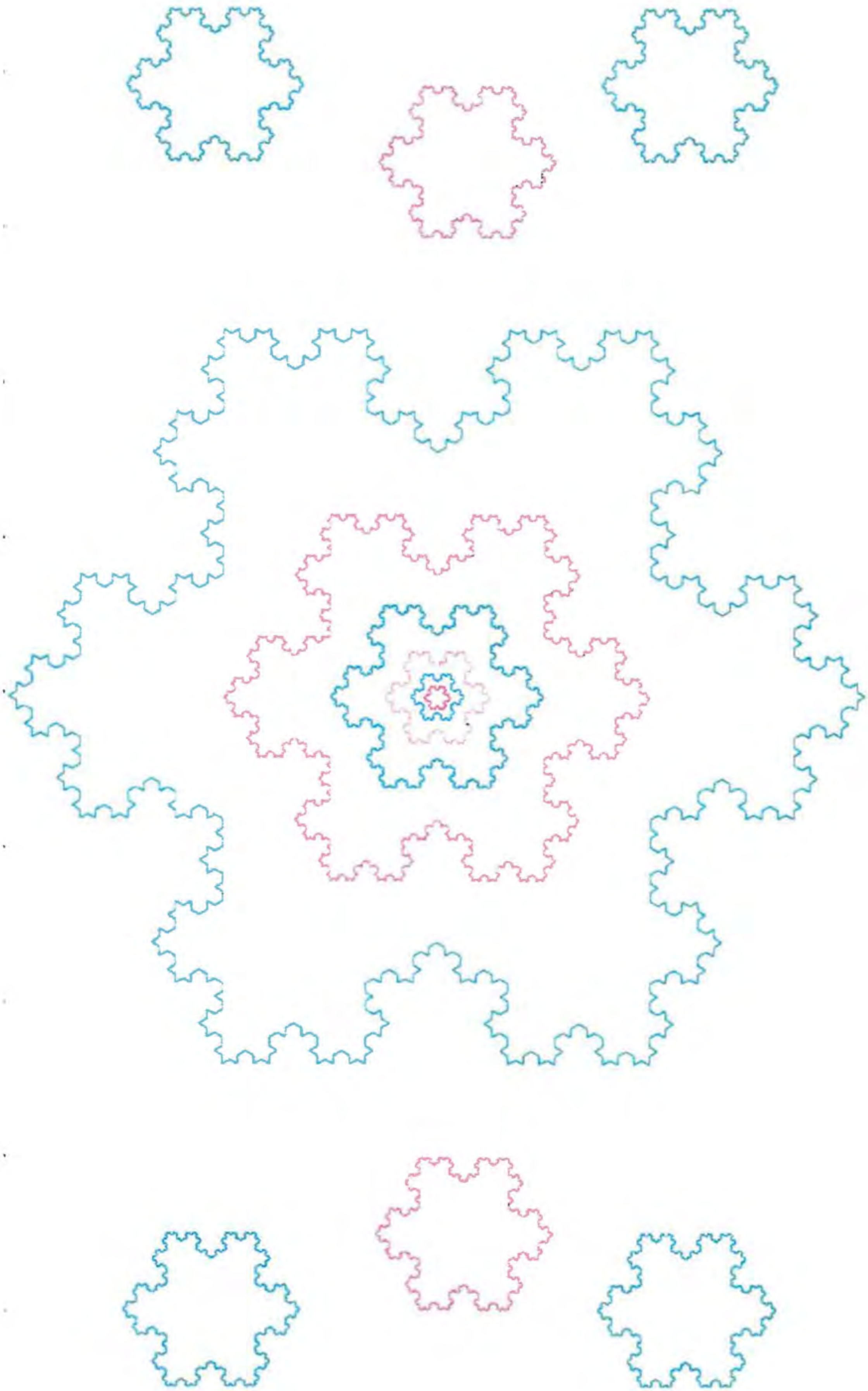
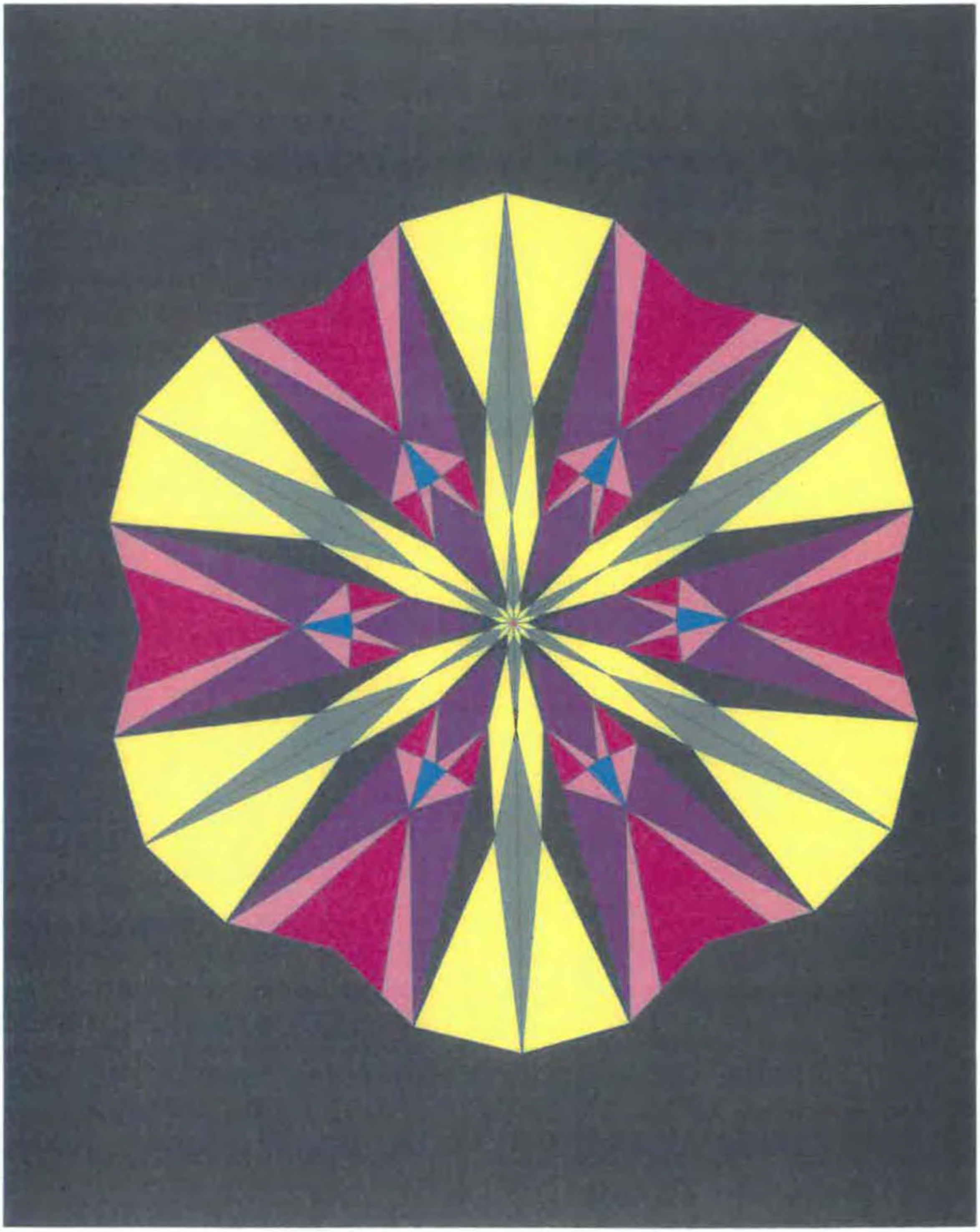
Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

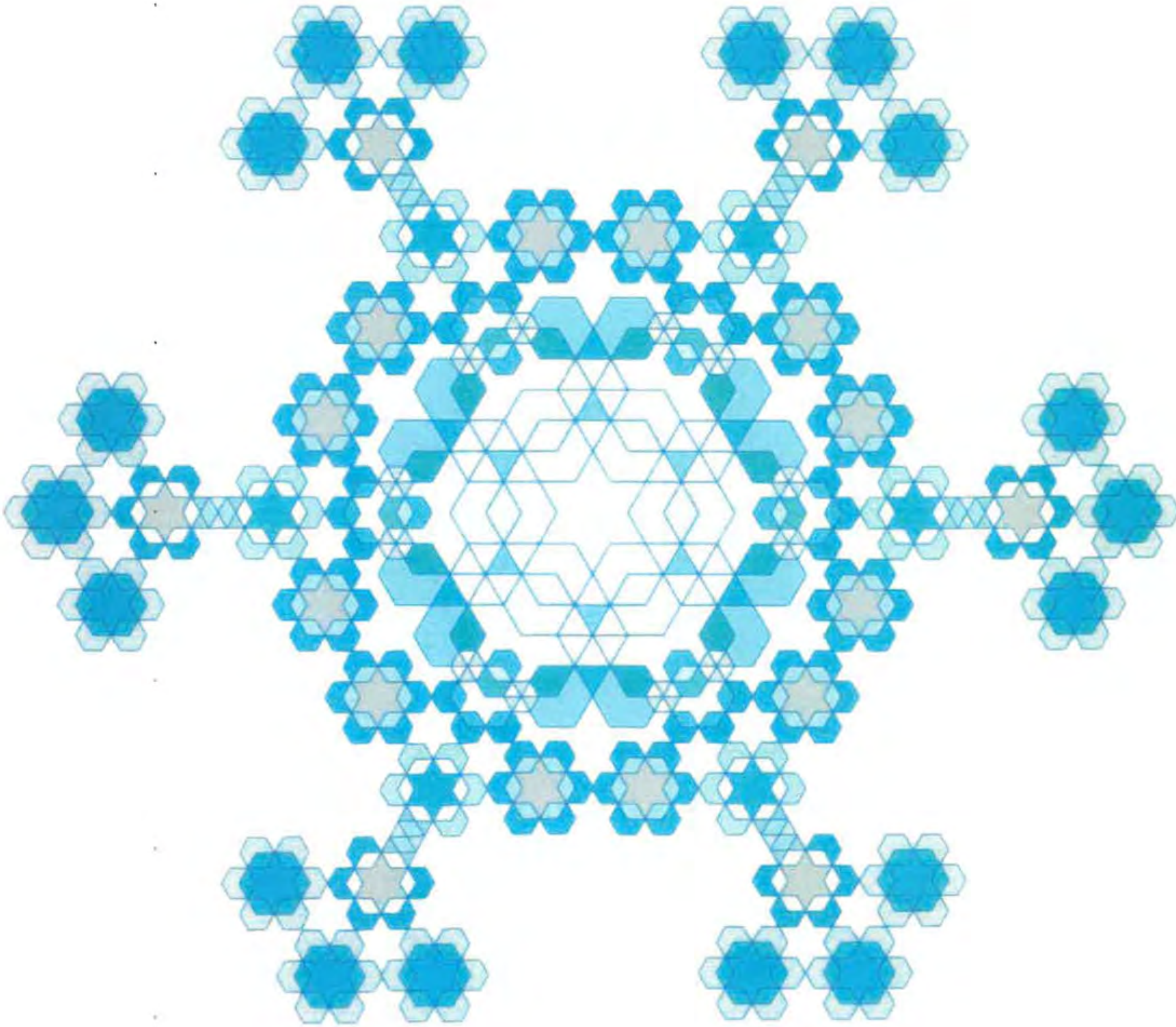
School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**MATH 325 Project Examples**
This documentation is relevant to Question number:	**16**
Briefly summarize the content of the file and its value as evidence supporting program review:	**This shows an example of students creative works related to transformational geometry and symmetry.**

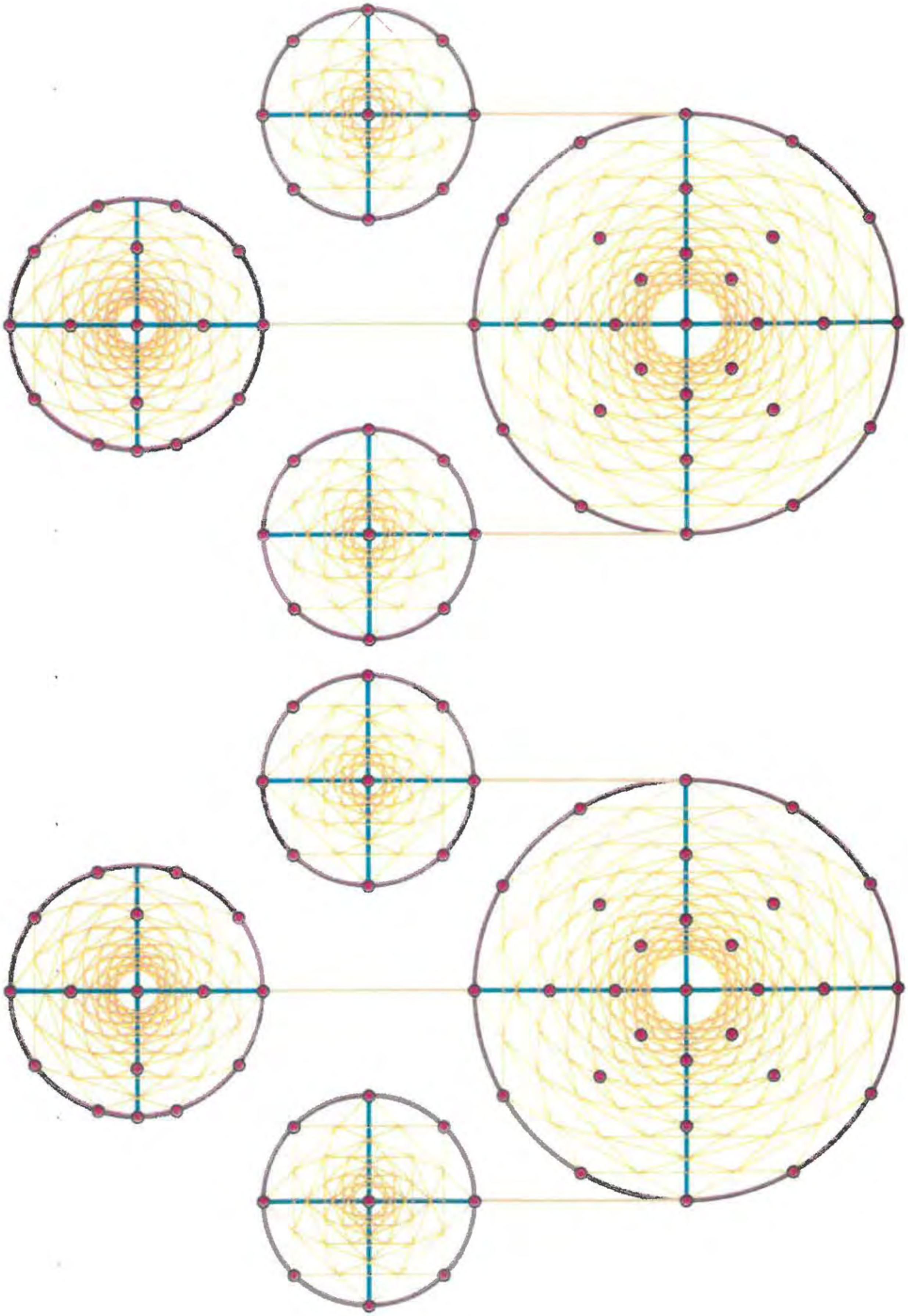


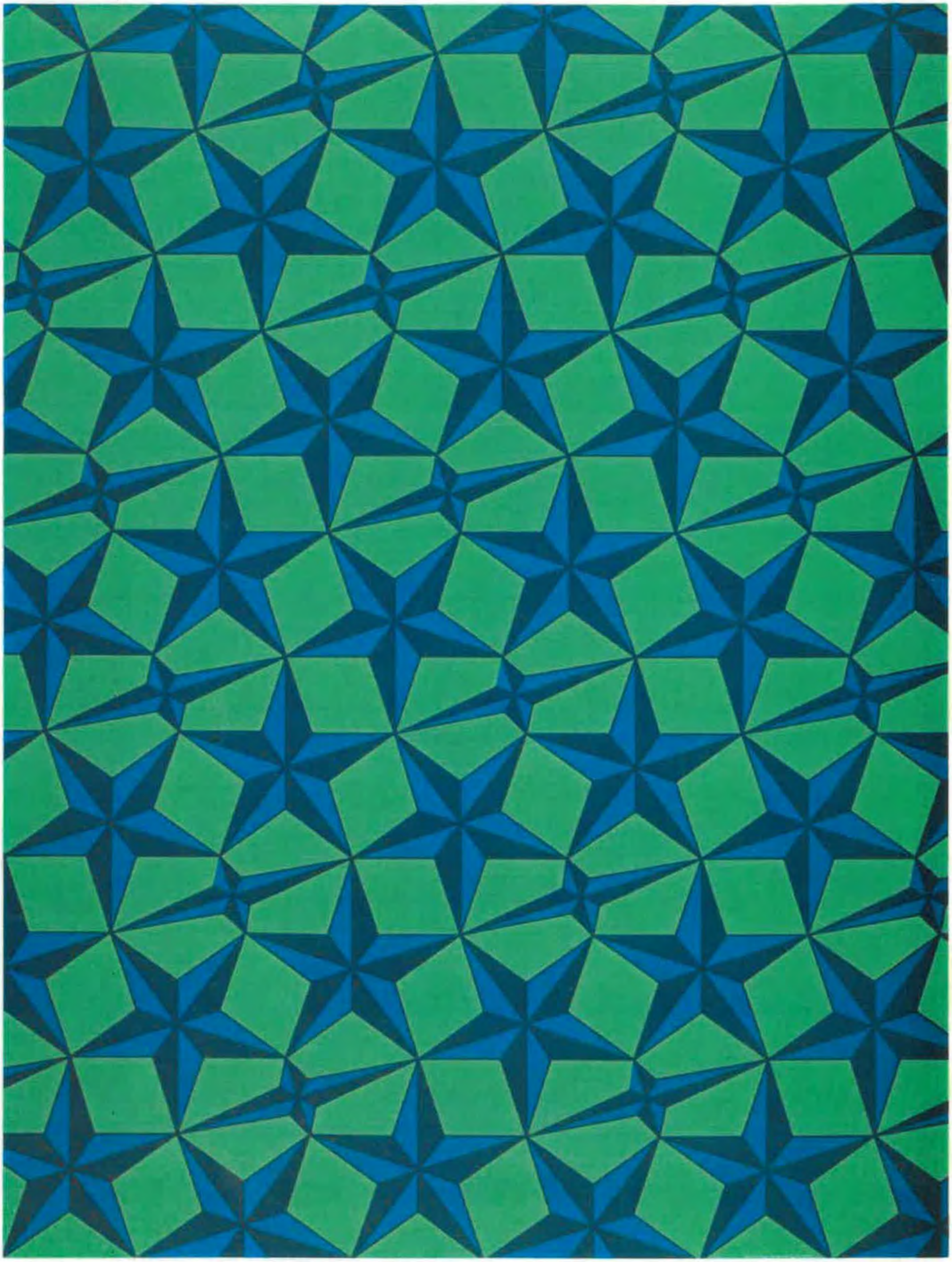












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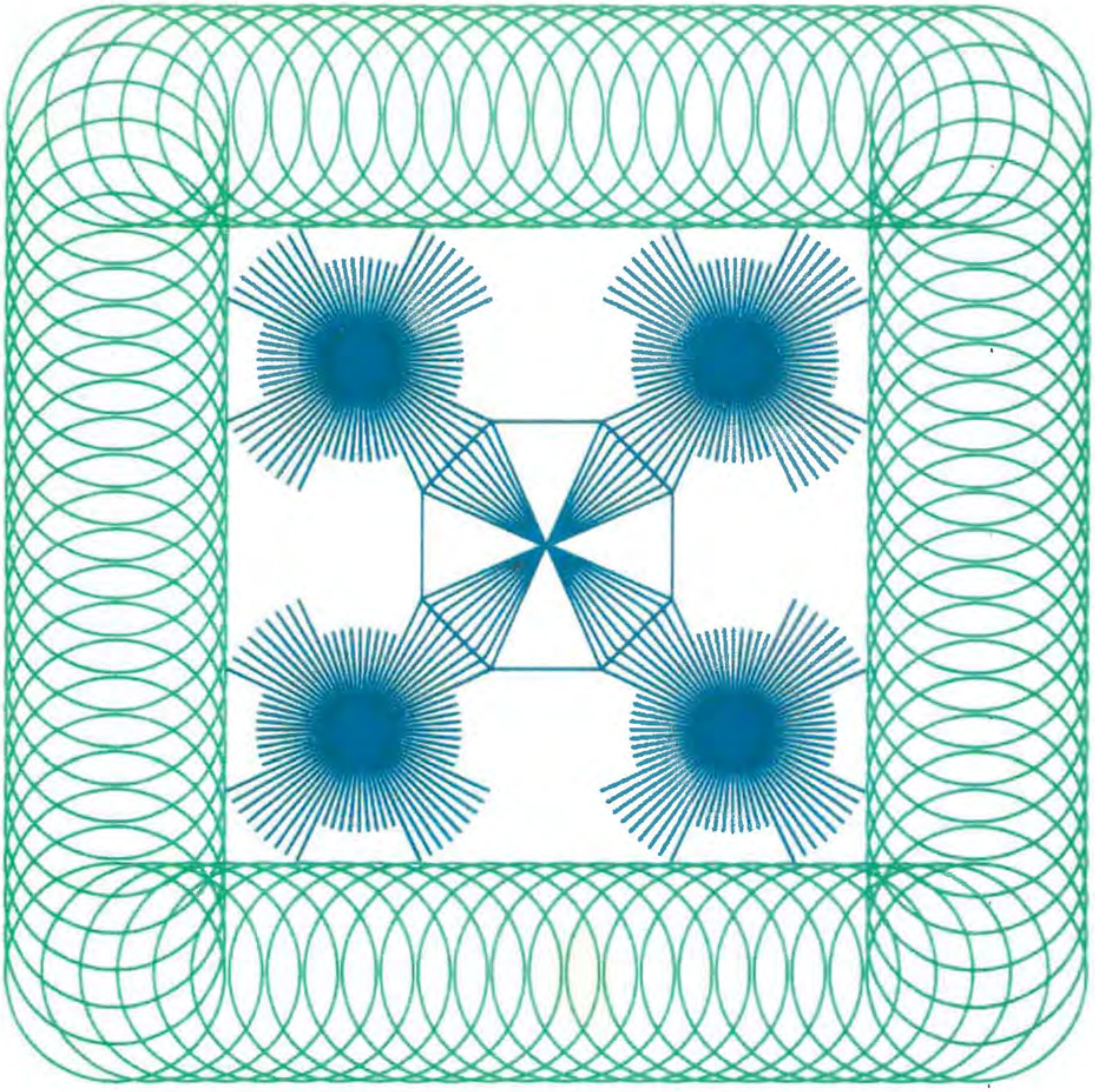
Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**MATH 325 Portfolio Example**
This documentation is relevant to Question number:	**16**
Briefly summarize the content of the file and its value as evidence supporting program review:	**This shows an example of a student's portfolio. The student collects his/her best work and reflects on the learning process.**



Math 325

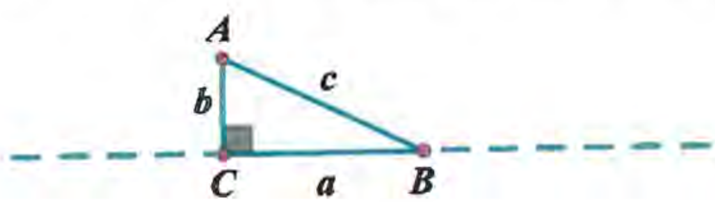
Portfolio

1. Construct ΔABC such that $\angle C$ is a right angle.
   a. Draw a vertical segment, $\overline{AC}$, with the segment tool.

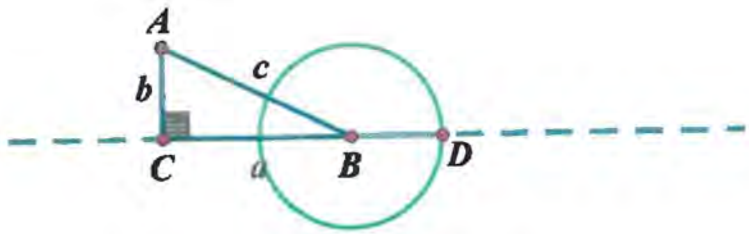
   b. Click $\overline{AC}$ and click C. On the menu click Construct and in the drop-down-menu click Perpendicular line.

   c. Construct segment $\overline{BC}$ by clicking C and a random spot on the perpendicular line using the segment tool.

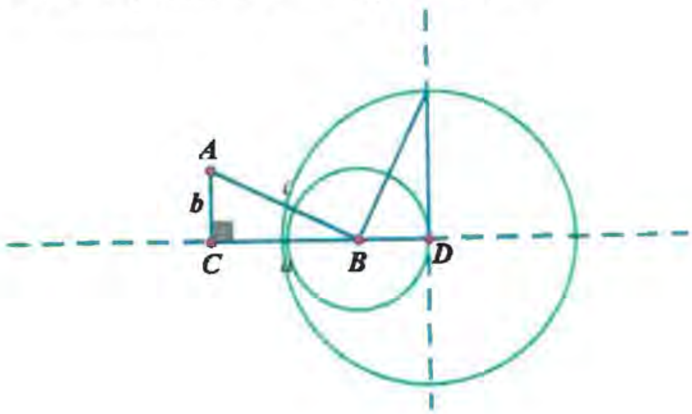
   d. Construct segment $\overline{AB}$. Select each segment and label them lower case letter of their opposite angle. Mark your $\angle C$ as a right angle with the marker tool.



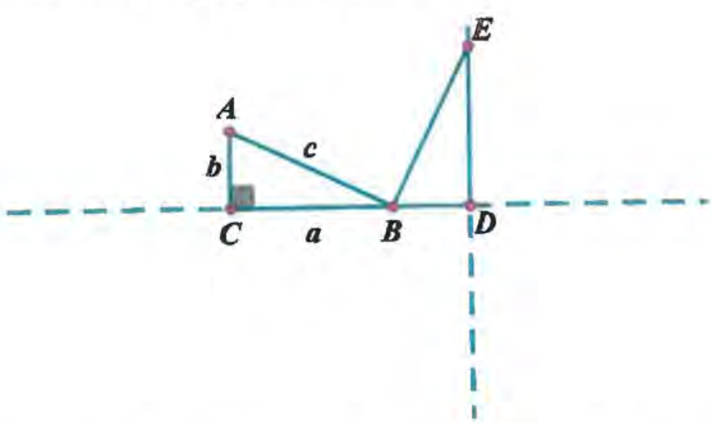
2. Construct ΔBDE such that $\overline{BD} \cong \overline{AC}, \overline{DE} \cong \overline{BC}$ and $\angle D$ is a right angle.
   a. Construct $\overline{BD}$ by clicking $\overline{AC}$ and point B, Construct-Circle by Center+Radius. Point D will be the intersection of ⊙B and $\overleftrightarrow{CB}$, construct segment $\overline{BD}$. So that D does is not the intersection between $\overline{BC}$.



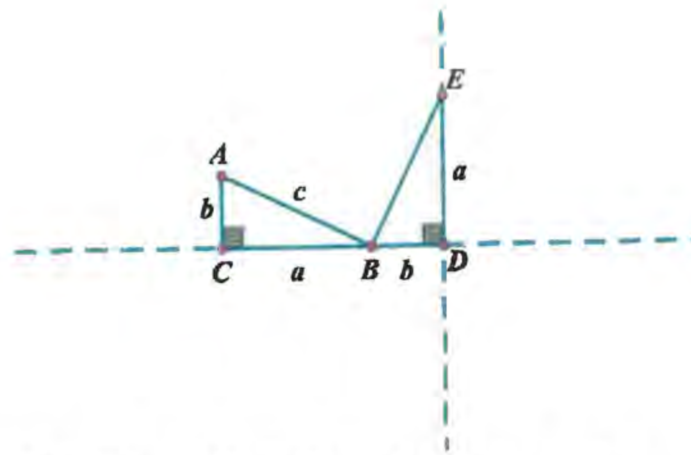
b. Construct $\overline{DE}$ by selecting point D and $\overleftrightarrow{CB}$, Construct-Perpendicular Line. Select D and $\overline{BC}$, Construct-Circle by Center +Radius. Point E is the intersection of $\odot D$ and $\overleftrightarrow{ED}$. Connect point E to B in a segment as well.



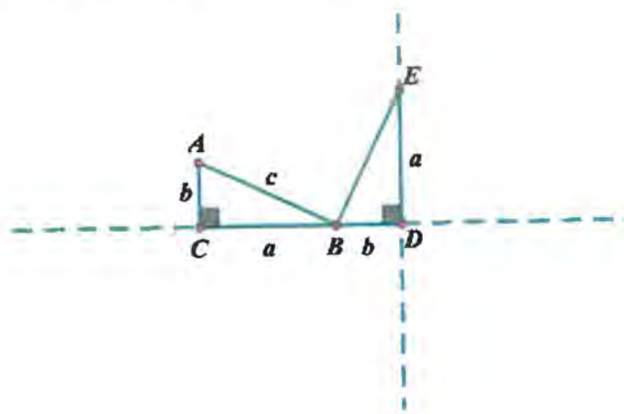
c. Select all circles, Display-Hide Circles.



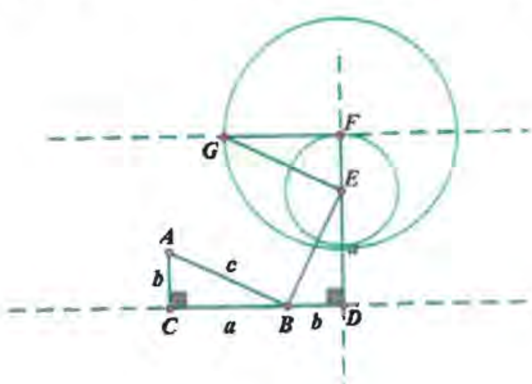
d. Label sides by their congruencies with a and b. Mark your $\angle D$ as a right angle with a marker tool.



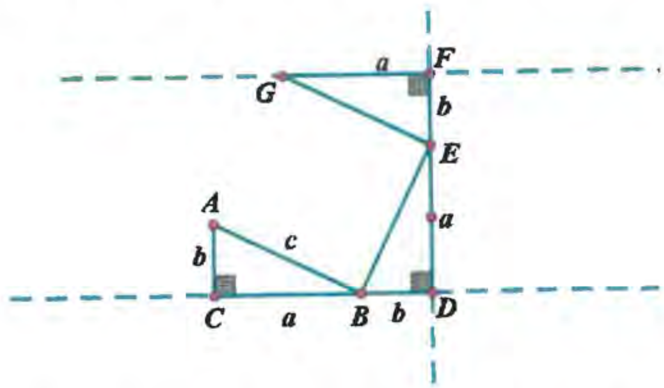
3. Construct ΔEFG such that $\overline{EF} \cong \overline{AC}, \overline{FG} \cong \overline{BC}$ and $\angle F$ is a right angle.
    a. Select $\overline{AC}$ and point E, Construct-Circle by Center+Radius. Label the intersection of $\odot E$ and $\overleftrightarrow{ED}$ point F. Construct segment $\overline{EF}$.



    b. Construct $\overline{FG}$ by selecting point F and $\overleftrightarrow{ED}$, Construct-Perpendicular Line. Select F again and $\overline{CD}$, Construct-Circle by Center +Radius. Label the intersection of $\odot F$ and this perpendicular line G. Construct $\overline{FG}$ and $\overline{GE}$.

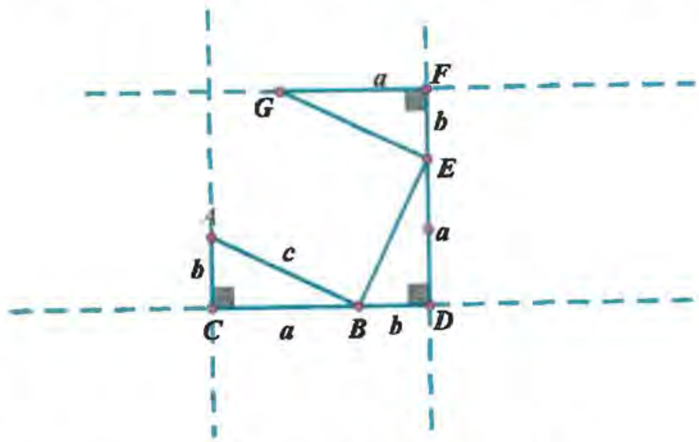


c. Select all circles, Display-Hide Circles. Label sides by their congruencies with a and b. Mark your $\angle F$ as a right angle with a marker tool.

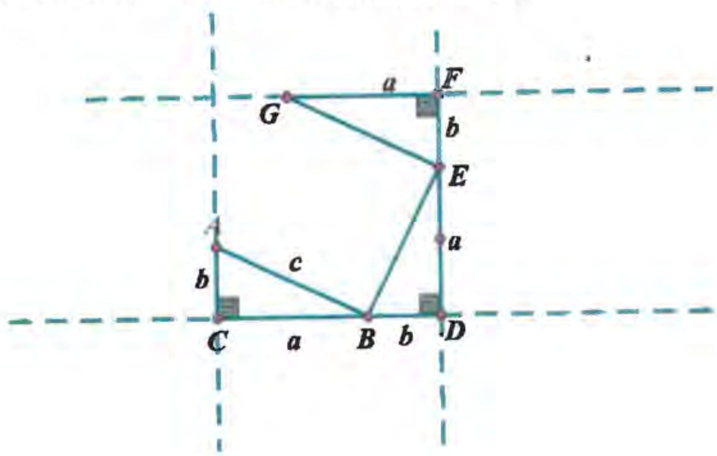


4. Construct ΔAGH so that H lies on the intersection of $\overleftrightarrow{FG}$ and $\overleftrightarrow{CA}$.

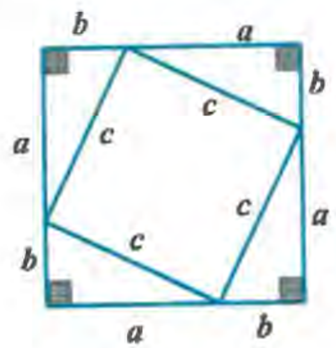
   a. Construct $\overleftrightarrow{AC}$ by using your line tool and selecting point A and then C.



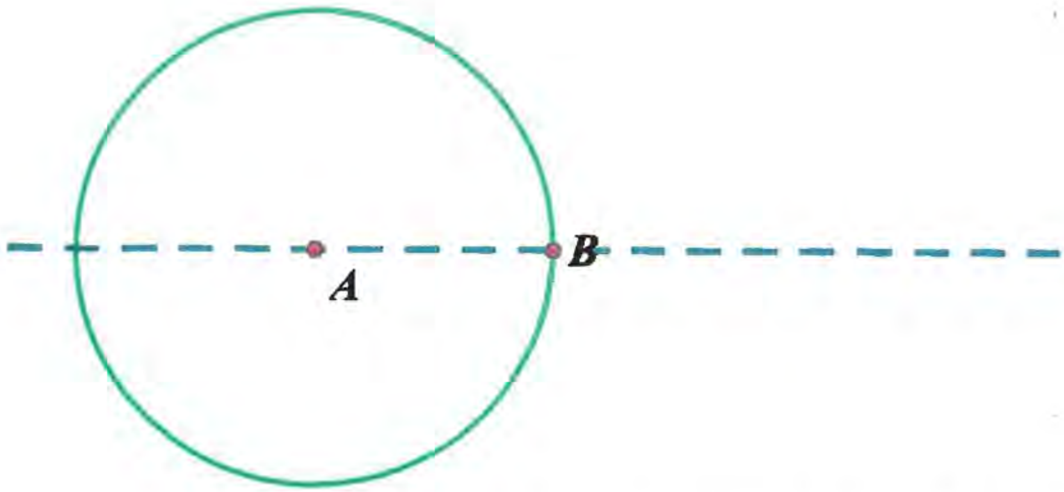
   b. Label the intersection H. Construct $\overline{HG}$, $\overline{AH}$, and $\overline{AG}$.



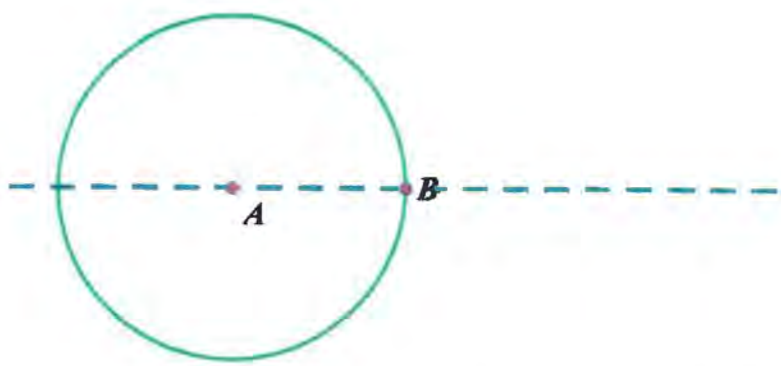
5. Proving sides $\overline{HG} \cong b$ and $\overline{AH} \cong a$.
    a. Since $\angle F \cong \angle D \cong 90°$ and 90°+90°=180°, by Thm 10 $\overleftrightarrow{HF} \parallel \overleftrightarrow{CD}$.
    b. With transversal $\overleftrightarrow{HC}$, using Thm 10 we know $\angle H + \angle C$=180°. By substitution $\angle H$°+90°=180°. By CN 3, $\angle H$ =90°.
    c. From this we can deduce that CHFD is a rectangle. By Corollary 15 we know that $\overline{CD} \cong \overline{HF}$ and $\overline{FD} \cong \overline{CH}$.
    d. $\overline{DF} = a + b$, $\overline{CH} = b + \overline{AH}$, by substitution $a + b = b + \overline{AH}$. By CN3, $a = \overline{AH}$.
    e. $\overline{CD} = a + b$, $\overline{HF} = a + \overline{GH}$. By substitution, $a + b = a + \overline{GH}$, by CN3 $\overline{GH} = b$.
6. Proving $\overline{AG} \cong \overline{EG} \cong \overline{BC} \cong c$.
    a. By SAS $\Delta ABC \cong \Delta BED \cong \Delta EGF \cong \Delta GAH$
    b. By CPOCT $\overline{AG} \cong \overline{EG} \cong \overline{BC} \cong c$.
    c. Label new congruencies with respect to a, b and c. Next hide lines and points.



7. Construct a square with sides a+b.
    a. Place a point A and select a segment length of a. Construct –Circle by Center+Radius. Construct a line through the center. Label one intersection of the circle and the line B.

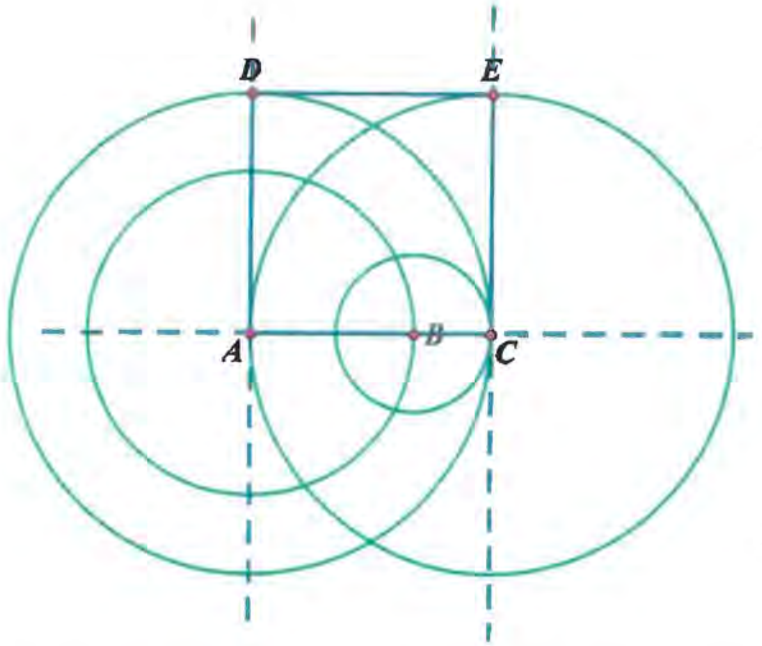


b. Select B and a segment of length *b*. Construct-Circle by Center+ Radius. Construct the segment from the center of the first circle to the final intersection of the last, point C. $\overline{AC} = a + b$.

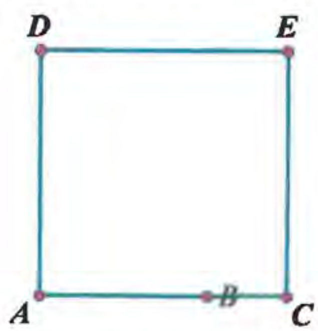


c. Select the $\overline{AC}$ and both points A and B. Construct + Circle by Center + Radius. Select the same segment and points. Construct – Perpendicular Lines. Construct the segment $\overline{AD}$ formed by the intersection of $\odot A$ and the perpendicular line through A. Similarly, construct $\overline{CE}$. Then connect D and E with a segment.

Note: We know ACED is a square throught the following: based on Thm 10 and 14 we can deduce that all angles are right, therefore it is a rectangle. Since $\overline{DA} \cong \overline{EC} \cong \overline{AC}$, and we can conclude that through the definition of a rectangle $\overline{DE} \cong \overline{AC}$ and through substitution creating them all to be equivalent and thus forming a square.

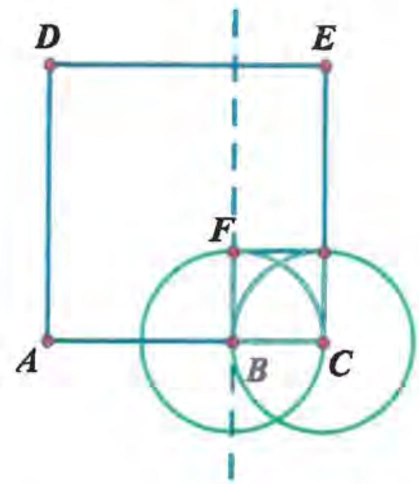


d. Hide all lines and circles so only ACED is shown. Leave point B as we know $\overline{AB} = a$ and $\overline{BC} = b$, as we will use this later.

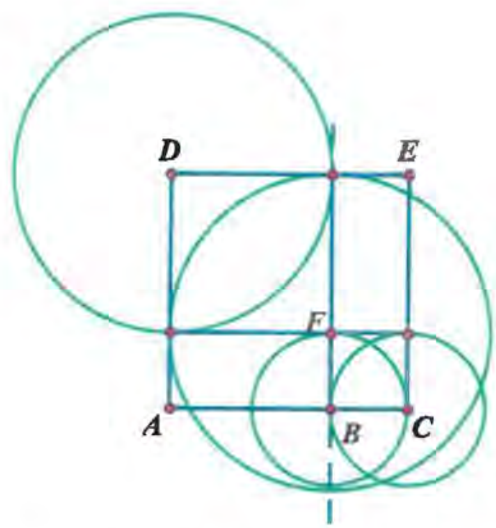


e.

8. Construct the interior of ADEC such that there are two squares; one with side lengths of a and another with side lengths of b.
   a. Construct segment $\overline{BC}$ and allow it to remain selected, then select C and B, Construct- Circles by Center + Radii. Select B and $\overline{EC}$, Construct –Parallel Line. Connect all intersections and label the corner of this new square that is within ADEC point F.

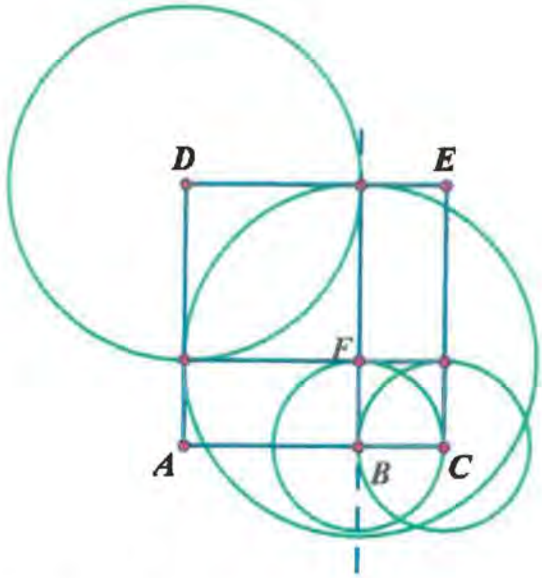


b. Since the line you constructed is parallel to $\overline{EC}$, and $\overline{EC} \parallel \overline{AD}$, by Thm 10, the line is also parallel to $\overline{AD}$ through CN 1. By creating $\overline{AB}$ and using it as a radius, select the point F and point D, construct Circle by Center+ Radius. Construct the segments that are formed from the centers of the circles and their intersections on ADEC.

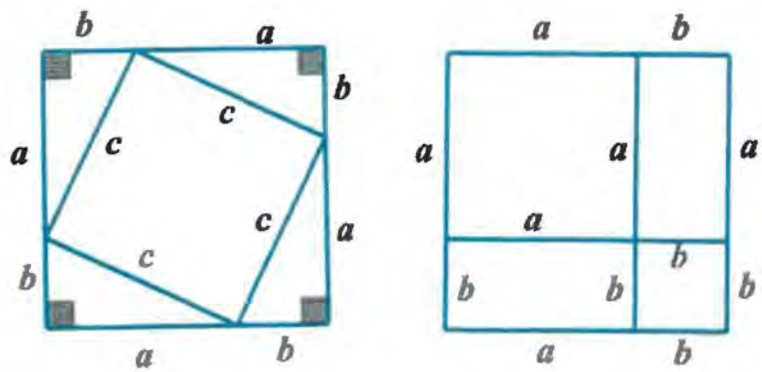


c. Hide all circles, points, and the line; label all segments within and on the square with respect to a and b.

Note: All distances between two outer sides of the square are equivalent to $a+b$ therefore, if on part of it is a, then the other part must be b by CN3.



9. Observe the two figures side by side. We now prove that $a^2+b^2 = c^2$. Note the area of each individual sections of the square.



a. We assume the area of a square is $A = bh$. A triangles area is $A=\frac{1}{2}bh$.

b. The total area of these two squares is equivalent as they both have equivalent bases of $a+b$ and heights of $a+b$.

c. Within the first figure we have four triangles each having and area of $A=\frac{1}{2}ab$. Thus, the total area for all four triangles is $2ab$. The second part is a square of $A=c^2$. Therfore the entire area of the first square we constructed: $A=2ab+c^2$.

d. Within the second figure we have two rectangles with $A=ab$, thuse one part of the area is $2ab$. We also have a square with $A=b^2$. The final part of this is the second figure's interior is a square with $A=a^2$. Thus, we know the area of the second square $A=2ab+a^2+b^2$.

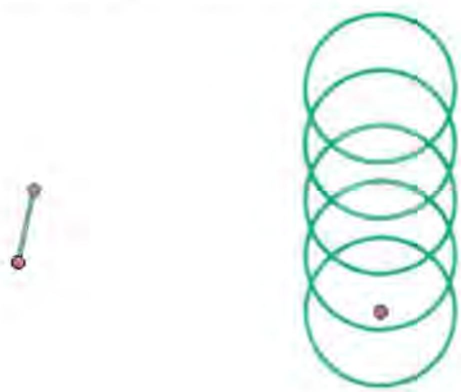
e. Since the total areas of the squares are equivalent, we can use substitution to find that : $2ab+a^2+b^2=2ab+c^2$ and then by CN 3: $a^2+b^2=c^2$, as desired.

1. Using the Straightedge tool, construct a segment.

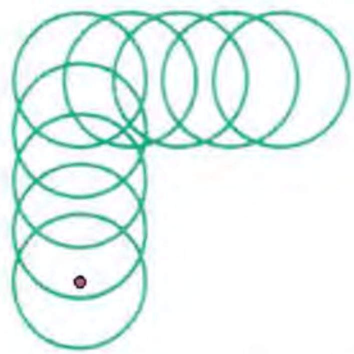
2. Using the point tool construct a point.

3. Select the segment and point and then select Construct-Circle by Center+Radius

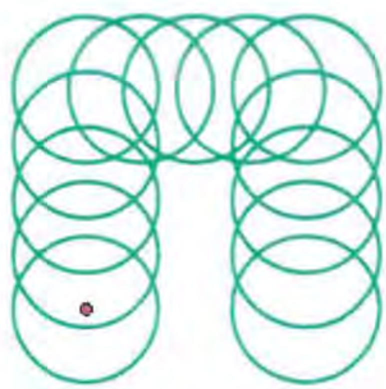
4. Select the circle and Transform-Translate repeatedly at 90° until you reach a desired side length for your square. The length at which you translate is your choice. Personally, I chose 1cm for this since the distance shows overlapping.



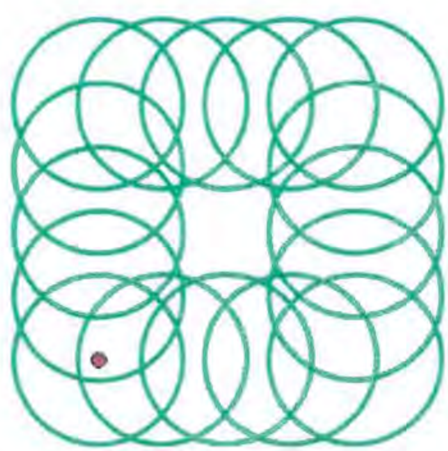
5. Transform-Translate, but this time choose either 0° or 360° to form the second side of your square, repeat this until the length of this side is equivalent to that of the other side. In other words the amount of circles will be the same.



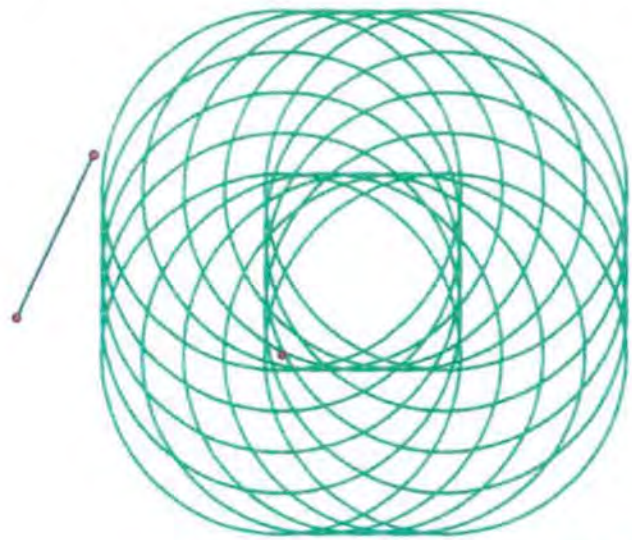
6. Transform-Translate at 270°, repeating until the length of this side is equivalent to the other two.

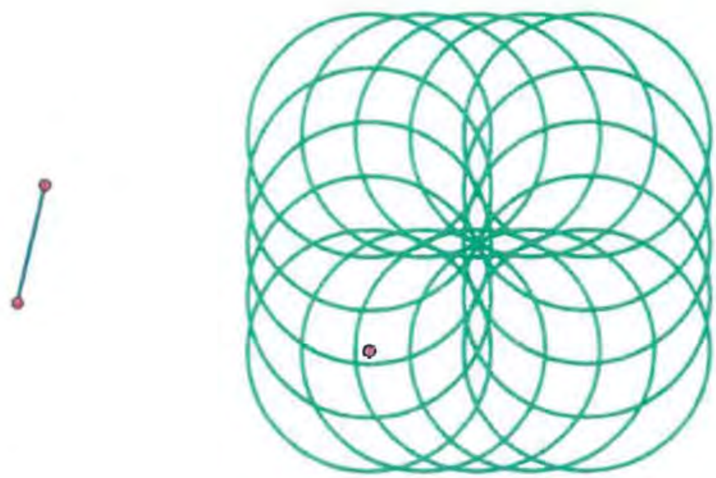


7. Transform – Translate at 180° until you connect the last circle and close your square.



8. The advantage of setting a radius in the beginning is that you can now use this segment to alter the radius of all the circles and create many different images simply.





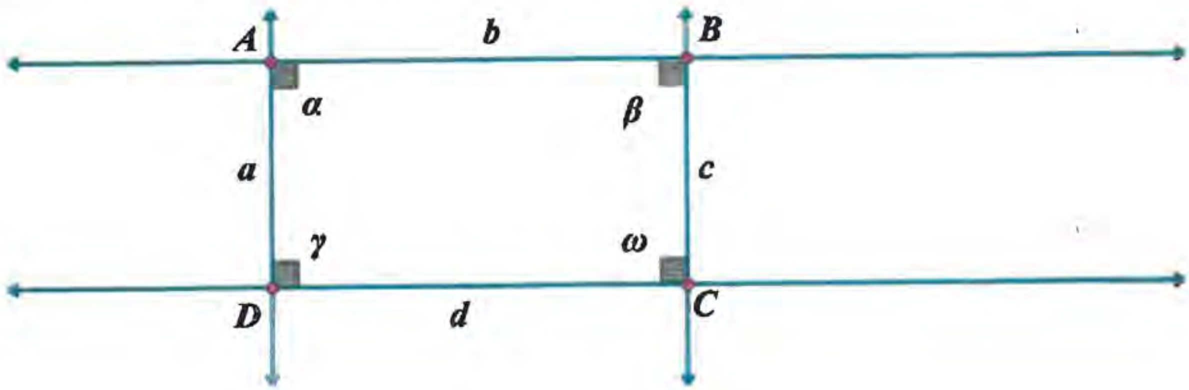
9. Hide the center of the original circle and the segment once you've picked a radius you like, now you have a symmetrical and robust construction of a border or a unique shape.

After the very first proof I realized many things about proof writing, after all this was the first official geometric proof that I've ever written. I started to write my proof immediately without even thinking about it and this lead to many mistakes because I would go back and realize I didn't give reasoning for certain things. After a few fails I chose to just figure it out first and then write the proof, this first proof really helped me to understand how I wanted to format my proofs and helped me to find the strategy behind solving proofs that works for me. One thing that I did really notice was the fact that this proof was wordy. I almost went into too much evaluation of the proofs and realized this as my proof writing progressed.

Theorem: A rectangle is a parallelogram.

Given: Let points A, B, C, D form the rectangle given for the proof. By definition of a rectangle, ABCD is a quadrilateral with all interior angles right (90°).

The points of the rectangle make up segments $\overline{AD}, \overline{AB}, \overline{BC}$, and $\overline{CD}$. By applying Axiom 2, all of these line segments can be indefinitely extedned to form lines. For sake of simplicity, let us name the lines and segments as seen below:



[Strategy: Proving $b \parallel d$.]

Lines b and d are both intersected by line c, by construction since c goes through points B and C, B intersecting line b, and C intersecting line d. The two interior angles are β and ω, both known to be right angles by definition of a rectangle. Right angles, by definition, are equivalent to half of a straight angle; thus, $\beta+\omega=180°$. Since the interior angles β and ω add up to a straight line, by the Corollary to Axiom 5/ Playfair, we know $b \parallel d$.

[Strategy: Proving $a \parallel c$.]

Lines a and c are intersected by line b, by construction since line b goes through points A and B, B intersecting line c, and A intersecting line a. The two interior angles of this intersection are α and β, both known to be right angles by definition of a rectangle. By this knowledge it is also known that $\alpha+\beta=180°$. Since these two interior angles add up to a straight angle, we know $a \parallel c$, by the Corollary to Axiom 5/Playfair.

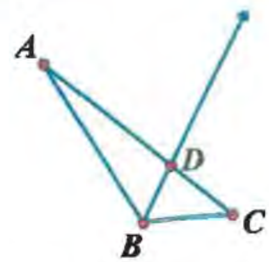
[Strategy: Showing ABCD is a parallelogram.]

We now can deduct that since lines b and d are both parallel to one another and $\overline{AB}$ lies on line b, while $\overline{CD}$ lies on line d, that $\overline{AB} \parallel \overline{CD}$. Since $a \parallel c$, and $\overline{AD}$ lies on a while $\overline{BC}$ lies on line b we can deduce that $\overline{AD} \parallel \overline{BC}$. The definition of a parallelogram is that the two opposite sides of a quadrilateral are parallel to one another on both sets of sides. In rectangle ABCD this means $\overline{AB} \parallel \overline{CD}$ and $\overline{AD} \parallel \overline{BC}$. Which we just proved and we have now determined that a rectangle is a parallelogram, as desired.

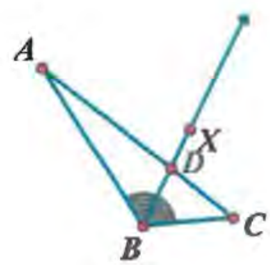
The next set of proofs was on angle bisectors, this was an if and only if proof, but broken into two proofs. I found that it was very helpful to see this proof in two different ways. If and only if proofs are really unique because you always know that if one is true the other is and that makes everything easier trying to prove something that uses this theorem. These proofs are much easier to write knowing that you have to prove it both ways and picking the easier one first. After that the harder ones start to fall into place.

Theorem: Any point on an angle bisector is equal distance from the two sides of an angle.

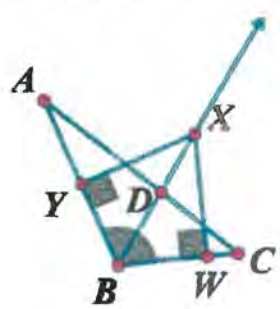
Given: Let there be ΔABC, construct the bisector of $\angle$ABC and label it $\overrightarrow{BD}$, with D as the intersection along $\overline{AC}$. See figure below.



By construction, $\angle$ABD $\cong$ $\angle$CBD. Assume, without loss of generality that there lies a point X on $\overrightarrow{BD}$. See image below.



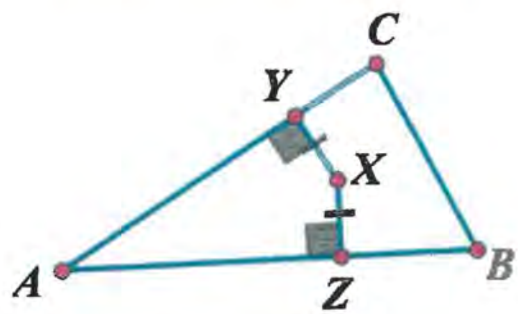
Construct $\overline{XY}$ so that Y is the intersection along $\overrightarrow{AB}$ and $\overline{XY} \perp \overrightarrow{AB}$. Construct $\overline{XW}$ so that W intersects $\overrightarrow{BC}$ and $\overline{XW} \perp \overrightarrow{BC}$, we can do this by Thm 23. Note that the measurements of $\overline{XW}$ is the distance from X to $\overline{BC}$ and the length of $\overline{XY}$ is the distance from X to $\overline{AB}$. See below.



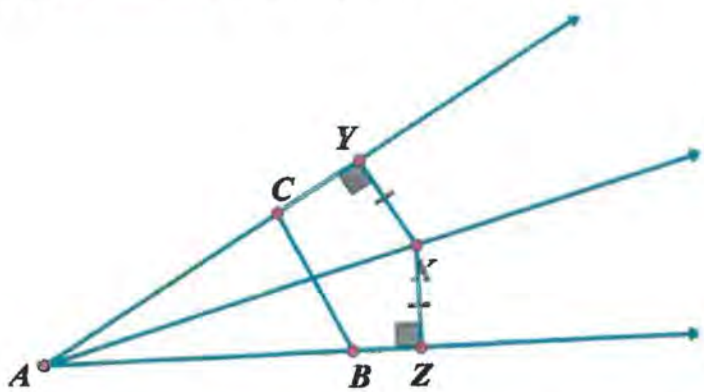
By reflexive property, $\overline{BX} \cong \overline{BX}$. By construction, and Axiom 4, $\angle BWX \cong \angle XYB \cong 90°$. $\Delta WBX \cong \Delta YBX$ by Thm 17. Thus, by CPOCT, $\overline{WX} \cong \overline{YX}$. This means that X is equal distance from side $\overline{AB}$ and $\overline{BC}$, as desired.

Theorem: Any point an equal distance from the two sides of an angle, lies on the angle bisector of that angle.

Given: Let there be ΔABC. Construct an arbitrary point X that is equal distance from $\overline{AB}$ and $\overline{AC}$. That is, the perpendicular segment between X and $\overrightarrow{AB}$ is congruent to the perpendicular segment between X and $\overrightarrow{AC}$. Label these intersections Y and Z, see below.



Note that since X is arbitrary it can also lie past $\overline{BC}$. This is shown in the following figure. By Axiom 1, construct $\overline{AX}$. (By Axiom 2, $\overrightarrow{AB}$ and $\overrightarrow{AC}$ are extended.)

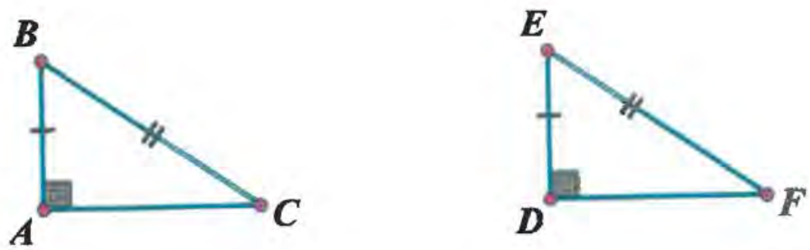


By the reflexive property $\overline{AX} \cong \overline{AX}$; by Thm 18, $\Delta AXC \cong \Delta AXB$ since they are both right triangles with $\overline{AX}$ as their hypotenuse and $\overline{ZX} \cong \overline{YX}$ as given. By CPOCT $\angle BAX \cong \angle CAX$. In other words, $\angle BAC$ is split into two equal parts making $\overrightarrow{AX}$ its angle bisector. And X, of course, lies on $\overrightarrow{AX}$, as desired.

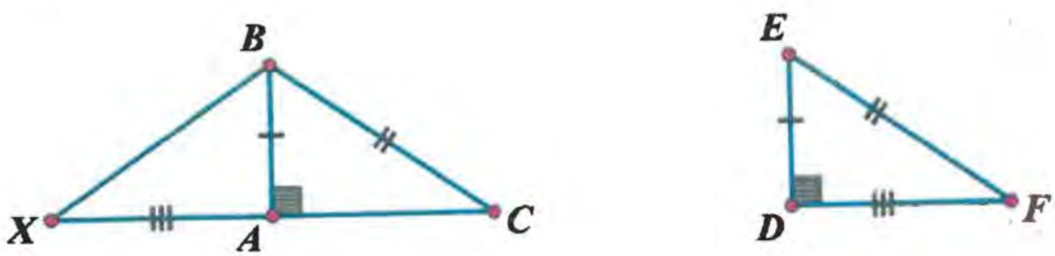
When looking at these two proofs back to back, they were similar in two different ways. One of which was that they both had to do with right triangles, and another was that there was a trick to proving it that wasn't originally in the theorem. The trick was to add an additional triangle with certain specifications. The Hypotenuse-Leg Theorem was a little more difficult to think of adding another triangle, because you already had two. Once I constructed X so that I could prove the equivalencies it all fell into place. It took quite a while to figure this out, but the upside is after I did it once, the thought of doing it in the Converse of Pythagorean Theorem came easier.

Theorem: If ΔABC and ΔDEF have right angles at $\angle A$ and $\angle D$, and $\overline{AB} \cong \overline{DE}$ and $\overline{BC} \cong \overline{EF}$, then $\Delta ABC \cong \Delta DEF$.

Given: $\angle A \cong 90°$ and $\angle D \cong 90$, thus by substitution $\angle A \cong \angle D$. Also $\overline{AB} \cong \overline{DE}$ and $\overline{BC} \cong \overline{EF}$. See image below.



Construct point X on the opposite side of $\overrightarrow{AC}$ so that $\overline{AX} \cong \overline{DF}$. Connect X to B. See image below.



[Strategy: Proving $\Delta ABX \cong \Delta DEF$]

Since $\angle XAB$ and $\angle BAC$ form a straight line, $\angle BAC + \angle BAX = 180°$, by substitution $90° + \angle BAX = 180°$, by CN 3 $\angle BAX = 90°$. By CN 1, $\angle BAX \cong \angle BAC$. By SAS, $\Delta ABX \cong \Delta DEF$.

[Strategy: Proving $\angle X \cong \angle C$]

By CPOCT, $\overline{BX} \cong \overline{EF}$. By substitution, $\overline{BX} \cong \overline{BC}$. By Thm 8, ΔBCX is isosceles; therefore $\angle X \cong \angle C$.

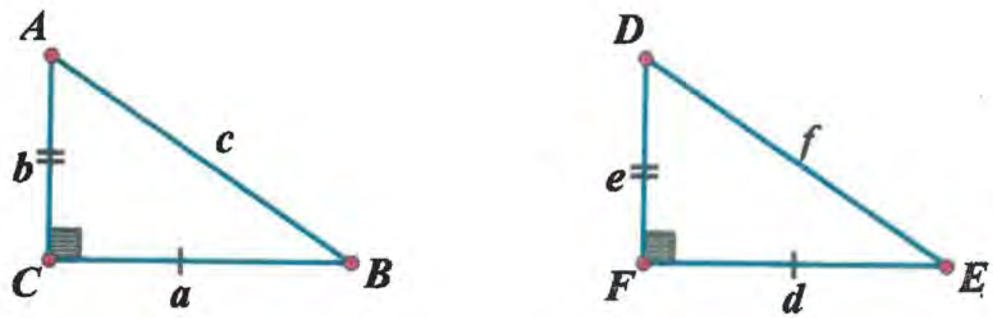
[Strategy: Proving $\Delta ABC \cong \Delta DEF$]

By CPOCT, $\angle X \cong \angle F$. By substitution, $\angle C \cong \angle F$. By AAS ($\angle A \cong \angle D$; $\angle C \cong \angle F$; $\overline{BC} \cong \overline{EF}$), $\Delta ABC \cong \Delta DEF$, as desired.

Theorem: If ΔABC has sides a, b, and c (labeled opposite of the angle), such that $a^2 + b^2 = c^2$, then $\angle C = 90°$.

Given: Let there be ΔABC such that $a^2 + b^2 = c^2$, named opposite their angle.

Construct ΔDEF so that $\angle F = 90°$, label sides lower case of their opposite angle, and $a \cong d$ and $b \cong e$. See below.



[Strategy: Proving $\Delta ABC \cong \Delta DEF$]

By Thm 22, since ΔDEF is a right angle triangle we know $d^2 + e^2 = f^2$. By substitution, $a^2 + b^2 = f^2$. Also by substitution, $c^2 = f^2$. From this we deduce that $c = f$. Therefore, by SSS, $\Delta ABC \cong \Delta DEF$.

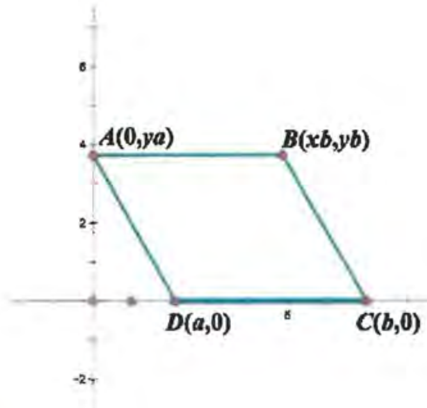
[Strategy: Proving $\angle C = 90°$]

By CPOCT for $\Delta ABC \cong \Delta DEF$, $\angle C \cong \angle F$. Thus, by substitution, $\angle C = 90°$ as desired.

The following set of proofs was very interesting to switch gears into. The advantage of using coordinate based proofs verses Euclidian was that you actually have coordinates on the xy-plane to work with, even if the coordinates are technically arbitrary. These coordinates really helped in that from that point it was usually just algebra. By using algebra and formulas to prove things it felt more definite at the end than a Euclidian proof, even though the Euclidian proof was still definite as well.

Theorem: The diagonals of a rhombus are perpendicular bisectors of one another.

Given: Let rhombus ABCD be positioned in the xy-plane so that A lies on the y-axis, and both C and D lie on the x-axis with arbitrary x-values a and b. See figure below y_a, y_b, and x_b are unknown.



[Strategy: Finding y_a, y_b, and x_b]

By definition of a rhombus, we know $\overline{AB} \parallel \overline{CD}$. Since $\overleftrightarrow{CD}$ has a slope of zero, so does AB which makes $y_a = y_b$.

Using the distance formula for points C and D we find: $d = \sqrt{(b-a)^2 + (0)^2} = \sqrt{(b-a)^2} = (b-a)$

By definition of a rhombus, we know all sides are congruent; therefore, all distances betweenthe two vertices of a side are (b-a).

Applying the distance formula and substitution to A and B we find: $b - a = \sqrt{(0 - x_b)^2 + (y_a - y_b)^2}$

Since $y_b = y_a$, $y_a - y_b = 0$. $b - a = \sqrt{{x_b}^2} = x_b$. Therefore, $B = (b-a, y_a)$.

Applying the distance formula to A and D: $b - a = \sqrt{(0 - x_b)^2 + (0 - y_a)^2}$

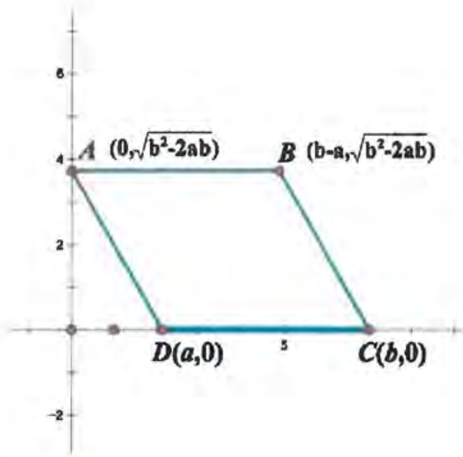
$$(b-a)^2 = a^2 + {y_a}^2$$

$$b^2 - 2ab + a^2 = a^2 + {y_a}^2$$

$$b^2 - 2ab = {y_a}^2$$

$$\sqrt{b^2 - 2ab} = y_a$$

By CN1 $\sqrt{b^2 - 2ab} = y_b$. Therefore, $A = \left(0, \sqrt{b^2 - 2ab}\right)$. See newly marked figure below.



[Strategy: Proving $\overline{AC} \perp \overline{BD}$]

Name the slopes of $\overline{AC}$ and $\overline{BD}$, m_1 and m_2 respectively. By using the equation of a slope we find:

$$m_1 = \frac{\sqrt{b^2 - 2ab} - 0}{0 - b} = \frac{\sqrt{b^2 - 2ab}}{-b}$$

$$m_2 = \frac{\sqrt{b^2 - 2ab} - 0}{(b - a) - a} = \frac{\sqrt{b^2 - 2ab}}{b - 2a}$$

By Thm 5.5, if $m_1 \cdot m_2 = -1$, then $\overline{AC} \perp \overline{BD}$.

$$m_1 \cdot m_2 = \frac{\sqrt{b^2 - 2ab}}{-b} \cdot \frac{\sqrt{b^2 - 2ab}}{b - 2a} = \frac{b^2 - 2ab}{-b(b - a)} = \frac{b(b - 2a)}{-b(b - 2a)} = -1$$

Therefore, by Thm 5.5, $\overline{AC} \perp \overline{BD}$.

[Strategy: Proving the intersection of $\overline{AC}$ and $\overline{BD}$ is the midpoint of $\overline{AC}$.]

Applying point-slope formula with point C and slope m_1 we find the equation for $\overleftrightarrow{AC}$.

$$y = \frac{\sqrt{b^2 - 2ab}}{a}(x - b)$$

Similarly we find the equation for $\overleftrightarrow{BD}$ with slop m_2 and point D.

$$y = \frac{\sqrt{b^2 - 2ab}}{b - 2a}(x - a)$$

We know that they intersection shares the same y-coordinate so using substitution we find the intersection of $\overleftrightarrow{AC}$ and $\overleftrightarrow{BD}$ is $\left(\frac{b}{2}, \frac{\sqrt{b^2-2ab}}{2}\right)$.

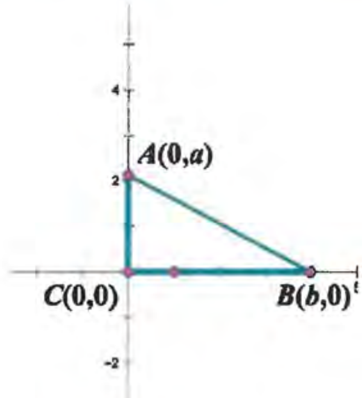
By applying Thm 5.1 we find the midpoint of $\overline{AC}$. Midpoint$_{AC}$=$\left(\frac{0+b}{2}, \frac{\sqrt{b^2-2ab}+0}{2}\right) = \left(\frac{b}{2}, \frac{\sqrt{b^2-2ab}}{2}\right)$ which is the same coordinate as the intersection.

[Strategy: Proving the intersection of $\overline{AC}$ and $\overline{BD}$ is the midpoint of $\overline{BD}$.]

By applying Thm 5.1 to BD we get its midpoint. Midpoint$_{BD}$=$\left(\frac{(b-a)+a}{2}, \frac{\sqrt{b^2-2ab}+0}{2}\right) =$ $\left(\frac{b}{2}, \frac{\sqrt{b^2-2ab}}{2}\right)$ which is the same coordinate as the intersection, as desired.

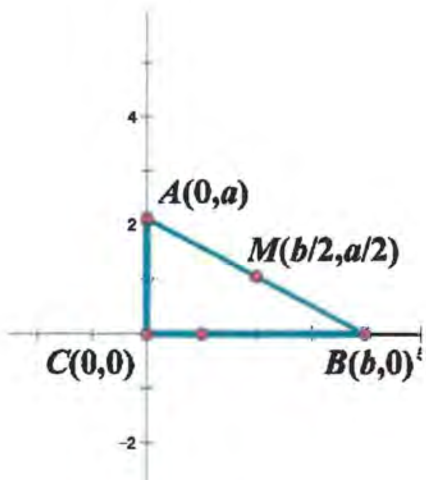
Theorem: The midpoint of the hypotenuse of a right triangle is equidistant from all vertices.

Given: Let ΔABC, with right angle C, be positioned in the xy-plane with C= (0,0). From this we have arbitrary points of A=(0, a) and B=(b, 0). See below.



[Strategy: Finding the midpoint of the hypotenuse.]

The hypotenuse in ΔABC is $\overline{AB}$. Naming the midpoint M and applying Thm 5.1, we get $M = \left(\frac{0+b}{2}, \frac{a+0}{2}\right) = \left(\frac{b}{2}, \frac{a}{2}\right)$. Plot this point as below.



[Strategy: Proving M is equidistant from A, B, and C.]

Name the distance from: A to M= d_1, B to M = d_2, and C to M=d_3. Using the distance formula:

$$d_1 = \sqrt{\left(0-\frac{b}{2}\right)^2 + \left(a-\frac{a}{2}\right)^2} = \sqrt{\left(\frac{-b}{2}\right)^2 + \left(\frac{a}{2}\right)^2} = \sqrt{\frac{b^2}{4}+\frac{a^2}{4}} = \sqrt{\frac{b^2+a^2}{4}} = \frac{1}{2}\sqrt{a^2+b^2}$$

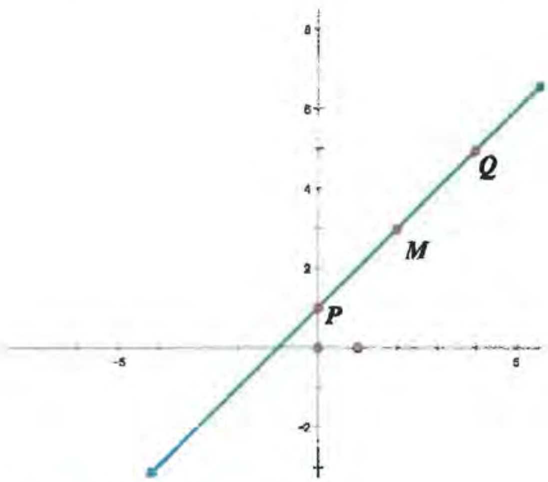
$$d_2 = \sqrt{\left(b-\frac{b}{2}\right)^2 + \left(0-\frac{a}{2}\right)^2} = \sqrt{\left(\frac{b}{2}\right)^2 + \left(\frac{-a}{2}\right)^2} = \sqrt{\frac{b^2}{4}+\frac{a^2}{4}} = \sqrt{\frac{b^2+a^2}{4}} = \frac{1}{2}\sqrt{a^2+b^2}$$

$$d_3 = \sqrt{\left(0-\frac{b}{2}\right)^2 + \left(0-\frac{a}{2}\right)^2} = \sqrt{\left(\frac{-b}{2}\right)^2 + \left(\frac{-a}{2}\right)^2} = \sqrt{\frac{b^2}{4}+\frac{a^2}{4}} = \sqrt{\frac{b^2+a^2}{4}} = \frac{1}{2}\sqrt{a^2+b^2}$$

By CNI, $d_1 = d_2 = d_3$, as desired.

Theorem: The midpoint of the segment between points $P(x_p, y_p)$ and $Q(x_q, y_q)$ is the point $M\left(\frac{Xp+Xq}{2}, \frac{Yp+Yq}{2}\right)$.

Given: Line $\overleftrightarrow{PQ}$ contains points $P(x_p, y_p)$ and $Q(x_q, y_q)$. We show that point $M\left(\frac{Xp+Xq}{2}, \frac{Yp+Yq}{2}\right)$ is the midpoint. In order to satisfy this definition M must both lie on $\overleftrightarrow{PQ}$ and be equal distance from P and Q.



[Strategy: Proving M is equal distance from P and Q]

Construct $\overleftrightarrow{PQ}$ on the xy-plane. Draw M.

We want to show the distance from P to M equals the distance from M to Q. By applying the distance formula $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 - 2|x_2 - x_1||y_2 - y_1| \cos 90°}$. The 90° is set in place since we are in the xy-plane. Since $\cos 90° = 0$, we are left with: $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$. Applying $(x_1, y_1) = (x_p, y_p)$ and $(x_2, y_2) = \left(\frac{Xp+Xq}{2}, \frac{Yp+Yq}{2}\right)$. We can find the distance between P and M. Let us label that distance z.

$$z = \sqrt{\left(\frac{Xp + Xq}{2} - x_p\right)^2 + \left(\frac{Yp + Yq}{2} - y_p\right)^2}$$

$$z = \sqrt{\left(\frac{Xp + Xq - 2Xp}{2}\right)^2 + \left(\frac{Yp + Yq - 2Yp}{2}\right)^2}$$

$$z = \sqrt{\left(\frac{Xq - Xp}{2}\right)^2 + \left(\frac{Yq - Yp}{2}\right)^2}$$

$$z = \sqrt{\frac{Xq^2 - 2XqXp + Xp^2 + Yq^2 - 2YpYq + Yp^2}{4}}$$

Applying $(x_1, y_1) = (x_q, y_q)$ and $(x_2, y_2) = \left(\frac{Xp+Xq}{2}, \frac{Yp+Yq}{2}\right)$we get the distance between M and Q, Let us name this distance W.

$$W = \sqrt{\left(\frac{Xp+Xq}{2} - x_q\right)^2 + \left(\frac{Yp+Yq}{2} - y_q\right)^2}$$

$$W = \sqrt{\left(\frac{Xp+Xq-2Xq}{2}\right)^2 + \left(\frac{Yp+Yq-2Yq}{2}\right)^2}$$

$$W = \sqrt{\left(\frac{Xp-Xq}{2}\right)^2 + \left(\frac{Yp-Yq}{2}\right)^2}$$

$$W = \sqrt{\frac{Xp^2 - 2XqXp + Xq^2 + Yp^2 - 2YpYq + Yq^2}{4}}$$

The result of W is equivalent to the result of Z, thus W=Z, by substitution. In other words the distances from P to M and from M to Q are equivalent.

[Strategy: Proving M lies on $\overleftrightarrow{PQ}$.]

Line $\overleftrightarrow{PQ}$ has the equation using point-slope form of $y - y_1 = m(x - x_1)$. By definition of slope we get the equation $m = \frac{y_2-y_1}{x_2-x_1}$. Using $(x_1, y_1) = (x_q, y_q)$ and $(x_2, y_2) = (x_p, y_p)$ we get $m = \frac{y_p-y_q}{x_p-x_q}$. Choosing point P we get the equation $y - y_p = \frac{y_p-y_q}{x_p-x_q}(x - x_p)$. In order to prove M lies on $\overleftrightarrow{PQ}$ we must show that it satisfies the equation:

$$\frac{y_p+y_q}{2} - y_p = \frac{y_p-y_q}{x_p-x_q}\left(\frac{x_p+x_q}{2} - x_p\right)$$

$$\frac{y_q-y_p}{2} = \left(\frac{y_p-y_q}{x_p-x_q}\right)\left(\frac{x_q-x_p}{2}\right)$$

$$(x_p - x_q)(y_q - y_p) = (y_p - y_q)(x_q - x_p)$$

$$x_py_q - x_py_p - x_qy_q + x_qy_p = y_py_q - y_px_p - y_qx_q + y_qx_p$$

$$0 = 0$$

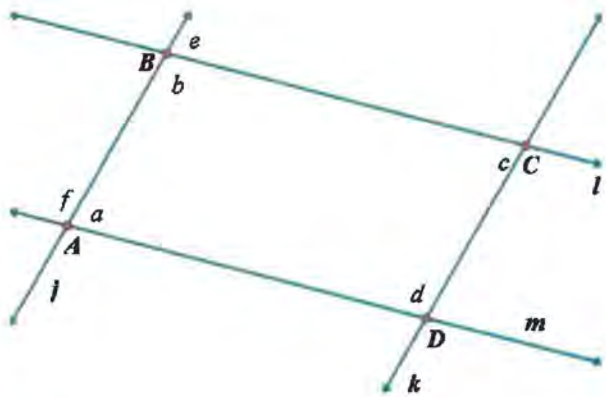
Everything cancels out with each other so M satisfies the equation for $\overleftrightarrow{PQ}$, as desired.

If quadrilaterals are parallelograms, that creates a whole new set of rules. These different proofs were all subsections of a theorem and it was actually more helpful to disregard the original order of these. I, personally skipped b and came back to it because proving that the opposite sides were congruent before proving that the diagonals bisected each other because I wanted to use the theorem for b in my proof. This saved a lot of time when proving part c.

Theorem: If a quadrilateral is a parallelogram, then the opposite angles are congruent.

Given: Quadrilateral ABCD is a parallelogram, by definition we know $\overline{AB} \parallel \overline{CD}$ and $\overline{AD} \parallel \overline{BC}$.

Using Axiom 2, extend all segments and label them j, k, l, and m as seen below. Also name all angles as labeled.



[Strategy: Proving $a = c$.]

Using j as a transversal of $l \parallel m$, $a = e$, by Thm 10c. By Thm 10b, transversal l of $k \parallel j$, $e = c$. By CN1, $a = c$.

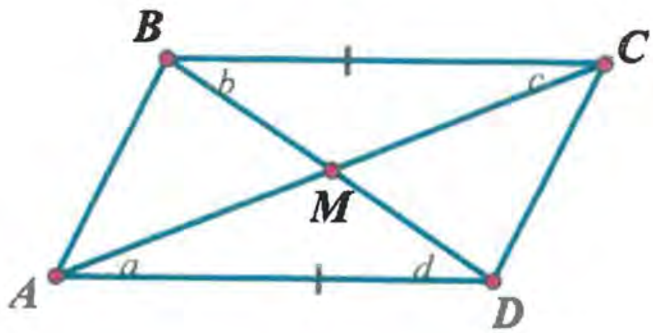
[Strategy: Proving $b = d$.]

By Thm 10b, using transversal j of $l \parallel m$, $b = f$. Using transversal m of $\parallel j$, $f = d$, by Thm 10c. By CN 1, $b = d$, as desired.

Theorem: If a quadrilateral is a parallelogram, then the diagonals bisect each other.

Given: Let quadrilateral ABCD be a parallelogram, by definition we know $\overline{AB} \parallel \overline{CD}$, and $\overline{BC} \parallel \overline{AD}$. By Thm 26c we know $\overline{BC} \cong \overline{AD}$.

Construct diagonals $\overline{AC}$ and $\overline{BD}$, label their intersection M and all angles are named as below.

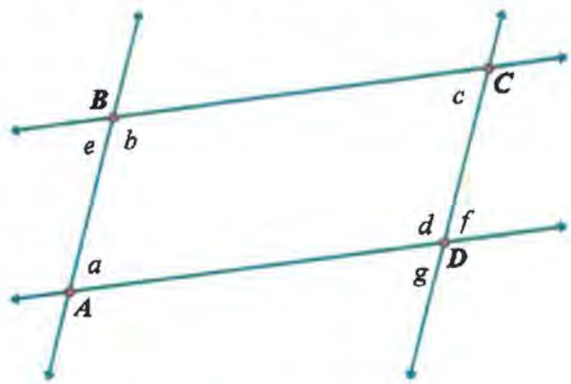


We want to show that $\overline{AM} \cong \overline{MC}$ and $\overline{BM} \cong \overline{MD}$ to prove M is the bisection of both diagonals. Using $\overline{BD}$ as transversal of $\overline{BC} \parallel \overline{AD}$, by Thm 10b, b=d. B Thm 10b, using transversal $\overline{AC}$ and $\overline{BC} \parallel \overline{AD}$, c=a. By SAS, $\Delta BCM \cong \Delta DAM$. By CPOCT, $\overline{CM} \cong \overline{AM}$, likewise, $\overline{BM} \cong \overline{DM}$, as desired.

Theorem: If a quadrilateral is a parallelogram, then the opposite sides are congruent.

Given: Quadrilateral ABCD is a parallelogram, by definition we know $\overline{AB} \parallel \overline{CD}$ and $\overline{AD} \parallel \overline{BC}$.

Using Axiom 2, extend all segments. Name angles as labeled below.

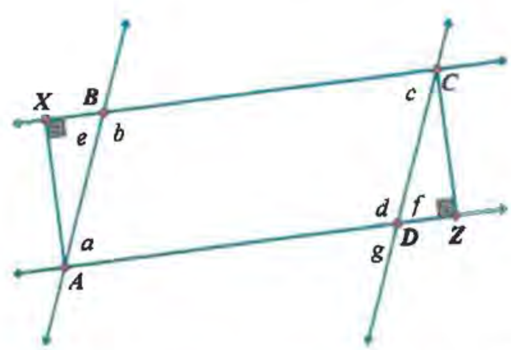


[Strategy: Proving opposite sides are congruent if ABCD is a rectangle.]

By the Corollary 15 we know opposite sides of a rectangle are congruent.

[Strategy: Proving $\overline{AB} \cong \overline{CD}$, assuming ABCD is not a rectangle]

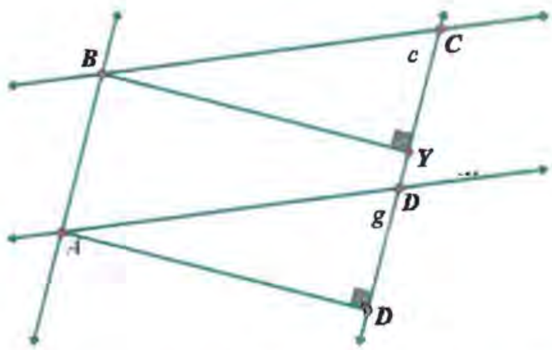
Construct $\overline{AX}$ such that $\overline{AX} \perp \overleftrightarrow{BC}$ and X lies on $\overleftrightarrow{BC}$. Likewise, construct Z on $\overleftrightarrow{AD}$ so that $\overline{CZ} \perp \overleftrightarrow{AD}$. See image below.



By Thm 14, $\overline{AX} \cong \overline{CZ}$. By definition of perpendicular, $\angle CZD \cong \angle AXB \cong 90°$. By Thm 10b, using transversal $\overleftrightarrow{AB}$ and $\overleftrightarrow{BC} \parallel \overleftrightarrow{AD}$, e = a. By Thm 10 c, using transversal $\overleftrightarrow{AD}$ of $\overleftrightarrow{AB} \parallel \overleftrightarrow{CD}$, a=f. By CN1 e=f. By Thm 17 $\Delta CZD \cong \Delta AXB$. By CPOCT, $\overline{AB} \cong \overline{CD}$.

[Strategy: Proving $\overline{BC} \cong \overline{AD}$, assuming ABCD is not a rectangle]

Construct $\overline{BY}$ such that $\overline{BY} \perp \overleftrightarrow{CD}$ and Y lies on $\overleftrightarrow{CD}$. Similarly, construct T on $\overleftrightarrow{CD}$ so that $\overline{AT} \perp \overleftrightarrow{CD}$. See image below.



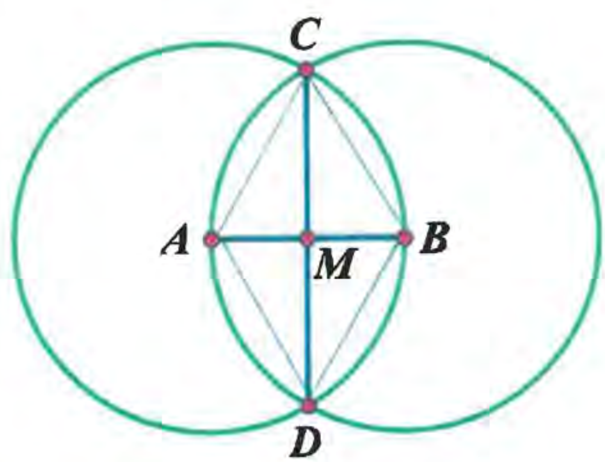
By Thm 14, $\overline{AT} \cong \overline{BY}$. Using $\overleftrightarrow{CD}$ as transversal of $\overleftrightarrow{BC} \parallel \overleftrightarrow{AD}$, c=g, by Thm 10c. By definition of perpendicular, $\angle ATD \cong \angle BYX \cong 90°$. By Thm 17 $\Delta ATD \cong \Delta BYC$. By CPOCT $\overline{BC} \cong \overline{AD}$, as desired.

The best part about proving the construction of a midpoint with a compass and a straight edge was that we had already done it in the very beginning, knowing it was possible and how to do it was very helpful since we were able to know what was to come from it. Writing this proof would have been much more difficult had we not already constructed it and messed around with it in lab.

Theorem: If you have a line segment $\overline{AB}$, the midpoint M can be constructed with only a straight edge and a compass.

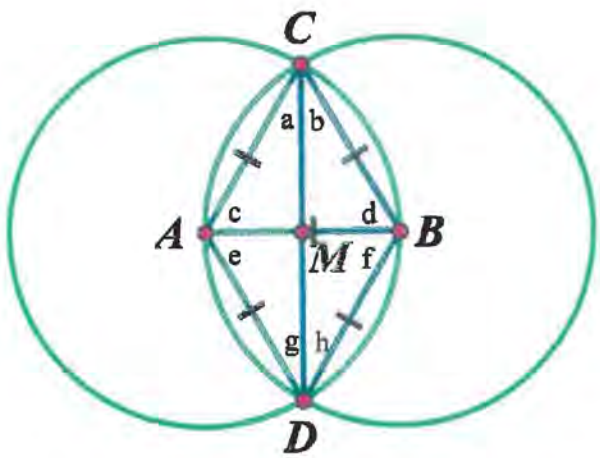
Given: Let points A and B construct line segment $\overline{AB}$.

Using Axiom 3 construct $\odot A$ with radius $\overline{AB}$. Construct $\odot$B with radius $\overline{AB}$ through Axiom 3. These two circles intersect at two points, let us name the intersections C and D. Connect points C and D to form line segment $\overline{CD}$, which intersects $\overline{AB}$ at point M. Next construct segments: $\overline{AC}, \overline{BC}, \overline{AD}$, and $\overline{BD}$. See visual representation below.



[Strategy: Proving ΔABC and ΔABD are isosceles.]

Note that since $\odot A$ and $\odot B$ share radius $\overline{AB}$ they are similar circles. By definition of semi-circles and radii: $\overline{AB} \cong \overline{BC} \cong \overline{AD} \cong \overline{BD} \cong \overline{AB}$ as they are all radii of either $\odot A$ and $\odot B$. This congruency is displayed in the following figure along with the labels of angles formed by line segments.



Due to ΔABC having congruent sides it is an iscoceles triangle. By Thm 5 the base angles c and d of ΔABC are congruent. Likewise, ΔABD has two congruent sides forming an isosceles triangle with base angles e and f. Thm 5, $e \cong f$.

[Strategy: Proving $\Delta ADC \cong \Delta BDC$]

By CN2, $c + e \cong d + f$. Following this $\Delta ADC \cong \Delta BDC$ by SAS. {S₁: $\overline{AD} \cong \overline{BD}$, A: $a \cong b$, S₂: $\overline{AC} \cong \overline{BC}$. }

[Strategy: Proving $\Delta ACM \cong \Delta BCM$]

Since $\Delta ADC \cong \Delta BDC$ we can deduce that $a \cong b$, by CPOCT. By CN 4, we are aware that $\overline{CM} \cong \overline{CM}$. Thus $\Delta ACM \cong \Delta BCM$ by SAS. {S_1: $\overline{AC} \cong \overline{BC}$, A: $a \cong b$, S_2: $\overline{CM} \cong \overline{CM}$.}

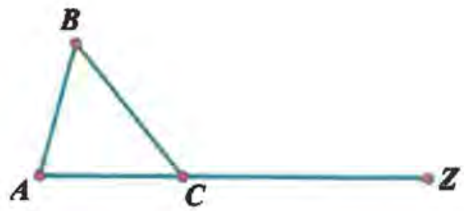
[Strategy: Proving M is the midpoint of $\overline{AB}$]

By CPOCT for $\Delta ACM \cong \Delta BCM$, we deduce that $\overline{AM} \cong \overline{BM}$. By definition of midpoint, the M must split $\overline{AB}$ into two equal line segments. As previously discovered M dissects $\overline{AB}$ into congruent segments $\overline{AM}$and $\overline{BM}$. Thus, we can conclude that we did in fact construct a midpoint of segment $\overline{AB}$, as desired.

These two proofs are about exterior angles, exterior angles are a weird concept to grasp because it's so blatantly clear that the exterior angle will be larger. The hint our book gave us assisted me greatly. When proving that the exterior angle is equivalent to the two interior angles, it was very helpful because we already knew it was bigger; but to place a value on that was very simplistic and yet made everything come together in the end. Thinking about it later on, had we done the proof which proved the equivalence of the exterior angle and skipped that the exterior angle was larger, I think that it would have been a waste. I think this because the exterior angle theorem really helped in later proofs just in the concept of altering the original figure and adding to it.

Theorem: An exterior angle of a triangle will have a greater measure than either of the non-adjacent interior angles

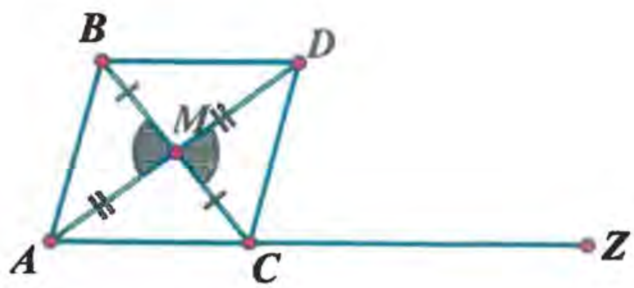
Given: Let there exist a triangle, let us name ABC. One of its segments we extend to a point, namely Z.



From the illustration above we see the exterior angle is $\angle BCZ$. We show both $\angle ABC$ and $\angle CAB$ are smaller than the exterior angle.

[Strategy: Proving $\angle ABC < \angle BCZ$]

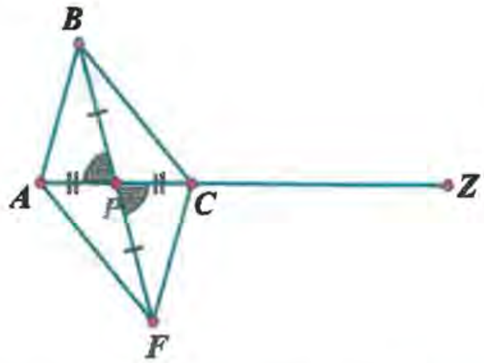
To begin this proof, using Thm 6, construct a midpoint M on $\overline{BC}$. Create line segment $\overline{AD}$ such that M is also the midpoint of $\overline{AD}$. Form line segments $\overline{BD}$ and $\overline{CD}$. Observe in the figure below that we have constructed four triangles.



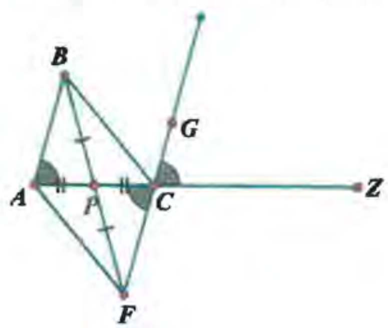
Above, the following congruencies are marked $\overline{BM} \cong \overline{CM}$, by definition of a midpoint; $\overline{AM} \cong \overline{DM}$, by construction; $\angle AMB \cong \angle CMD$ by the Vertical Angle Theorem. Thus, by SAS, $\Delta AMB \cong \Delta DMC$. By CPOCT, $\angle ABC \cong \angle BCD$. Since $\angle BCD$ is part of $\angle BCZ$, we know, by CN 5, that $\angle BCD < \angle BCZ$. Thus, by CN 1, $\angle ABC < \angle BCZ$.

[Strategy: Proving $\angle BAC < \angle BCZ$]

Reverting back to our original triangle we are going to use Thm 6 to construct a midpoint P on $\overline{AC}$. Similar to the previous strategy we will construct $\overline{BF}$ so that P is also the midpoint. See below.



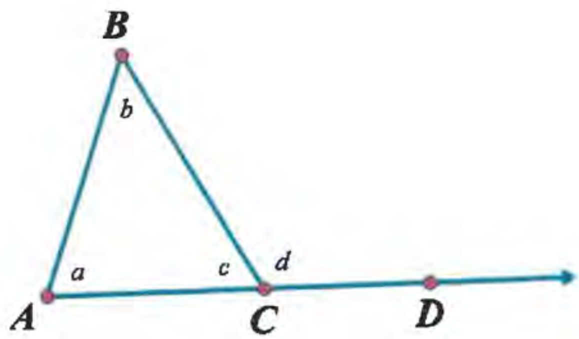
Again, above congruencies are marked as follows $\overline{AP} \cong \overline{CP}$, by definition of a midpoint; $\overline{BP} \cong \overline{FP}$, by construction; by the Vertical Angle Theorem $\angle APB \cong \angle FPC$. $\Delta APB \cong \Delta CPF$ by SAS. By CPOCT we know $\angle BAP \cong \angle FCP$. Next, let us extend $\overline{CF}$ pas C to a point, namely G.



$\angle PCF \cong \angle GCZ$, by the Vertical Angle Theorem. Additionally, since $\angle GCZ$ is a part of $\angle BCZ$, by CN 5, we can deduce that $\angle GCZ < \angle BCZ$. Applying CN 1 $\angle BAC < \angle BCZ$. Which finalizes our proof that the interior angles non-adjacent to the exterior angle are smaller than the exterior angle, as desired.

Theorem: An exterior angle of a triangle will have a measure equal to the sum of non-adjacent interior angles.

Given: Let there be ΔABC, extend $\overrightarrow{AC}$, by Axiom 2, to a point D and name angles as labeled below.

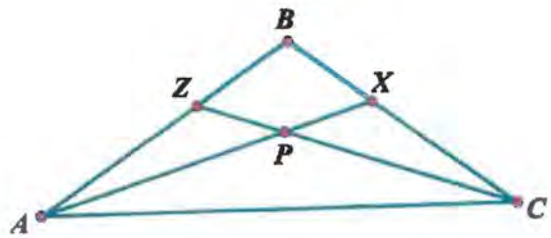


By supplementary angles **c+d=180°.** By Thm 12, **a+b+c=180°.** By substitution, **a+b+c =c+d. By CN 3, a+b=d, as desired.**

This final set of proofs was on Cevians. These were by far my favorite to prove. It was really unique to work with different cases where just because one was didn't necessarily mean the whole proof was true. By this I mean proving the left and then the right was false verses saying just because it isn't on the left means it isn't anywhere except coinciding with Y'. On top of this, the medians were really nice to work with because it clarified the Cevian Theorem for me. Honestly, I feel doing the proof of the medians actually explained what the Cevian Theorem's formula meant more than the original theorem.

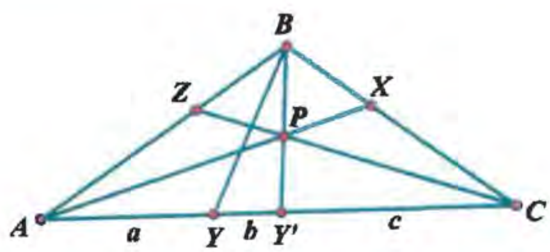
Theorem: In ΔABC, with Cevians AX, BY, and CZ, if $\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY}{YA}=1$, then the Cevians are concurrent.

Given: Let there be a triangle ABC so that $\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY}{YA}=1$. Construct the cevians AX and CZ. See below.



Suppose, FSOC, that the Cevian $\overline{BY}$ does not go through P. Construct $\overline{BY'}$ so that it goes through point P. Let there be, two cases: Case 1, the order on $\overline{AC}$, is A,Y,Y',C; Case 2, the order on $\overline{AC}$ is A, Y', Y, C.

Case 1: Construct Cevian $\overline{BY}$ sp that Y lies to the left of Y'. Label measurements as below.



By Ceva's Thm, $\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY'}{Y'A}=1$, it was given that $\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY}{YA}=1$. By substitution $\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY'}{Y'A}=\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY}{YA}$. Through algebra this simplifies: $\frac{CY'}{Y'A}=\frac{CY}{YA}$. By substitution in the measurements from our figure: $\frac{c}{a+b}=\frac{b+c}{a}$. Through algebra:

$ca=(a+b)(b+c)$

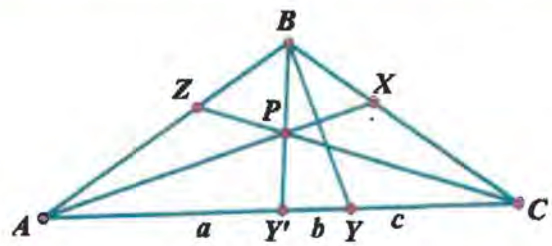
$ca=ab+ac+b^2+bc$ By algebra

$0=ab+b^2+bc$ By CN3

$0=b(b+a+c)$ By Algebra

b+a+c = $\overline{AC}$, which cannot be zero. Therefore, b must be zero in order to satisfy the equation. If b=0 then there is no distance between Y and Y'. In other words, they coincide so Y cannot lie to the left of Y'.

Case 2: Construct Cevian $\overline{BY}$ so that Y lies to the right of Y'. Label measurements as below.



Similarly to case one we reach this point:

$\frac{AZ}{ZB} \cdot \frac{BX}{XC} \cdot \frac{CY'}{Y'A} = \frac{AZ}{ZB} \cdot \frac{BX}{XC} \cdot \frac{CY}{YA}$

$\frac{CY'}{Y'A} = \frac{CY}{YA}$ By algebra

$\frac{c}{a+b} = \frac{b+c}{a}$ By substitution

$ca = (a+b)(b+c)$ By algebra

$ca = ab + ac + b^2 + bc$ By algebra

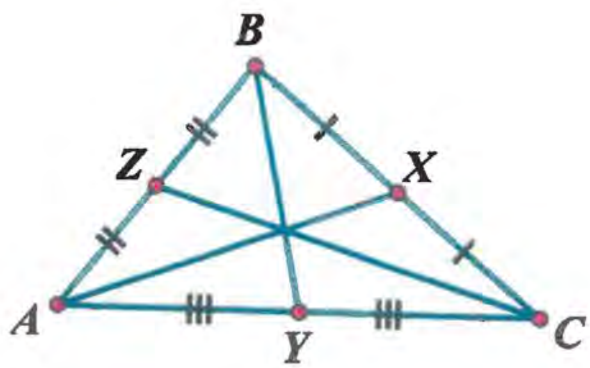
$0 = ab + b^2 + bc$ By CN3

$0 = b(b + a + c)$ By Algebra

Through similar logic of Case 1: we deduce that Y and Y' coincide because b=0; therefore, Y cannot lie to the right of Y' either. The only location left for Y is at Y' In other words, Y'=Y so $\overline{BY}$ goes through P, as desired.

Thereom: IfΔABC has medians $\overline{AX}, \overline{CZ},$ and $\overline{BY}$, then these medians are concurrent.

Given: ΔABC with medians $\overline{AX}, \overline{CZ},$ and $\overline{BY}$. See figure below: marked congruencies are by construction and defintions of median.



$\overline{BZ} \cong \overline{AZ}$, thus $\frac{BZ}{AZ} = 1$; $\frac{AY}{YC} = 1$ since $\overline{AY} \cong \overline{CY}$; $\overline{BX} \cong \overline{XC}$ so $\frac{BX}{XC} = 1$. By substitution we get: $\frac{BZ}{AZ} \cdot \frac{AY}{YC} \cdot \frac{BX}{XC} = 1 \cdot 1 \cdot 1$. By Thm 36, since $\frac{BZ}{AZ} \cdot \frac{AY}{YC} \cdot \frac{BX}{XC} = 1$, $\overline{BX}, \overline{XA}$, and $\overline{CZ}$ are concurent, as desired the medians of ΔABC are concurrent.

A Final Reflection:

I'm very thankful that I took this geometry class as an elective because I've been able to work on thinking more abstractly throughout this course. Working in labs was very entertaining and helped to make the proofs of the chapter come to me easier sometimes because I observed it through an activity. Compared to the typical geometric proofs that I did in high school geometry, these proofs actually make me feel as though I accomplished something. I always enjoyed geometry in high school as well as trigonometry, but I had never noticed how beautiful it actually is. Stepping back and proving things that are already known makes everything a bit more definite and I appreciate it. After taking this class I feel that I've developed my proof writing strategy as well as the strategies I use when I become stuck on certain topics.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**MATH 401 Project Paper**
This documentation is relevant to Question number:	**16**
Briefly summarize the content of the file and its value as evidence supporting program review:	**This shows two examples of papers for group projects in MATH 401. The students must collect, analyze and communicate information.**

3D Lotka-Volterra Models

The reason that this group chose this project was our fascination with penguins. We knew we wanted to do some type of food chain project using the Lotka-Volterra model we used in class. Therefore, we looked up different food chains dealing with penguins and decided to look more carefully at the Antarctic food chain. Going into this project, we knew that we had to do something a little bit more difficult than the models in class. Since the models in class used two animals, or two species, we decided to look at different models with three different species. While doing this project, our group noticed that we could use some of the information that we learned during the SIR models and incorporate into these models as well. As we got a little farther into the semester we noticed that there were other types of food chain systems that interested us as well. For example, there are two types of other models: the diamond food chain and the circle food chain. However, these models got a little bit more complicated since they used 4 species instead of three.

To start, the easiest model is the two dimension that we learned in class. Just as an intro to the rest of the paper this model uses two different equations, one for the predator and one for the prey.

$$x' = Ax - Bxy$$

$$y' = -Cy + Dxy$$

In these two equations the x is used as the prey and the y is the predator. We know this based on the fact that when y is non existent the x is positive, which means that the prey can survive when there are no predators. That is why the growth rate for the y equation is negative, because as more predators are being born, the lower amounts of them there will be because more will be killing the prey. The term in the equation with the x and the y is when both species are in the food chain. You could consider this the interaction variable between the two species and since the predator will win that battle that is why it has a positive interaction term and the prey has a negative interaction term. This was the easy model. The next models only get more difficult and more involved.

The model that we first built off of the one learned in class was a 3D model using sort of a straight line chain. Where

$$X \longrightarrow Y \longrightarrow Z$$

In this model we used a similar approach to the 2D model and also the SIR models that we learned in class. The way we first thought of these equations was setting up terms in sort of two 2D models since the "B" becomes a prey after it is a predator. In this specific food chain, A represents the squid, B represents the penguins and C represents the leopard seal. The equations that we came up with for this 3D model are as followed

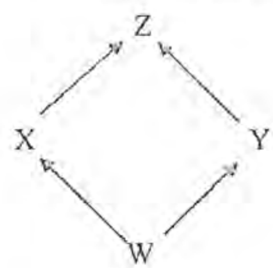
$$x' = Ax - Bxy$$

$$y' = -Cy + Dxy - Eyz$$

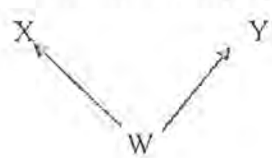
$$z' = -Fz + Gyz$$

In these equations A through G are all positive rates. These equations work the same way that the 2D models works, with x being the squid and being the prey to the penguins (y) and then the leopard seal (z) becomes the predator to the penguins. When coming up with these equations breaking them down was a little easier. We made two 2D models with the squid and the penguins. After that we made another model with the penguins and the leopard seal and just put them together since the squid and the seal don't truly have any type of interaction. When we were trying to graph these equations we couldn't really use sage since we could not get the 3D to really work, so we had to use Mathematica. In some of the comments made, you suggested to try and incorporate a x^2 function into the equations and we just weren't sure how to really do that. If we had more time to really look at these equations and more time to understand how the x^2 function changed the equations we could have incorporated it into the project, but this model was the easiest of the models that we looked into. The next one has multiple parts and can be broken down in a couple different ways.

We call this next model the diamond formation model. This model is slightly more complicated than the above model because the squid now has two different predators and the leopard seal now has two prey. This model looks like the following



In this model W is the squid, the X is the penguins and now Y is the crabeater seal and Z is the leopard seal. When we first came up with this model we had a couple questions on how the final equations were going to look. For example, is there any competition between the penguins and the crabeater seal. We decided that there wasn't and the reason that we decided this was that when we broke the food chain down in to two different models it made a little bit more sense. We started with the bottom half of this model with one prey and two different predators.



This model deals with the same three species as above. But deals with the competition question since there are two different predators. But we broke it all the way down to the 2D models and came up with the following equations,

$$x' = Ax - Bxy - Cxz$$

$$y' = -Dy + Exy$$

$$z' = -Fz + Gxz$$

In these equations the x is the squid with the other two equations being interchangeable as the two predator equations. We decided that there wasn't much predator competition here, but if the food chain got big enough then there would be more competition. For example, let's say that there was one more predator. If we were to look at more numbers from the last couple years of different food chains we may consider putting in some competition term, which would go into the y and z equations in this model where it would be a negative term in both of these equations, but a smaller rate than the other rates involved. On the flip side there is the top half of the diamond formation where there is two prey and one predator. This is the easier half of the model since there is no competition factor. These equations look like,

$$x' = Ax - Bxz$$

$$y' = Cy - Dyz$$

$$z' = -Ez + Fxz + Gyz$$

In these equations the x and y are the prey with z being the top predator. When coming up with the diamond model we started very simple and built up from there. After coming up with these two different models we put them together to come up with the equations for the diamond formation

$$w' = Aw - Bwx - \mathrm{Cwy}$$

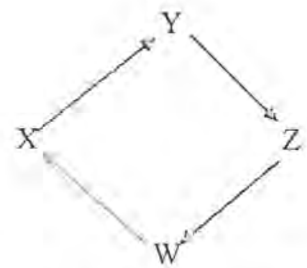
$$x' = -Dx + Ewx - \mathrm{Fxz}$$

$$y' = -Gy + Hwy - Jyz$$

$$z' = -Kz + Lxz + Myz$$

These equations represent that first diamond formation with w being the squid x and y are the penguins and the crabeater seals and z is the leopard seals. When going to graph these equations we broke it down into the two simpler equations first. We then were able to graph the 4D model on Mathematica. Working with these equations using different coefficients, we found that this model is very chaotic because it changes significantly.

The last model we looked at was a circle food chain. This model does not exist inside of the Antarctic food chain, but it does exist in other food chains. For an example when there are decomposers involved, or in some cases people consider this food chain when mosquitos are involved. This food chain looks like,



This model is more difficult from the last two because it really never stops. The other hard part is we know that W starts off this model but when it comes to Z eats W does the model continue or does it stop? The way we approached it is we tried to imagine that the model was the first 3D model constantly, so at each letter we started the model so each equation looks similar because of that. The equations look like,

$$w' = Aw(1-\frac{w}{k_1}) - Bwx + Cwz$$

$$x' = Dx(1-\frac{x}{k_2}) + Ewx - Fxy$$

$$y' = Gy(1-\frac{y}{k_3}) + Hxy - Jyz$$

$$z' = Kz(1-\frac{z}{k_4}) + Lyz - Mwz$$

In these equations the first part of each equation deals with the growth rate of the species if just that animal lived by itself in the habitat. Think about the negative rate for the predators and the positive for the prey put together, that's what this first term is in each of these equations. The other parts of these equations deal with the interaction parts of both when that animal is the predator and when that animal is the prey. When graphing this model we found that it really just stayed level because that it keeps going in a circle so most of the time it stays in the original spots.

One other thing that we looked was environmental factors, in this case it would be the temperature changing, which could go two different ways. The first way would be if the temperature rose so that the ice was melting. The way we think that these systems would be affected would be that the squid population would go down, because of the less space on the land for the penguins to stay, they would be in the water more, which then they would be hunting more squid, which would lead to a bigger decrease in squid, but same with the penguins, the penguin population would go down because they would be in the water more often with the leopard seals whose population would go up at the end of all of it. Now if the temperature went the other way and decreased so it got colder, we would see the opposite, where the squid population would most likely increase because now there is more land for the penguins and the seals to be on so they aren't in the water as much. Now these increases and decreases are very small, just because the temperature goes up or down is not going to determine the feeding rate of these animals. They are going to be feeding at the same rate, so the rates should not change much just because they are in the water more. It just gives them a higher chance to feed on the squid because they are in the water more often. We didn't add anything to these equations but if we did it would be a mixture of rates for the squid and the penguins where the seals increase would be higher depending on the temperature increase.

Overall in this project we learned a lot about these models and how they work. During the first couple of weeks we were all confused on how to even come up with some of the optimizations models. The fact that we came up with some of the models by ourselves was very rewarding. Also, learning about these penguins was nice for us because that was one of the reasons we chose this food chain in the first place. This project challenged our thinking, but it was a good way to end the semester because we all enjoyed this class.

APRIL 27, 2018

PORTFOLIO SELECTION

By:

Creating a stock portfolio is never an easy task; starting the stock portfolio is the hardest step to take especially as a beginning investor. No one just looks at a stock and has a realization that they should invest in that stock; all smart investors make calculations. It takes months, sometimes even years for people to learn how to manage a portfolio and select the correct investments. This is where our project came into play. Over our time here at LSSU, we have learned some concepts of the stock market. This includes how investing works, what risk comes with investing, and how to diversify a portfolio in order to reduce that risk. Knowing the concepts behind investing we were able to determine that by implementing a linear program we could simplify how one should choose their starting stocks for a portfolio. Originally, our intent was to created a model that reduced risk and maximized return, this is still the case, but it is for beginning investors that do not know where to start. This linear program takes into consideration diversification, cost of stocks, the risk within stocks, and the return we hope to achieve.

There are multiple constraints on our model, and they differ depending on the preferred outcome. There are two different options one can look into. First, a model that returns the different stocks that they should add to their portfolio. This model informs them to purchase only one of each suggested stock. This model leads to the investor having the capability to buy more of each stock. For that model it is necessary to use binary. The second model, one prefered by some beginning investors, is a model that tells you both the stock to purchase, and how much stock from that company should be purchased. This needed many extra constraints because with the linear program, it would instantly invest as much as it could into the stock that had the highest return. The next constraint that was needed for this is the one that limits how many stocks can be purchased from each company. For example, if you want to buy a maximum of five stocks from a certain company you would set that as your individual constraint. As a beginning investor, a model such as this would be ideal to show one where to start. There are many different informative sites out there on how to invest in stock, but it is still hard to decide the specific stocks to invest in. For that reason, we chose to look into this project.

To tackle this project we used a linear programming model. For our project, there were eighty-three different stocks that were implemented under variables and then chosen from. Each of these values have meaning, and the output in our situation is the number of stocks one should purchase from that specific company's stock. This only applies in the nonbinary version, otherwise, it is just the stocks to invest in, not the amount.

The objective function of our model was to maximize the return, but this model also had to have different constraints depending on the variable of each stock. If one simply sets a function to maximize, the program would say to invest in every stock holding a positive return. Below is a sample of how the information was inputted as a variable. For each ticker, the ticker symbol itself represented the return. The ticker symbol followed by "cost" represented the cost per stock. Finally, the ticker symbol followed by "beta" represented the beta of that specific stock.

```
BMY =0.000277662123144
BMYcost =63.9220967741935
BMYbeta =0.73
```

The following is a mathematical explanation of the constraints and then objective function used in our linear model:

Objective function:

$$\sum_{i=0}^{82} TickerSymbol * x[i]$$

Cost Constraint:

$$\sum_{i=0}^{82} TickerSymbolcost * x[i] \leq TotalAllowance$$

Beta Constraint:

$$0.90 \leq \sum_{i=0}^{82} TickerSymbolbeta * x[i] \leq 1.1$$

The objective function and the total allowance constraint were fairly straight forward, set each sum as a multiple of the cost associated with individual tickers. As for the beta constraint, this one had to be implemented as two individual constraints: one keeping average beta above 0.9 and another keeping average beta below 1.1. Also, since this is a linear programing model in sage we could not implement an average on the left side of the inequality. Instead, the right side of the equation was (desired beta)*(the number of total stocks), this was a way of keeping the average contained in a linear model. The final constraint, which was only necessary to implement in non binary mode, was the constraint that limited the total number of stock that could be bought from a single stock. This one was actually implemented as 83 different constraints, each just a single stock less than the total allowed per stock. By keeping these constraints in the model, and then maximizing the return, we were able to achieve a desired beginning portfolio output.

The math that comes from these equations is mostly related to basic financing concepts. We needed a constraint for the total amount of money available because having unlimited funds is unrealistic. The beta constraint is for the risk that comes with investing in a portfolio. As a beginning investor, it is safer to keep beta around one because it is the measure of a stock's volatility (or riskiness) as it relates to the market. The market itself has a beta of 1.0 and stocks are ranked according to how much they deviate from the market. Keeping it close to 1.0 is a way of reducing this risk. The last constraint is that of the limiting per stock, or the binary setting. If the binary setting is in place, the program will only output a one if it finds that stock worth investing in. Therefore, you would buy one unit of that stock and the cost doesn't matter because it was already implemented into your total budget. If one were to want a total amount to invest in each stock instead of only buying one unit of each, then they would use the constraint where each individual integer, x[i], is less than the maximum number they wanted to buy of one singular company's stock. This constraint was set into place because of diversification. It is necessary to diversify your portfolio so that if a specific area of the market crashes, not all of your money is invested in that individual area, or company either.

To interpret the output of this program, you need to know which stock is related to which x[i]. For this reason, we made our program in mostly alphabetical order, and the order that the variables are inputted in is the order that they are inputted into the linear model. The following is a screenshot of one section of output:

```
 ... ...,
 45: 0.0,
 46: 1.0,
 47: 0.0,
 48: 1.0,
 49: 0.0,
 50: 1.0,
 51: 0.0,
```

This output states that you should buy one unit of stock x[46], x[48], and x[50]. These integers as actual stocks can be find by looking at an inputted constraint:

```
        +LOW*x[42]+MET*x[43]+MMM*x[44]+MO*x[45]
        +MON*x[46]+MRK*x[47]+MS*x[48]+MSFT*x[49]
+MA*x[50]
```

From this, we see that the code suggests we invest in MON, MS, and MA companies. These are ticker symbols of which stand for Monsanto Co., Morgan Stanley, and Mastercard Inc.. So the user of this program would then add one stock of each of those companies to their portfolio, or a higher amount if the investor desires to do so.

In order to test out our model, we made mock portfolios on investopedia. These two mock portfolios came from the \$1,000 and \$25,000 investments. Both had successful positive returns. They were created April 11, 2018. The ending values were evaluated on April 22, 2018. So these portfolios were only active for a little over a week, and yet the results are still satisfying. The more time the stocks remain invested, the more return an investor can expect to see. These mock portfolios were how we tested our model, and we are satisfied with the outcome. Overall, this project returned desired results, in fact there were more ways to approach this project than we initially thought. If we were to expand on this project in the future, we would try to take live data from the stock market and include virtually every stock in the market.

Appendix Cover Sheet

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**MATH 207 Project**
This documentation is relevant to Question number:	**16**
Briefly summarize the content of the file and its value as evidence supporting program review:	**This shows the assignment description, rubric and two final three final papers for a statistical project where students collect and analyze data.**

MATH 207 Statistical Analysis Project

The purpose of this project is for you to determine questions that can be answered with the statistical knowledge you will gain throughout the semester, and then use statistics to develop an answer for your questions. The questions should be about something of interest to you and your group. The statistical analysis should provide at least partial answers to your questions. A good project also results in more questions for future study.

Part 1: Experimental Design (5 points) Due start of class Thursday, September 6

a. Determine at least 2 questions to analyze statistically. Keep in mind that you will need to collect data with at least three variables, including at least two quantitative variables and at least one qualitative variable, with a suggested sample size of 40.

b. Describe how you will determine a sample and collect data for each question. Submit your questions and your data-collection plan for approval ***before*** collecting your data.

Part 2: Meet With Professor (5 points) Schedule: Start Thursday, September 6
Meet by 5:00 p.m. Friday, September 14

This meeting is for you to discuss your proposed questions and data-collection methods, and to end up with approval of one question and associated data-collection methods.

Part 3: Data Collection and Data Description (20 points) Due Tuesday, October 2

When your questions and sampling method have been approved, collect your data. Analyze your data by determining and producing appropriate graphs for your data, creating visuals of the data and determining the descriptive statistics for your data and investigating possible correlations in your data. Include text that succinctly explains each visual and also points out the interesting aspects of your data that each visual reveals.

Note: Your analysis will be accepted only if prior approval was given for the data-collection method.

Part 4: Inferential Statistics (10 points) Due Tuesday, November 27

Apply inferential statistics to your data. Write a description of the question(s) and the inferences (confidence intervals and hypothesis tests) you can make, including a description of the mathematical work. Describe in words what you now know about your population(s). Include the question(s), the data you used and you conclusions.

Part 5: Final Report (10 points) Due Thursday, December 6

Your final report puts all 3 parts together into one well-formatted and well-written document that you can be proud of.

MATH207 Descriptive Statistics Project — Rubric
Group members:

Points	Excellent	Good	Fair	Unacceptable
Sampling Method	A simple random sample, or chose a population to suit the situation	Used students from a class or location which may exclude some of the population	Voluntary sample	Made up values to make it look like a sample
Questions	Easy to understand, quick to answer, responses were analyzable	Easy to understand, quick to answer, some responses not analyzable	Not all easy to understand or quick to answer	confusing, poorly worded questions, not analyzable
Graphs	Histograms, etc appropriate for the type of data and correctly drawn	Histograms, etc. appropriate for the data, but some errors in accuracy	Graphs not appropriate for the type of data	No graphs
Descriptive Statistics	One or more measure of center for each set of data, appropriately used, and standard deviation and outliers discussed if appropriate for the level of measurement	Some measures of center but not all, appropriately used, or discussion of standard deviation and outliers not complete	Some measures of center for each set of data, or standard deviation and outliers discussed not complete	No measures of center or standard deviation included
Discussion	Problem described, and results discussed which responded to the problem	Some description but limited discussion of the answer to the problem	Some description but problem not discussed	No discussion or description

Math 207 Experimental Design **Fall 2018**

Due Start of Class Thursday September 6, 2018

Directions: Please type your answers, save the document to your own computer or jump drive, print it out, proofread, and submit in class. *No data collection will begin before the plan has been approved.*

Your Name:

Full names and email addresses of other members of your group:

1. Determine a question that can be answered with a statistical analysis.

2. Who are the individuals or objects of interest?

3. Specify the variables. Be sure to include at **least one** qualitative and **at least two** quantitative variables.

4. If this design is approved, what sampling method or methods will be used? See page 25 of our text. State the name of the sampling method and explain how you will carry out finding the sample.

5. If you use a survey, list the questions you will ask. Review ch1 and carefully word your questions so you will get answers that can be used for analysis.

6. If you are taking direct measurements, describe how you will take these measurements.

7. Some data collection schemes require permission from the Institutional Review Board (IRB). After reading the policy at http://www.lssu.edu/irb/policy.php, will you need permission for your analysis?

MATH 207
Prof. Grace
April 26th, 2018

Statistical Analysis | University Student Daily Water Consumption

[redacted]

Our Main Questions:

- ❑ How much water does does an average student at Lake Superior State University drink every day?
- ❑ Does bringing a water bottle to class help students increase their water consumption?

Our Survey:

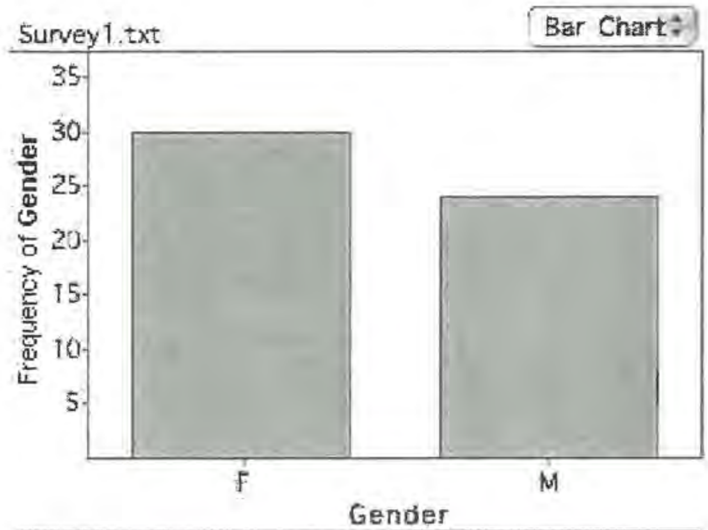
We surveyed a total of 110 students between two classes on Lake Superior State University's main campus. The two general classes surveyed were: Spring 2018 BIOL 132 and Spring 2018 CHEM 116. Of the 110 surveyed as a simple random sample, we ensured randomness by selecting half (55) at random and recorded the results. Our survey consisted of the following questions:

- What is your gender?
- Do you bring a water bottle to class?
- How much water (in cups) do you drink daily?
- How much water (in cups) do you think you *should* drink daily?
- Do you drink a different beverage more than you drink water?
- If so, what is that beverage?
- If so, how much (in cups), if any, of that beverage do you drink daily?

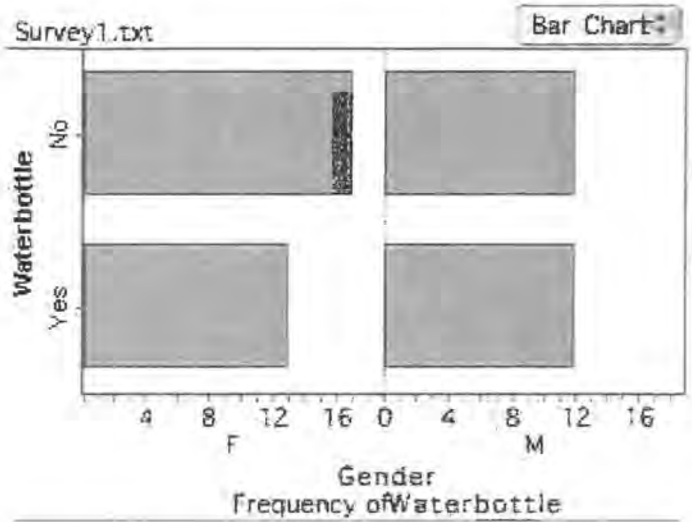
These questions gave us 7 answers for each survey: 4 qualitative and 3 quantitative. The suggested sample size for this project was 40 to ensure that we obtained a sample size greater than that of the requirement for the central limit theorem. The individuals of interest in this survey are general students that attend Lake Superior State University. It is important to note that this survey may have included a little bit of convenience sampling however it was hard to avoid without any funds or any aspirations for a larger sample size. It was convenient, however I believe there was a good pool of students that were surveyed at the campus that provided a variety of results.

The Data:

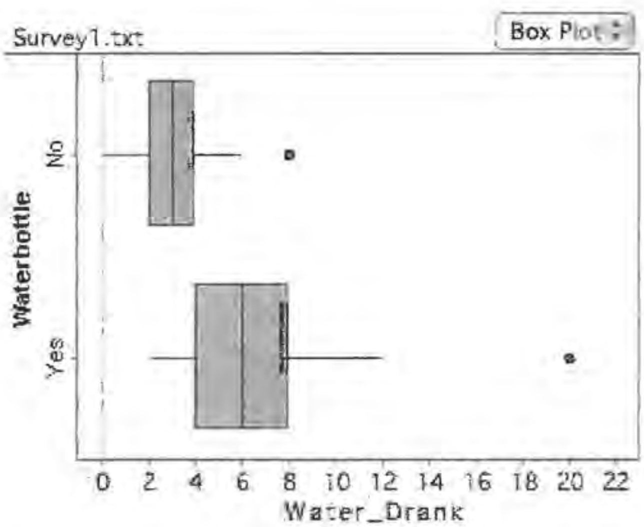
The data below was collected via survey and was input into the software *Fathom*. The program *Fathom* was used to create multiple graphs that compare two or more variables. Following each graph, there will be a description and interpretation.



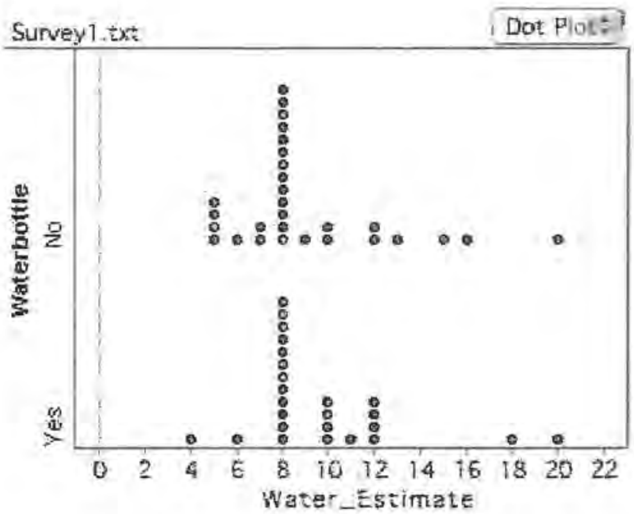
This graph displays the population that was surveyed. The information here shows how many males and females took the survey. Out of 55, 30 females and 25 males participated. These results were put in their own graph to display that the sample was not primarily males or females, but contained an average mix of each gender.



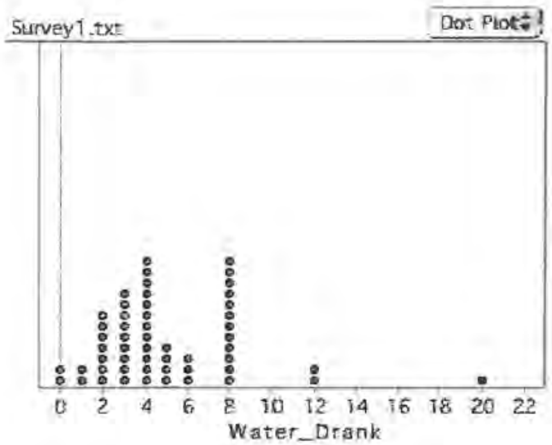
For this graph, it looks at each gender and the trends of bringing a water bottle if you are male or female. Given females, more females didn't bring water bottles; given males, the same number of males did or didn't bring a water bottle to class. This just shows that primarily it doesn't matter if you are male or female, both genders were very close to equal when it came to bringing a water bottle to class or not.



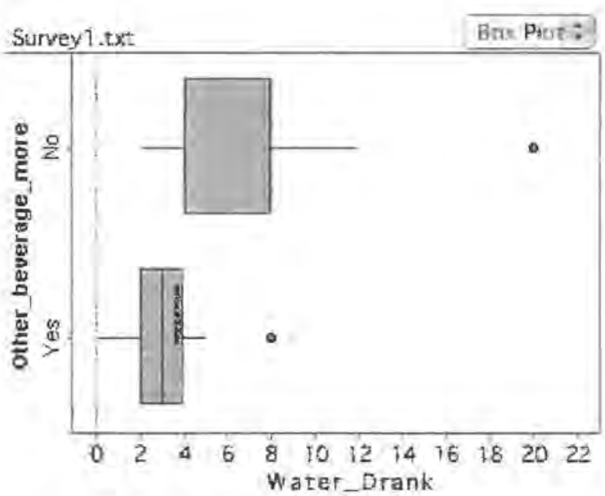
For this box plot, it compares how much water students drank if they brought a water bottle to class or not. This shows that the students who brought a water bottle to class drank on average 3 more cups of water per day than those who didn't. This is a very important statistic to support our questions at the very beginning. Does bringing a water bottle to class help students drink more water? Here it is prevalent that if you were to bring a water bottle class, you are more likely to drink on average 6 cups a day compared to just 3. There are two outliers to note on this box plot. For the students who did not bring a water bottle to class, an outlier of 9 cups of water drank per day was recorded. For the students that did bring a water bottle to class, there was an outlier of someone who drank 20 cups of water per day. The highest amount drank by students who didn't bring a water bottle (not taking account the outlier) was 6 cups. The highest amount for students who bring water bottles to class (not taking account the outlier) was 12 cups.



This dot plot shows that the majority of people think that individuals should drink 8 cups of water per day. Furthermore, those who did not bring a water bottle and those who did bring a water bottle appear to think the same thing. This makes us think that people are educated about how much to drink, but that doesn't effect if they bring a water bottle or not. It has always been portrayed by the government that people should drink 8 cups of water per day for awhile and that is always what we have known. 8 cups of water per day is a good starting point, but additional water may be needed to compliment a higher calorie diet. These facts aside, it is interesting to see that the students who don't bring a water bottle are educated enough to know how much water they need to drink, but still do not bring a water bottle to class or drink enough water.



This dot plot shows us simply that most people drink less than 8 cups per day, with the most frequent (mode) being 8 cups per day and 4 cups per day. This dot plot is quite interesting because as we saw in the graph above, the majority of the sample knew that you should drink about 8 cups per day. This shows us that a lot of people drink 8 cups per day, but a lot of people also drink 4 cups per day. Two people even said that they do not drink any cups of water per day and one person said they drink 20 cups per day. This all compiles into an average of 4.65 cups per day.



This box plot connects how much water students drink versus if they consume other beverages more than water. It appears that the more water students drink, that they are more likely to consume water as their primary drink. This is a very logical conclusion because if you drink water as your primary drink, you will almost definitely drink more water than someone who doesn't primarily drink water. It is also an important concept for a population to know: if you make a deliberate point to drink primarily water, it will promote healthier consumption levels.

Data Summary:

These graphs display that average students drink around 5 cups of water per day. Also, it looks like bringing a water bottle to class helps water consumption. Out of all our data, it seems most students are well educated that you should drink around 8 cups of water per day. Some of the other beverages that students drink more than water are soda, coffee, tea, sports drink, milk, beer, juice, lemonade, and vitamin water. The most important connection to make from these graphs is that if you bring a water bottle to class, on average, you should drink more water than someone who does not bring a water bottle to class. The comparative box plots that support this conclusion are listed as the third graph from the top. This graph was an instrumental part in determining our conclusion for our project.

Inferential Statistics:

Confidence interval for a parameter of our data:

For our study, out of the 55 people in the sample, 25 of them brought their water bottles to class. The point estimate (p^) of this is 45.5%. A 95% confidence interval for this data would be **$.323 < p < .586$.** We got this confidence interval by using 1-proportion Z Interval function on the TI-84 Plus graphing calculator. From this, we are 95% confident that the true proportion of students who bring water bottles to class at LSSU falls between 32.3% and 58.6%.

Confidence interval for the mean of our data:

The mean of our data for water drank by students who bring their water bottle to class was 5.9 cups with a standard deviation of 1.0 cups. We constructed a confidence interval for our mean using Z Interval test function on the graphing calculator. The confidence interval for our mean is **$5.63 < \mu < 6.16$.** We are 95% confident that the true mean of water drank by students who bring their water bottle to class falls between 5.63 cups and 6.16 cups.

Hypothesis testing of our data and an online data source:

According to a survey by NCBI Bahlagi et al in 2011, the mean of water drank per day for university students is 7.92 cups per day. Our sample has a mean of water drank for LSSU students at 4.65 cups per day with a standard deviation of 1.7 cups. We tested the Null Hypothesis of $H_0: \mu=7.92$ and our alternative hypothesis is $H_1: \mu \neq 7.92$ to test that the mean water drank by college students is different using our study. We used Z Test function on the graphing calculator to find the **p value = 1.4 x 10^{-57}**. We decided that since the p value is less than our level of significance of 0.01, we will reject the Null Hypothesis (H_0). We have sufficient evidence at 5% level of significance to conclude that the mean water drank by college students is different from 7.92 cups per day.

Conclusion:

The purpose for this statistical analysis was to analyze these questions statistically and be able to confidently answer them with a background of statistical data.

a. How much water does does an average student at Lake Superior State University drink every day?

b. Does bringing a water bottle to class help students increase their water consumption?

We have come to conclude that for our first question (a): on average, general students that attend Lake Superior State University drink a little less than 5 cups of water per day. This number is quite low considering that these same students generally know that people should consume on average 8 cups of water per day.

We have also come to conclude for our second question (b): Bringing a water bottle to class does help students consume more water than students who do not bring their water bottle to class. This conclusion is supported by the box plot on page 3 that suggests students who bring a water bottle to class drink on average 3 more cups of water per day. This is also supported by the logical explanation that having more water available to you during all times of the day (including class) is helpful for students consuming water more often.

LSSU College Student Habits:

Exercise, Media, Screen Hours, and Weight

Statistics Project

MATH 207

Instructor: Grace Ngunkeng

By:

[redacted]

SURVEY EXAMPLE:

Statistics Project

Survey Questions

1) In what way do you spend most of your time in front of a screen watching a show or movie (television, Netflix, Hulu, DVDs, other)?

2) How many hours per week do you spend in front of a screen watching your shows or movies?

3) Do you use this time for leisure time or for watching projects for school?

4) How many hours per week do you work out?

5) Circle gender: F or M

6) What's your major?

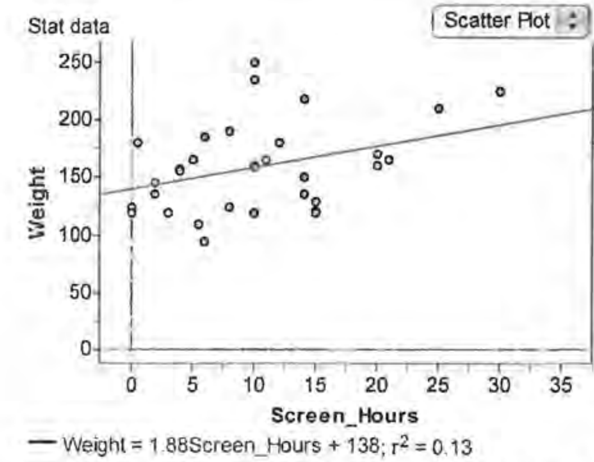
7) What is your current weight in pounds?

DATA COLLECTION:

Stat data2

	Media_...	Screen_...	Reason	Exercis...	Gender	Major	Weight	<new>
1	netflix	15	leisure	5	Female	Psych/S...	130	
2	netflix	10	leisure	3	Female	Accounti...	250	
3	netflix	10	leisure	0	Female	Business	160	
4	netflix	10	leisure	2	Female	Med. Lab...	120	
5	netflix	10	leisure	5	Female	pre-Nursi...	235	
6	netflix	3	projects	2	Female	fisheries ...	120	
7	netflix	0.5	leisure	5	Male	Geology	180	
8	netflix, D...	21	leisure	5	Female	history	165	
9	Youtube	20	leisure	0	male	Accounti...	171	
10	hulu	10	both	12	Female	history	160	
11	netflix	15	leisure	0	Female	chemistry	120.2	
12	other- list...	0	leisure	1	Female	biology	124	
13	netflix, h...	6	leisure	0.5	Male	criminal j...	185	
14	other-lap...	11	leisure	5	Female	conserv...		
15	netflix	11	leisure	9	Female	geology	165	
16	netflix	30	leisure	3	Female	Geology	225	
17	netflix, h...	6	leisure	5	Female	sports a...	95	
18	DVDs	14	leisure	5	Female	psycholo...	135	
19	TV	8	leisure	9	Male	criminal j...	190	
20	netflix	2	leisure	5	Female	fine arts	145	
21	TV	4	leisure	15	Female	undecided	157	
22	netflix, D...	8	leisure	7.5	Female	creative ...	125	
23	ndetflix, ...	15	leisure	10	Female	Psycholo...	120	
24	Hulu	5	leisure	25	Male	fire scien...	165	
25	youtube	12	leisure	6	Female	elementa...	180	
26	netflix	5.5	leisure	7.5	Female	business...	110	
27	hulu DVDs	10	leisure	6	Female	Biochemi...	159	
28	other	0	n/a	0	Male	biochemi...	120	
29	websites	2	leisure	2	Female	pre-Nursi...	135	
30	netflix, h...	15	leisure	3	Female	fire scien...	120	
31	netflix, c...	14	leisure	1.5	Female	fire scien...	218	
32	netflix	4	both	5	male	parmedic...	155	
33	netflix	14	leisure	10	female	fire scien...	150	
34	netflix	25	leisure	0	male	fire scien...	210	
35	netflix	20	leisure	4.5	Female	fire scien...	160	

College Student Weight vs. Hours of Media Watched per Week



Stat data

	Screen_Hours
Weight	0.35736501

S1 = correlation ( )

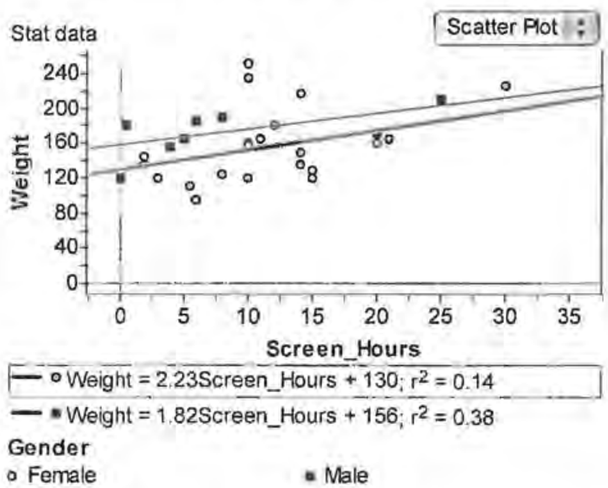
Stat data2

	Screen_Hours	Weight
	10.457143	157.62353

S1 = mean ( )

The above scatter plot shows the correlation between the weight of college students and hours spent watching some form of media. The r value is .357 indicating a very weak positive correlation between the two variables. The average number of screen hours is 10.46. The average weight is 157.62 pounds. Our r^2 value is 0.13 which tells us that 13% of our data values are represented by the least squares line y=1.88+138.

Gender Differentiation between Weight and Screen Hour Comparison



Stat data

		Screen_Hours
Gender	Female	27 11.018519
	Male	8 8.5625
Column Summary		35 10.457143

S1 = count ( )
S2 = mean ( )

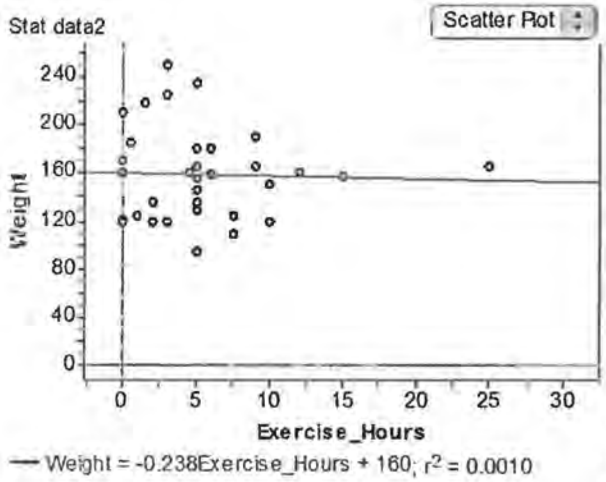
Stat data

		Weight
Gender	Female	26 153.2
	Male	8 172
Column Summary		34 157.62353

S1 = count ( )
S2 = mean ( )

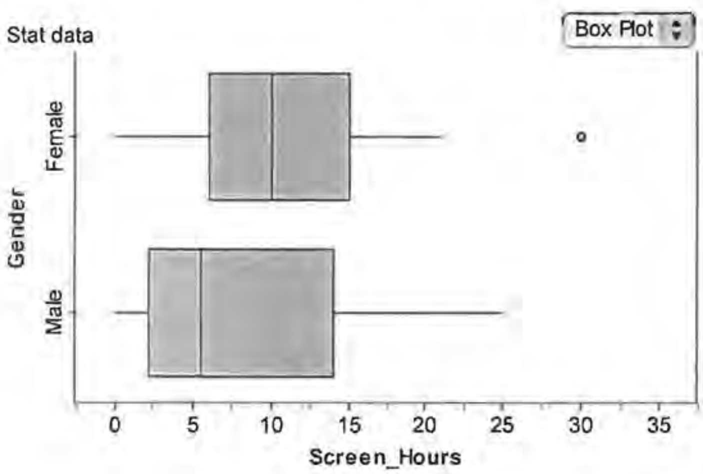
The above scatter plot shows the correlation between the screen hours and weight, but contrasts the data based on gender. Males had a positive correlation with r =0.62. Females had a slight positive to no correlation with r =0.40. The average female weight was 153.2 pounds and their average screen time was about 11 hours. The average male weight was172 pounds and their average screen time was about 9 hours. The male data had a stronger correlation compared to the female data. The male least squares line had a higher r squared value indicating that the line represented a greater proportion of the data collected.

College Student Weight vs. Hours Exercised per Week



The scatter plot above shows the relationship between college student's weight and the number of hours that they exercise per week. The data was completely scattered and our r squared value was very close to zero, indicating that no data is represented by the least squares line, expressing an end result of no correlation between the two variables. We had thought that more hours exercised would cause a lower weight, but the no correlation could be due to several factors. One factor not taken into consideration could have been that as some work out they are actually packing on muscle rather than losing weight, so their weights could be higher than someone who works out less. A BMI would have to be taken into consideration to further examine the correlation.

Gender vs. Hours of Watched Media per Week



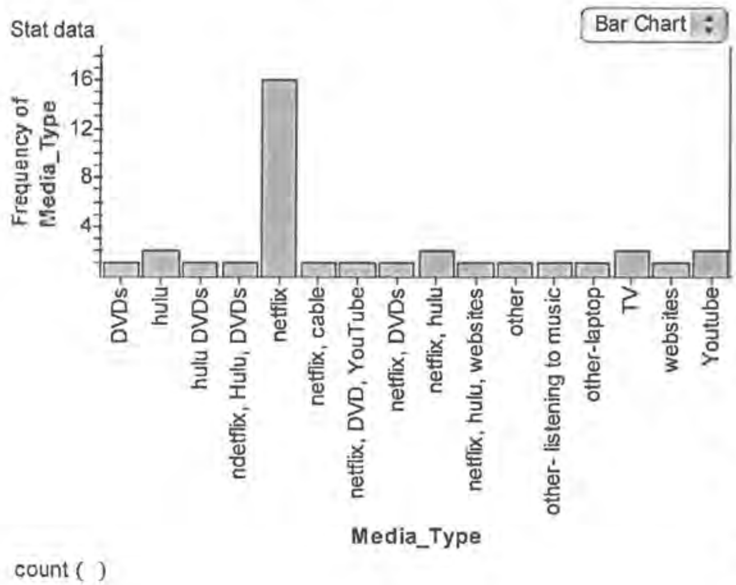
Stat data

	Gender: Female	Gender: Male	Row Summary
Screen_Hours	11.018519	8.5625	10.457143
	27	8	35
	0	0	0
	6	2.25	5
	10	5.5	10
	15	14	15
	30	25	30

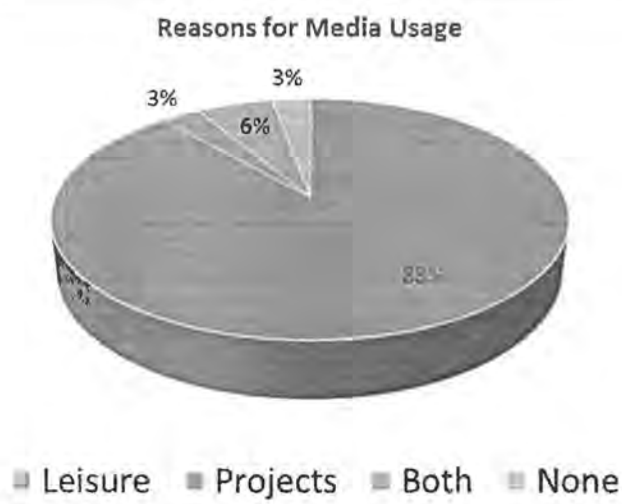
S1 = mean ( )
S2 = count ( )
S3 = min ( )
S4 = Q1 ( )
S5 = median ( )
S6 = Q3 ( )
S7 = max ( )

The box plot shows the comparison between genders and the hours of media/screen time college students watch per week. The female median was 10 hours watched per week and there was one outlier with a value of 30 hours. The female range was from 0 to 30 hours. Female data had an IQR of 9 hours. The male median was 5.5 hours and ranged from 0 to 25 hours. Male data had an IQR of 11.75 hours. (IQR=Q3-Q1)

Frequency of Media Type amongst College Students

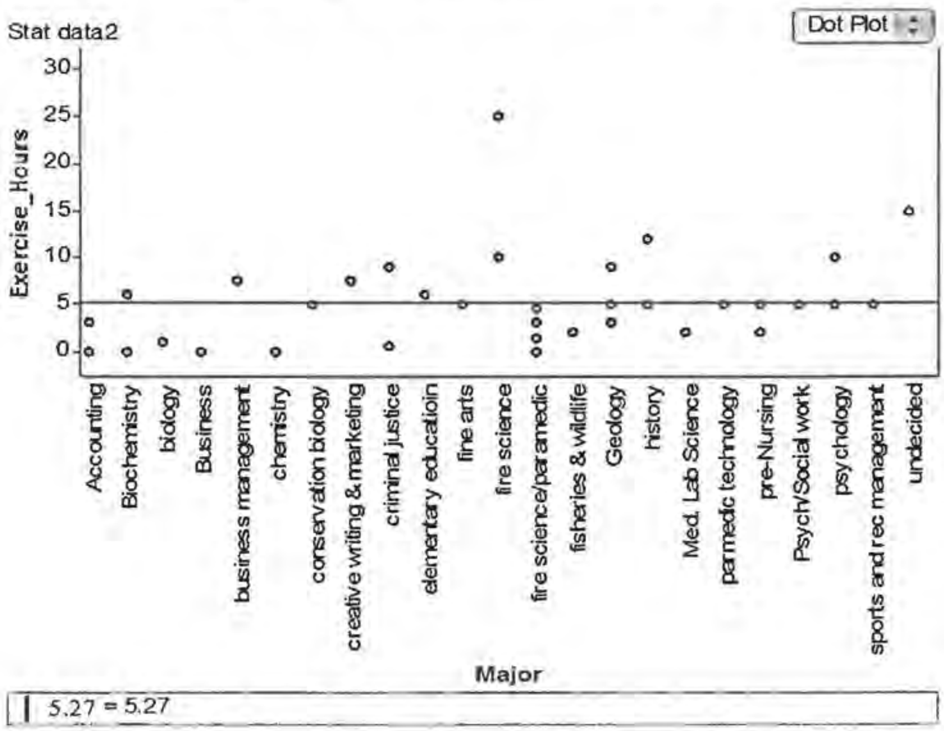


The bar graph shows the number of college students who use different types of media. Netflix was the most popular type, with having 23 out of 35 students reported that they watch it. Hulu was in second with 7 out of 35 students reportedly watching it. The third highest was DVDs with 5 out of 35 students. And television, YouTube, and other were tied at 3 out of 35 each. The least used form of media was website T.V. with 1 out of 35. In conclusion most of the student population reports having watched Netflix on a weekly basis.



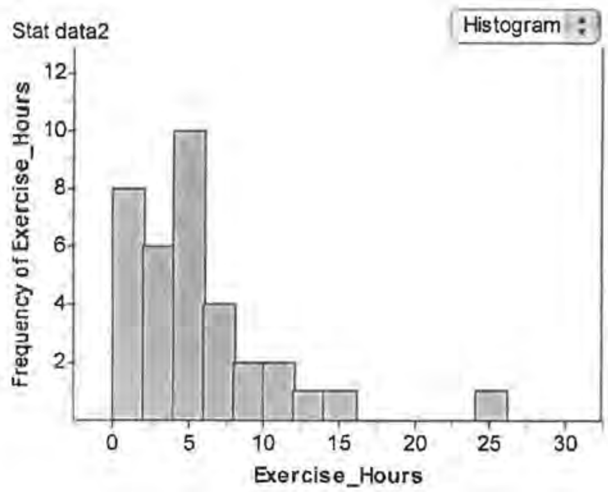
The pie chart indicates the percentage of students that watch media for various reasons. 88% of students reported watching media solely for the purpose of leisure. 3% reported they watched media for projects. Another 3% reported that they did not watch any form of media at all. Lastly 6% of student said that they watch media for projects and leisure.

College Major and Hours Exercised per Week



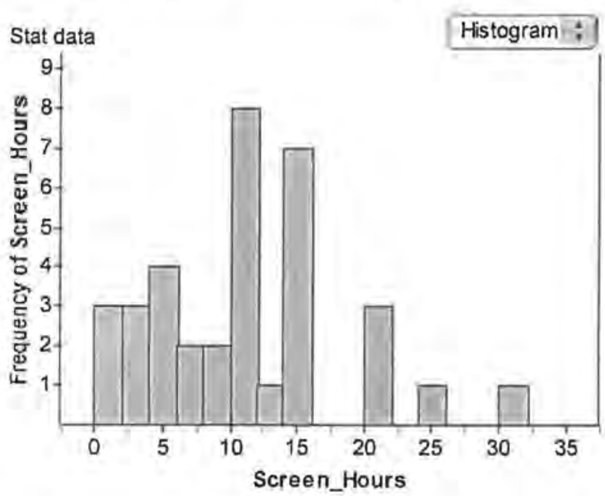
This plot shows the relationship between college majors and hours a student exercises per week. It indicates that the fire science major exercised the greatest amount with their max number of hours being 25. The lowest number of hours exercised per week was zero. Zero was recorded by an accounting, business, chemistry, biochemistry, and fire science/paramedic major. The average number of hours students exercised per week was 5.27 hours indicated by the blue line.

Histogram of Frequency of Hours Exercised per Week



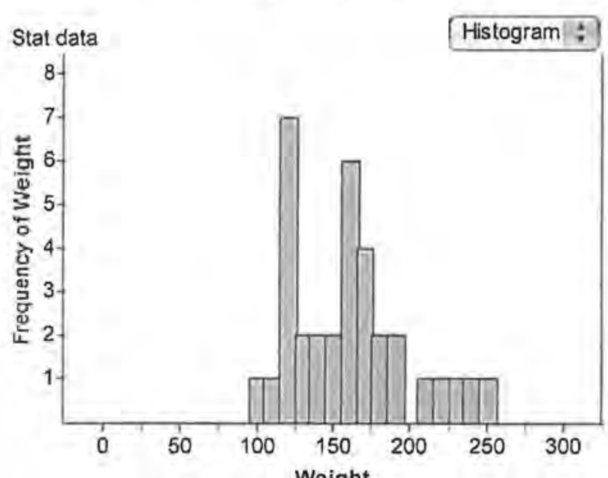
The histogram describes the frequency that college students exercised a certain amount of time per week. The graph is skewed right. The average number of hours a college student exercised per week was 5.27. The majority of the sampled students exercised between 0 and 7.25 hours. There was one outlier who exercised 25 hours per week.

Histogram of Frequency of Screen Hours of Media Use per Week



The histogram describes the frequency of screen hours spent on media by college students. The graph is sort of mound shaped with a slight skew to the right. The most occurring number of screen hours was between 10 and 15 hours.

Histogram of the Frequency of Weight amongst College Students



The histogram describes the frequency/ number of college students who reported being within each interval of a certain weight. The graph has a bimodal shape. One peak was around the 120 pound interval with the most frequency of occurrence. The second peak was around the 160 pound interval, which was the second most occurring weight interval.

CONFIDENCE INTERVALS:

95% Confidence Interval for Weight: 144.87 lbs. – 170.37 lbs.

We are 95% confident that the true population mean of the weight of LSSU student lies between 144.87 lbs. and 170.37 lbs.

SD=37.93, n=34, x bar= 157.62, E= 12.75

$144.87 \leq \mu \leq 170.37$

95% Confidence Interval for Screen Hours: 8.1 hours – 12.82 hours

We are 95% confident that the true population mean of the number of screen hours of media watched by LSSU students per week lies between 8.1 hours and 12.82 hours.

SD= 7.11, n=35, x bar= 10.46, E=2.36

$8.10 \leq \mu \leq 12.82$

95% Confidence Interval for the Population Proportion of Netflix Use: 50%-81%

We are 95% confident that the true population proportion of LSSU student that watch Netflix on a weekly bases lies between 50% and 81%.

P-hat=r/n=23/35= .6571, n=35

$.4999 < P < .8144$

HYPOTHESIS TESTS: 2 Populations Comparison Hypothesis Test at 5% Level of Significance

($\mu 1$=male population mean, $\mu 2$=female population mean)

<u>Screen Hours:</u>

- Null Hypothesis: $\mu 1 = \mu 2$
  - The sample mean of male LSSU student screen hours per week is the same as the sample mean of female LSSU student screen hours per week.
- Alternate Hypothesis: $\mu 1 \neq \mu 2$
  - The sample mean of male LSSU student screen hours per week is the same as the sample mean of female LSSU student screen hours per week.
- Test Statistic: Student T Test
  - t=-0.7096, d.f.=9.2268, P-Value=0.4955

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}}$$

- Decision: We fail to reject our null hypothesis
  - $P = .4955 > 0.05 = \alpha$
- Conclusion: We do not have sufficient evidence at a 5% level of significance to conclude that the number male LSSU student media screen hours per week is different than that of females.

Hours Exercised per Week:

- Null Hypothesis: $\mu 1=\mu 2$
  - The sample mean of hours exercised by male LSSU student per week is the same as the sample mean of hours exercised by female LSSU students per week.
- Alternate Hypothesis: $\mu 1\neq\mu 2$
  - The sample mean of hours exercised by male LSSU student per week is the same as the sample mean of hours exercised by female LSSU students per week.
- Test Statistic: Student T Test
  - t=0.1195, d.f.=7.7740, P-Value=0.9079
- Decision: We fail to reject our null hypothesis
  - P=.9079>0.05=α

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{S_1^{\ 2}}{N_1} + \frac{S_2^{\ 2}}{N_2}}}$$

- Conclusion: We do not have sufficient evidence at a 5% level of significance to conclude that the number hours exercised by male LSSU students per week is different than that of female students.

Weight:

- Null Hypothesis: $\mu 1=\mu 2$
  - The sample mean of male LSSU student weight is the same as the sample mean of female LSSU student weight.
- Alternate Hypothesis: $\mu 1\neq\mu 2$
  - The sample mean of male LSSU student weight is the same as the sample mean of female LSSU student weight.
- Test Statistic: Student T Test
  - t=1.5248, d.f.=17.6141, P-Value=0.1415
- Decision: We fail to reject our null hypothesis
  - P=.1415>0.05=α

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{S_1^{\ 2}}{N_1} + \frac{S_2^{\ 2}}{N_2}}}$$

- Conclusion: We do not have sufficient evidence at a 5% level of significance to conclude that the weight of male LSSU students is different than that of female students.

DATA COLLECTION METHOD: Our data was collected by sampling from random LSSU general education courses.

RESULTS/CONCLUSIONS:

- Our data has no correlation between number of hours of exercise an individual LSSU college student has per week and their weight. This could be due to the lack of consideration and measurement BMI (Body Mass Index). A person could be going to the gym a lot and packing on muscle. Muscle weighs more than fat. As a result we do not know if the higher weights are due to little exercise (accumulation of fat) or excess exercise (buildup of muscle). As a result our data is inconclusive when looking at this correlation.
- There is a positive correlation between the weight of LSSU male college students and the number of media screen hours watched per week. There was no correlation among women when regarding the same relationship with their weight and screen hours. As a whole when looking at the data of both men and women combined, the data has a very weak positive correlation.
- The most widely used form of media watched per week by LSSU college students is Netflix.
- Most (88%) of LSSU college students use media for leisure.
- The average screen hours per week was 10.46 hours.
- The average weight was 157.62 pounds.
- The average number of hours of exercise per week was 5.27 hours.
- More data would need to be collected to adequately identify relationships amongst weight, screen hours, and hours exercised in comparison to college major.
- There was not enough sufficient evidence at the 5% level of significance to conclude that male and female LSSU college students differed in their weight, media screen hours per week, and exercise hours per week.

[redacted]

Math 207 - Statistical Analysis Project

[redacted]

Statistical Analysis Report

Questions:

1. What are the ages of most of the people who go to the gym?
2. What days of the week is it most common for people to go to the gym?
3. How long do males workout for compared to females?
4. How much time do people spend working out a week with respect to their age?
5. What is the proportion of males and females that go to the gym?
6. What is the proportion of males that participate in group exercises and what is the proportion of females?

This project was conducted through a survey placed at the front desk of the gym we chose to obtain our sample from. Any individual walking through the gym door has the ability to voluntarily fill out a survey.

Survey: Below is the survey we used for our sample.

Please be honest when filling out this survey. This survey is anonymous and any information used in this survey will be to the benefit the math 207 statistical project at Lake Superior State University.

Please circle your gender:
Male Female

How old are you?

Generally, what time do you arrive at the gym to begin your workout?

Generally, what time do you leave the gym?

Do you workout more then once a day at the gym?
Yes No

How long on average do you stay at the gym for your workout?

How much time outside of the gym do you spend working out (on average) per week?

On average what days of the week do you always go to the gym? Please Circle.
Mon Tues Wed Thurs Fri Sat Sun

Do you workout with a partner at the gym?
Yes No

Do you get your workout through group exercises, personal training or through your own workouts? Please circle all that apply.
Group exercises Personal Training Independent workouts

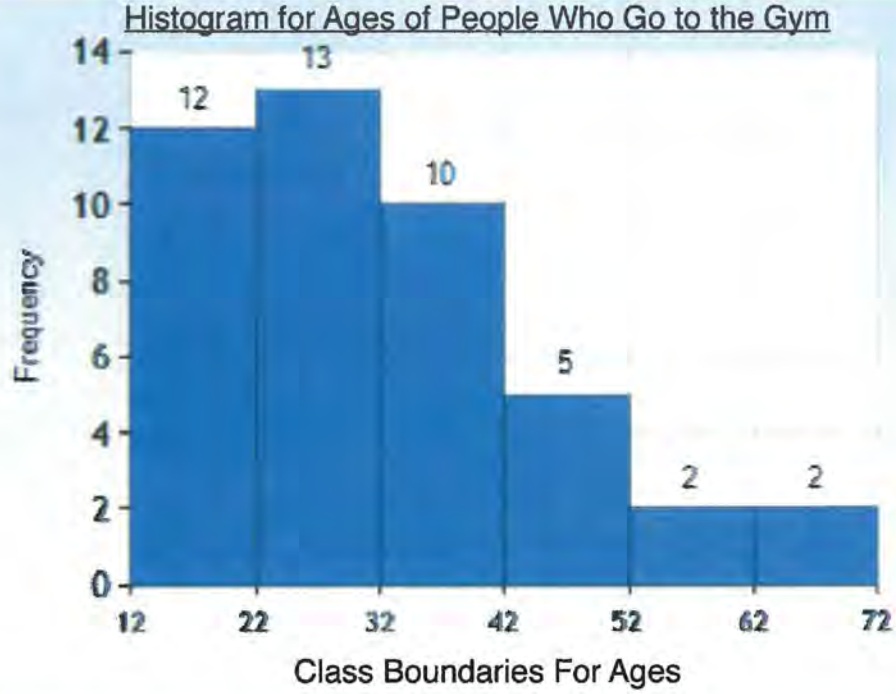
Results:
A sample of 44 gym goers was collected and the results were summarized into a frequency table with a histogram, different pie charts, and various bar graphs.

1. What are the ages of most of the people who go to the gym?

Frequency Table for Ages of People Who Go to the Gym

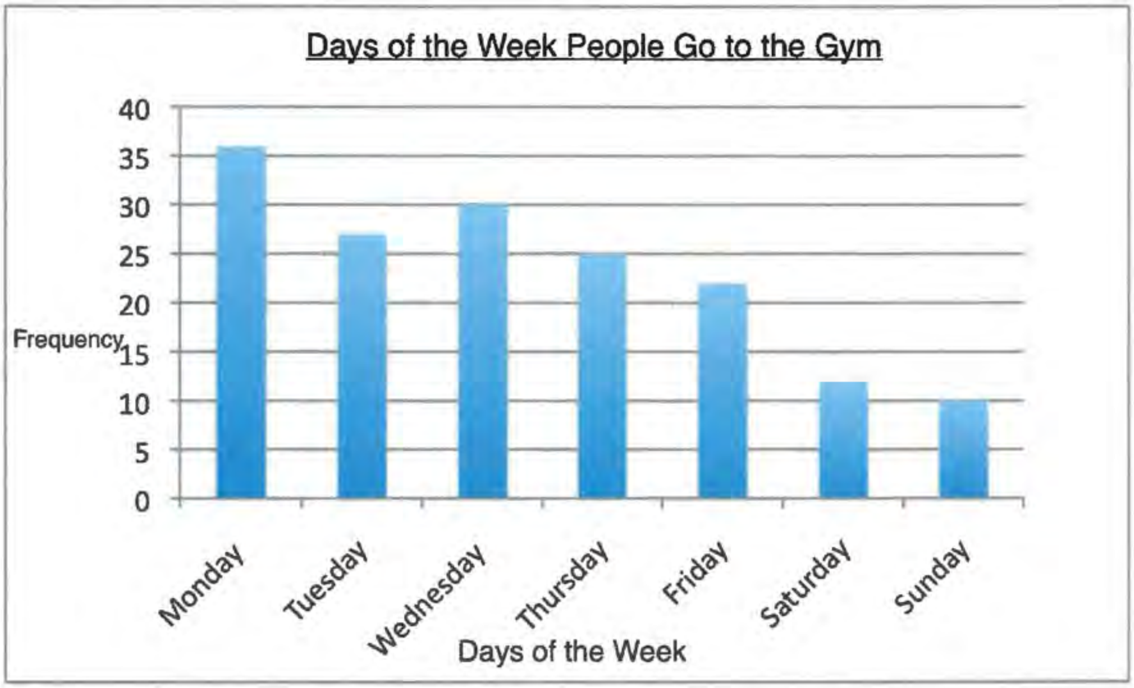
Class Limits	Class Boundaries	Class Midpoint	Frequency	Relative Frequency
12.5-21.5	12-22	17	12	0.272
22.5-31.5	22-32	27	13	0.295
32.5-41.5	32-42	37	10	0.227
42.5-51.5	42-52	47	5	0.114
52.5-61.5	52-62	57	2	0.045
62.5-71.5	62-72	67	2	0.045

Histogram for Ages of People Who Go to the Gym



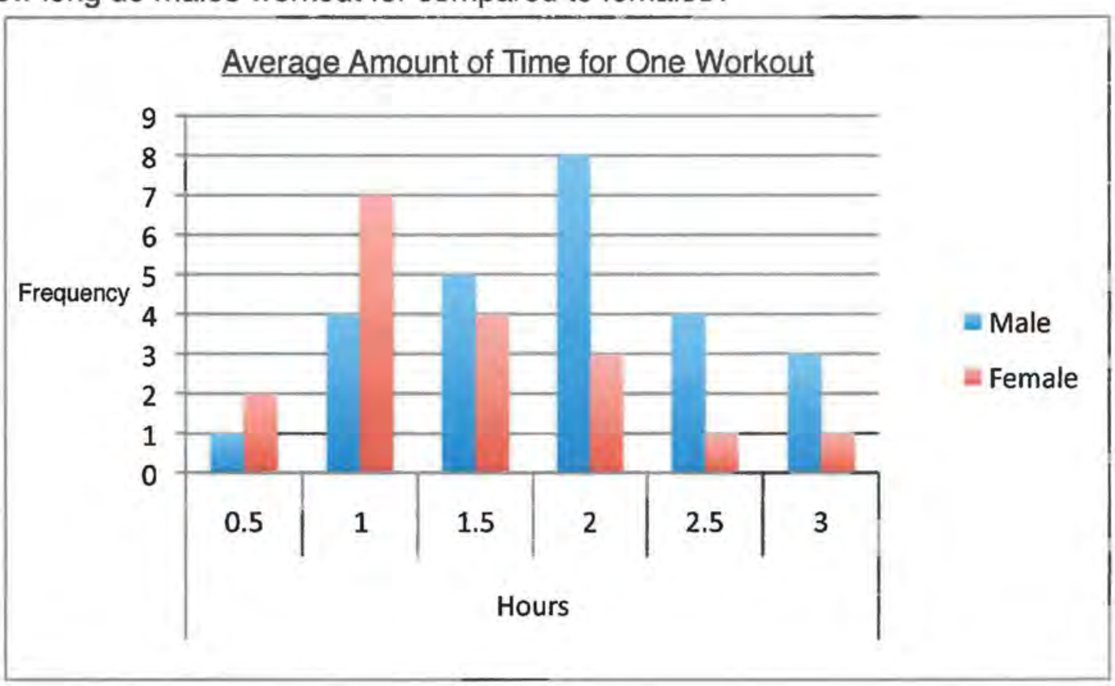
This histogram displays the ages of people who go to the gym that we collected our sample from. As you can see, most people who attend are between the ages of 22-32. Because of this the histogram is skewed right. The median of the data set is 28.5, the mean is 31.8, and the mode is 26. The range is 53.

2. What days of the week is it most common for people to go to the gym?



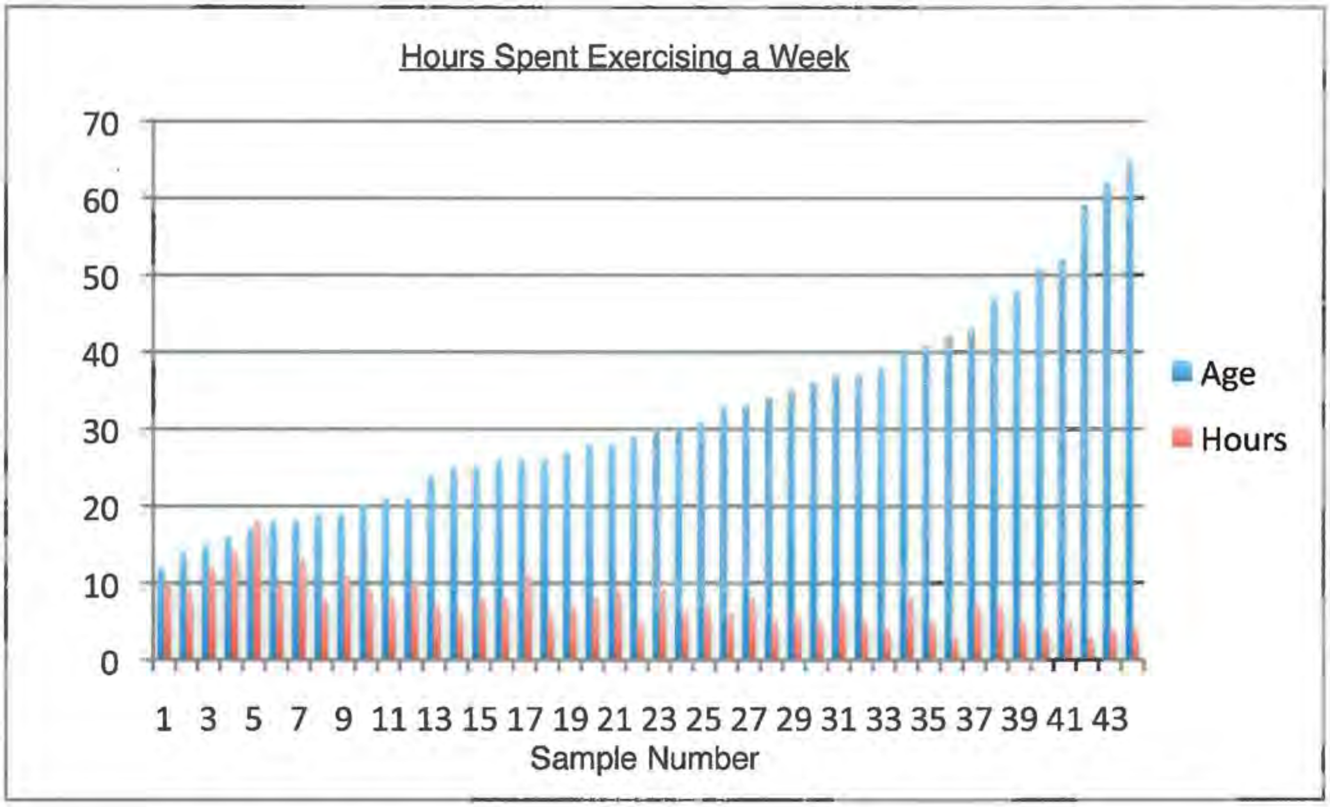
This bar graph displays what days are most common for people to go to the gym. It shows that monday is the most popular day, with saturday and sunday being this least popular. This could be due to the fact that many people like to take days off on the weekends.

3. How long do males workout for compared to females?



This cluster bar graph displays the average amount of time spent in the gym during one workout for the males and females in the sample. As shown in the graph, the male distribution has a bell shape with most of the workouts being two hours long. However, the females mostly workout for one hour as the distribution is skewed right. It can be concluded that the males in this sample tend to have longer workouts than the females.

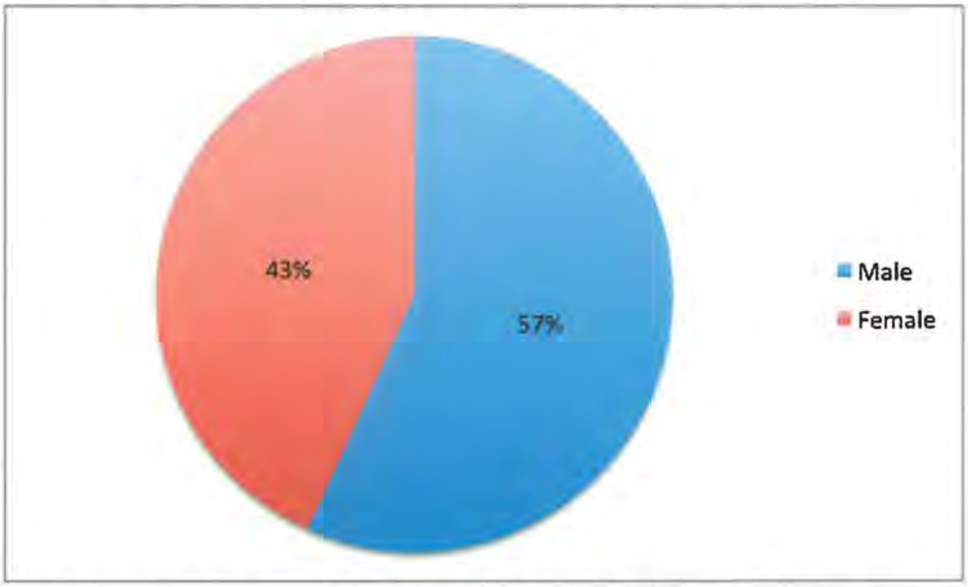
4. How much time do people spend working out a week with respect to their age? Note, the hours spent exercising per person in this sample were not just based on time spent in the gym, each person in the survey was asked to include the total time exercising outside the gym as well. The y-axis is a scale for both age and hours.



This graph displays the time each person in the sample spends exercising a week with respect to their age. As shown in the graph, as the age of each person increases, the amount of hours spent exercising tends to decrease. This could be due to a number of factors. A possible factor could be that many teenagers and young adults are involved in sports which could add on to the total time spent exercising a week. Also, most people over the age of 30 have a a full time job and may have less time to spend exercising during the week. In addition, younger people tend to be capable of more physical activity than older people without getting tired out and sore as easily.

5. What is the proportion of males and females that go to the gym?

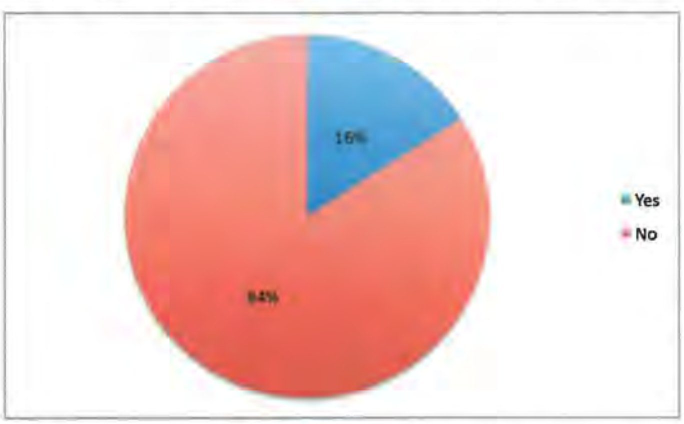
<u>Pie Chart for Males and Females That Go to the Gym</u>



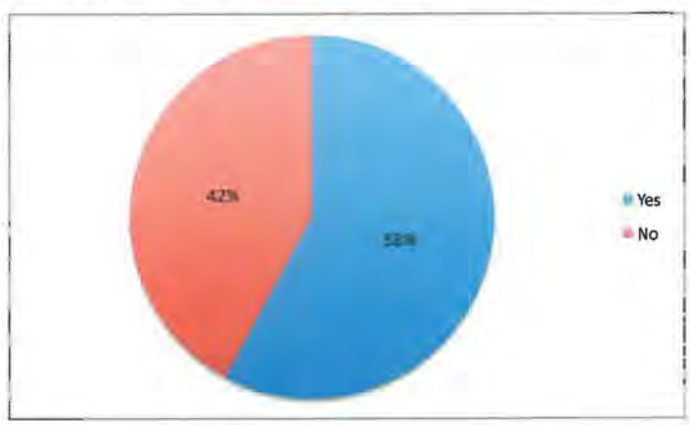
This pie chart displays the ratio of male gym goers to female. As shown, in the graph just over half of the people that go to the gym are males in this sample. The number of males was 25 and the number of females was 19.

6. What is the proportion of males that participate in group exercises and what is the proportion of females?

<u>Pie Chart for Males that Workout in Classes</u>



<u>Pie Chart for Females that Workout in Classes</u>



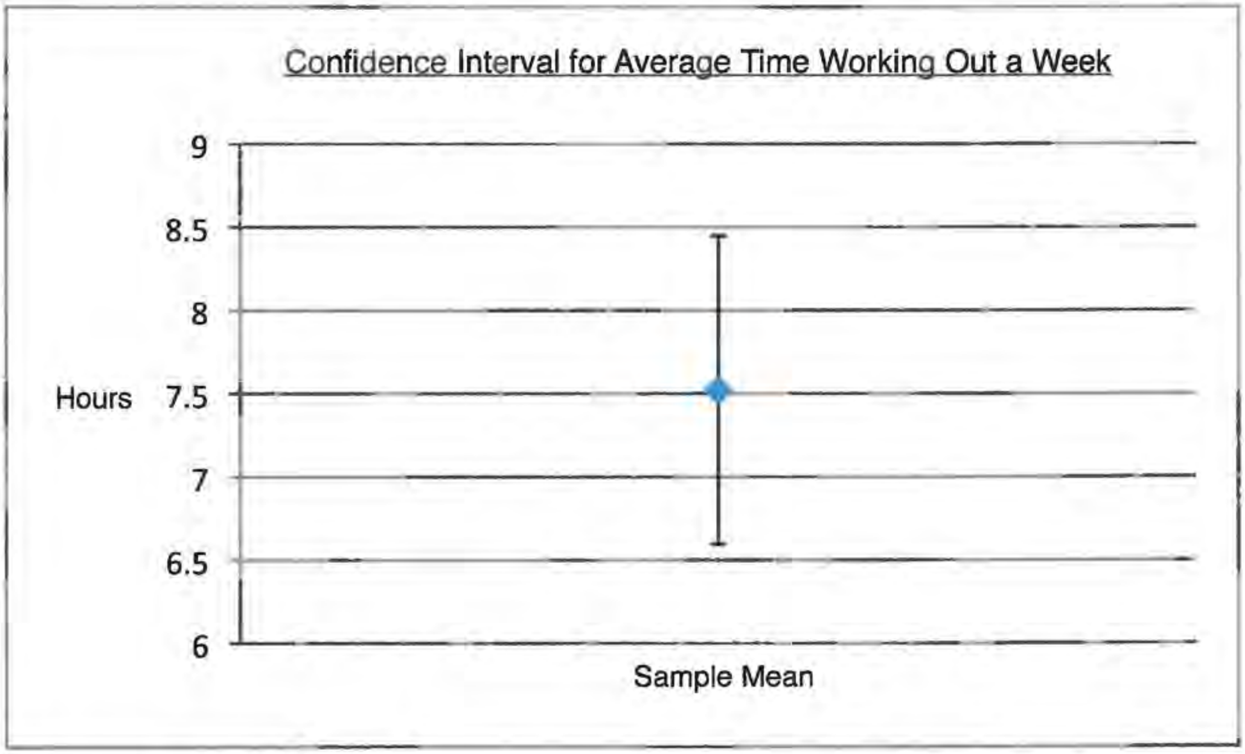
As shown in the left pie chart, most males (21/25) in this study do not participate in any kind of group exercise. On the other hand more than half of females do (11/19).

Confidence Intervals:

We chose three of our questions regarding quantitative data and created confidence intervals using the data obtained for each question. Because we had a sample without the population standard deviation, we used the t-distribution. Using the equation below we calculated the margin of error and then added it and subtracted it to the sample mean to find the confidence interval. We chose to make confidence intervals for the average workout time per week, the average age of the individuals in the gym, and the average length of one workout.

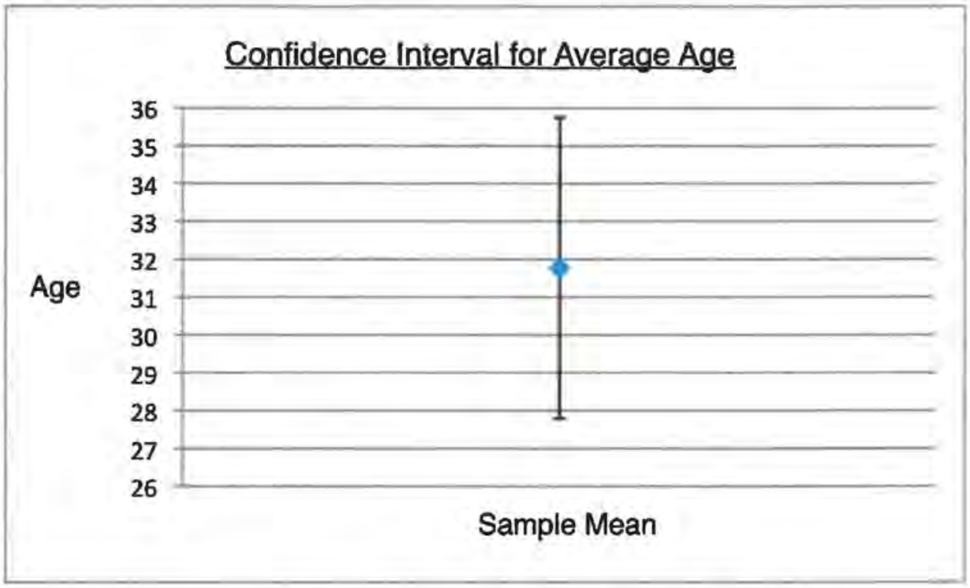
$$E = \frac{t_{\alpha/2} \cdot s}{\sqrt{n}}$$

1. Average workout time per week.



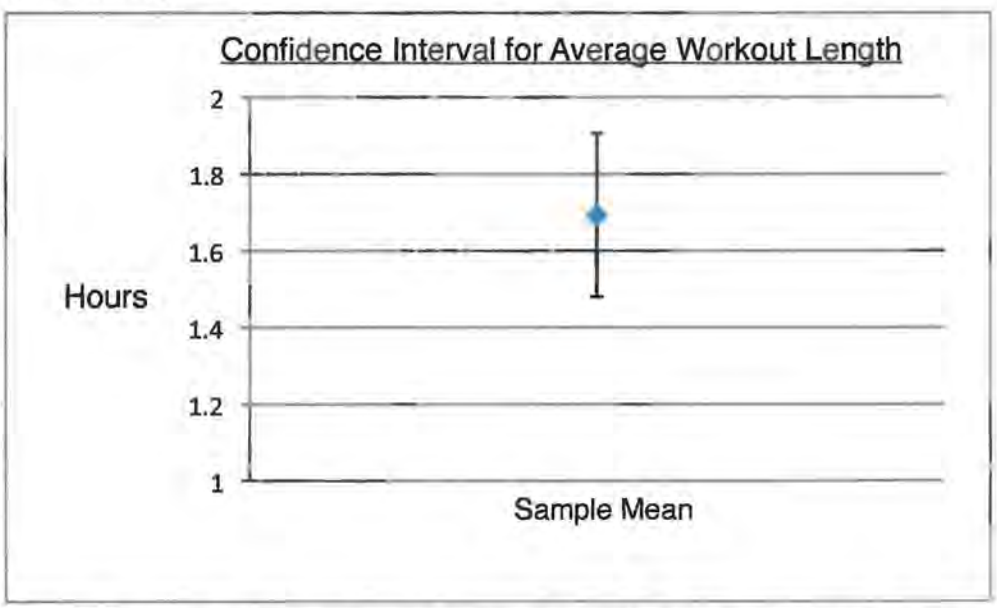
The graph above displays a 95% confidence interval for the average amount of time an individual spends exercising a week. A sample of 44 people that go to the gym was collected, the mean was 7.52 hours, the sample standard deviation was 3.05, and the t-value for a 95% confidence interval was 2.017 found from the chart. The margin of error was calculated to be +/- 0.926 which gives you an interval of 6.59 to 8.45 hours. We are 95% confident that the population mean lies within this interval.

2. Average age of the sample of the individuals in the gym.



The graph above displays a 95% confidence interval for the average age of the population of people that go to the gym. Out of the sample of 44, the mean was 31.8 years old, with a standard deviation of 13.15, the t-value was 2.017 and the margin of error was calculated to be +/- 3.99. Therefore, we are 95% confident that the population mean age for the people that go to the gym we surveyed is within the interval of 27.84 to 35.79 years old.

3. Average workout length.



The graph above displays a 95% confidence interval for the average length of one workout for the population of individuals that go to the gym we surveyed. The sample mean was 1.69 hours, with a standard deviation of 0.7, the t-value was 2.017, and the margin of error was +/- 0.213. Therefore, we are 95% confident that the population mean for the length of one workout is within the interval of 1.477 to 1.903 hours.

Hypothesis Testing: We used the data from our confidence intervals to perform hypothesis tests on.

Time Spent Working Out in a Week

Suppose we want to determine if the typical amount of time spent working out for each individual per week is greater than 7 hours. Our sample included 44 individuals from the gym we surveyed and the average amount of time is 7.52 hours. The sample standard deviation is 3.05. We will use a 0.01 level of significance to conclude if the typical amount of time spent working out is greater than 7 hours.

$$t = \frac{\overline{X} - \mu}{\frac{s}{\sqrt{N}}}$$

Null Hypothesis: population mean = 7.0 hours

Alternate Hypothesis: population mean > 7.0 hours

Test statistic: Using the equation above, we calculated the test statistic to be 1.13.

Critical value: Approximately 2.42 (determined from using the chart in textbook)

Decision: Because the test statistic is less than the critical value (1.13 < 2.4) we fail to reject the null hypothesis since we are using right-tailed area.

Conclusion: Since we fail to reject the null hypothesis, we have insufficient evidence to say that the average amount of time spent working out for each individual per week is greater than 7 hours at the 0.01 level of significance.

Average Age of an Individual at the Gym

Suppose we want to determine if the typical age of a person at the gym we surveyed is less than 35 years old. The average age of our sample of 44 was 31.8 years old. The sample standard deviation is 13.15. We will use a 0.05 level of significance to conclude if the average age of a person at the gym is less than 35 years old.

Null Hypothesis: population mean = 35 years old

Alternate Hypothesis: population mean < 35 years old

Test Statistic: Using the equation, we calculated the test statistic to be -1.61.

Critical value: Approximately -1.68 (determined from using the chart in the textbook)

Decision: Because the test statistic is greater than the critical value (-1.61 > -1.68) we fail to reject the null hypothesis since we are using left-tailed area.

Conclusion: Because we fail to reject the null hypothesis, we have insufficient evidence to say that the average age of a person at the gym is less than 35 years old at the 0.05 level of significance.

Average Workout Length

Suppose we want to determine if the typical length of a workout for a person at the gym we surveyed is different from 2 hours. The average workout length computed from our sample of 44 was 1.69 hours. The sample standard deviation was 0.7. We will use the 0.05 level of significance to conclude if the average length of a workout is different from 2 hours.

Null Hypothesis: population mean = 2 hours

Alternate Hypothesis: population mean =/= 2 hours

Test Statistic: Using the equation, we calculated the test statistic to be -2.94.

Critical value: Approximately -2.0 (determined from using the chart in the textbook)

Decision: Because the test statistic is less than the critical value (-2.94 < -2.0) we reject the null hypothesis since we are using two-tailed area.

Conclusion: Because we reject the null hypothesis, we have sufficient evidence to say that the average length of a workout for a person at the gym is different from 2 hours at the 0.05 level of significance.

Raw Data

Sample Number	Age	Gender	Hours Exercising a week	Days Usually at the Gym	Participate in Group Exercise or Classes	Length of a regular workout
1	12	M	10	MTWRF	No	2.5
2	14	M	9	MTWF	No	2
3	15	F	12	MWS	No	3
4	16	M	14	MTWRF	No	2
5	17	M	18	MWRFSu	No	3
6	18	F	10	TRF	Yes	2.5
7	18	M	13	MWRFS	No	3
8	19	M	8	TRS	No	2
9	19	M	11	MTWRF	No	2
10	20	F	9	MFSu	Yes	2
11	21	F	8	MTWR	No	2
12	21	M	10	MWRF	No	2.5
13	24	F	7	MTRF	Yes	1.5
14	25	F	6	WFS	Yes	2
15	25	M	8	MTWR	No	2
16	26	F	8	MTS	Yes	1
17	26	M	11	MWR	Yes	3
18	26	M	6	MWF	No	2
19	27	F	7	MWSSu	No	1.5
20	28	M	8	MTWR	No	1.5
21	28	M	9	MTWF	No	2
22	29	F	5	MRF	Yes	1.5

Sample Number	Age	Gender	Hours Exercising a week	Days Usually at the Gym	Participate in Group Exercise or Classes	Length of a regular workout
23	30	M	9	MRS	No	2.5
24	30	M	6	MTFSu	No	1.5
25	31	F	7	MTWRF	Yes	0.5
26	33	M	6	MTF	No	1.5
27	33	M	8	MTW	No	1.5
28	34	M	5	TR	Yes	1
29	35	F	6	MTWFSu	Yes	1
30	36	F	5	MWFSu	No	1
31	37	M	7	TWF	No	2.5
32	37	F	6	MTRS	Yes	1
33	38	F	4	MWSu	No	1
34	40	M	8	MWRSu	Yes	2
35	41	M	5	MTWRS	No	1
36	42	F	3	MTW	No	1
37	43	F	7	MTWR	No	1
38	47	M	7	MTWSu	Yes	1
39	48	M	5	TRF	No	1.5
40	51	F	4	MWRF	Yes	0.5
41	52	M	5	MR	Yes	2
42	59	M	3	RFSSu	No	0.5
43	62	F	4	TW	No	1.5
44	65	M	4	MTW	No	1

PART 2: Degree-Level Review

Degree Program: **B.S. Mathematics Elementary Teaching**

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

13. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

    The 4-Column Program Assessment Report is attached as a related document.

14. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

In 2016, upon completion of Program Review for this major, it was noticed that even though our majors passed overall at a rate of 100%, Measurement and Geometry was often the lowest sub-section of the MTTC exam. The study guide located at https://www.mttc.nesinc.com/Content/STUDYGUIDE/MI_SG_OBJ_022.htm was reviewed as well as the practice exam at https://www.mttc.nesinc.com/Content/STUDYGUIDE/MI_SG_SRI_022.htm . The instructor of MATH 325 College Geometry placed more emphasis on transformations and restructured the lesson on inscribed angles to contain circumscribed angles. While not statistically conclusive, both students who took the exam after this change were successful in this sub-area.

The University as a whole assessed Freshmen retention and found that students who took a university success seminar were more likely to be successful in their freshman year. While we had suggested students in this program take EDUC 101, it had not been required. As a result of that assessment, we now require students in this program to take EDUC 101.

In CSCI 105 Introduction to Computer Programming in 2017-2018, the ability to Acquire Data and the ability to Present and Display Data failed to meet expectations. This outcome is also reflected in the Student Learning Outcomes for the overall CSCI 105 course. As a result, both the outcomes related to the School of Education and the outcomes related directly to this course indicate a potential disconnect in the course. The students performed well on Transform Data using a Mathematical Calculation. This does not reflect the core competency in the topic of the course: programming. For the Fall 2018 semester, a new textbook was selected to strengthen the emphasis upon programming and data processing. This change was not driven just from this particular assessment, but also the SLO assessment from past offerings of the course.

Beginning in the Fall of 2018, this program now requires CSCI 106 instead of CSCI 103. CSCI103 is an introduction to the field of computer science, primarily for computer science and computer networking, majors. CSCI106 is about web design and development. Teachers are expected to be able to use a variety of print and electronic resources for lesson planning and interaction with other teachers and parents. Moreover, web design and development is currently used in elementary classrooms. Based on feedback from candidates and alumni, this change was implemented to better serve workplace needs.

Quality, Resources and Support (CC 3.A)

15. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

    There are many things that contribute to ensuring that the program-level and course-level learning outcomes are at an appropriate level.

    A) Prerequisite Structure

    Mathematics by its nature has a natural prerequisite structure. Each course must be rigorous enough to prepare students for courses which use it as a prerequisite.

    B) Historical

    Much of the early content in mathematics is inherited from a historical structure and must be easily transferred from one school to another. Many high school students take our MATH 151 and MATH 152 courses and transfer them to other schools including University of Michigan, so the content must be somewhat standardized.

    C) Standards and Guidelines

    We review our degree content against several standards. For our mathematics degrees, we review the Curriculum Guide to Majors in Mathematical Sciences, published by the Mathematical Association of America's Committee on Undergraduate Programs in Mathematics (CUPM). It can be found at:

    https://docs.google.com/viewer?url=https%3A%2F%2Fwww.maa.org%2Fsites%2Fdefault%2Ffiles%2Fpdf%2FCUPM%2Fpdf%2FCUPMguide_print.pdf.

    For the Mathematics Secondary Teaching degree we review the Michigan Department of Education Standards for the Preparation of Teachers of Mathematics–Elementary (EX) found at:

    https://docs.google.com/viewer?url=https%3A%2F%2Fwww.michigan.gov%2Fdocuments%2Fmde%2FElem_Math_Standards_554575_7.pdf

    Additionally, for both mathematics education degrees we use The Mathematical Education of Teachers II, (METII) published by the Conference Board of Mathematical Sciences in 2012. It can be found at:

    https://docs.google.com/viewer?url=https%3A%2F%2Fwww.cbmsweb.org%2Farchive%2FMET2%2Fmet2.pdf

The Lumina Foundation's Degree Qualification Profile (DQP) is suggested as a resource for answering the questions about what students should know and be able to do at each degree level:
http://degreeprofile.org/wp-content/uploads/2017/03/DQP-grid-download-reference-points-FINAL.pdf

Intellectual Inquiry (CC 3.B).

16. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

Students in this program complete many projects throughout their studies culminating in a capstone student-teaching experience. Here are two examples.

A) MATH 325 College Geometry Project and Portfolio

Students complete a geometry project in Geometer's Sketchpad using what they learned in an independent lesson on symmetry. Examples of some past projects are attached. The projects must include concepts of symmetry and transformational geometry. Students also complete a portfolio that includes their best proofs and constructions and reflects on the learning process. An example of a student portfolio is attached.

B) MATH 207 Statistics Project and Paper

Students are required to do a project and paper where they collect data, use inferential statistics and write a final report. The project description, rubric, and some examples of student work are attached.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Mathematics Elementary Education 4-column Report**
This documentation is relevant to Question number:	**13**
Briefly summarize the content of the file and its value as evidence supporting program review:	**It shows the four column report was completed.**

Assessment: Program Four Column

Program (ColS) - Mathematics Elementary Ed BS

Assessment Contact: Dr. Brian Snyder
Mission Statement: The School of Mathematics and Computer Science offers baccalaureate degree programs in mathematics and computer science that are designed to develop students? full potential and to prepare graduates for professional careers, and also to provide them with the background needed to pursue further study in graduate school.

The School also offers computer-related associate?s degrees, designed to prepare graduates for employment in technologically challenging positions in business and industry.

The School provides general education support in mathematics for all academic programs across the University.

Finally, the School provides important foundational support in mathematics and computer science to the various academic programs offered within other units of the University.

Student Learning Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Mathematical Processes and Number Concepts - Candidates will be able to use mathematical processes, axiomatic systems, computing, algorithms, and logical reasoning to solve problems and communicate mathematical ideas. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex ideas in written and oral presentations., ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an	**Direct - Exam/Quiz - Standardized -** The Mathematical Processes and Number Concepts subarea scores on the MTTC Mathematics (EX) Subject Test will be analyzed **Criteria Target:** 80% of students will score 3 or higher on the subarea score	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students scored 3 or higher. (04/21/2018)	**Use of Result:** While there are no concerns about the scores, we will work in the Fall of 2018 to develop a new plan for recruitment into this program. Only two students from this program took the exam this year. (04/21/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes No majors in this program took the MTTC exam this year. (One person pursuing a minor in Mathematics Elementary Teaching took the exam and had a subscore in this area of 4.) (04/22/2017)	**Use of Result:** There are no concerns at this time. (08/31/2017)
	Direct - Exam/Quiz - within the course - Candidates in MATH 325 College Geometry are asked to define undefined terms, axioms and	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes 100% of the students scored 7 or above. (05/05/2017)	**Use of Result:** There are no concerns at this time. We will assess again in the Spring of 2019. (05/05/2017)

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. **Revision Notes:** Alignment to Standards: InTASC: Standards 4 and 5 MDE Mathematics Secondary: 1.1, 1.2, 1.3, 1.5.1, 1.5.9, 1.5.12, 1.5.13, 1.6, 2.2	theorems in geometry, describe their role in axiomatic systems and to provide an example of each **Criteria Target:** 80% of students will score 7 or more points on the scoring guide. **Schedule/Notes:** MATH 325 is an alternate year course. **Related Documents:** MATH 325 Undefined Terms Axioms Theorems Scoring Guide.docx		
	Direct - Exam/Quiz - within the course - Candidates in CSCI 105 Introduction to Computer Programming will be able to acquire data and then transform that data using mathematical calculations **Criteria Target:** 70% of students will score 70% or above	**Finding Reporting Year:** 2017-2018 **Goal met:** No 60.9% of the students were able to acquire the data and 78.5% of the students were able to transform the data using mathematical calculations with a score of 70% or above. (05/01/2018)	**Use of Result:** The ability to Acquire Data failed to meet expectations. This outcome is also reflected in the Student Learning Outcomes for the overall CSCI 105 course. As a result, both the outcomes related to the School of Education and the outcomes related directly to this course indicate a potential disconnect in the course. The students performed well on Transform Data using a Mathematical Calculation. This does not reflect the core competency in the topic of the course: programming. For the Fall 2018 semester, a new textbook will be selected to strengthen the emphasis upon programming and data processing. This change is driven not just from this particular assessment, but also the SLO assessment from past offerings of the course. (05/01/2018)
	Direct - Exam/Quiz - within the course - Students in MATH 103	**Finding Reporting Year:** 2017-2018 **Goal met:** No	**Use of Result:** In the Fall of 2018, we will reinforce (through in class

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	[Number Systems and Problem Solving for Elementary Teachers] are able to describe and justify algorithms used in elementary school. **Criteria Target:** 70% of students are successful	56% of the students could complete this task and 88% were partially successful in that they were able to describe/replicate the algorithm but could not fully justify it. (05/01/2018)	activities) the justification of algorithms. We will also develop a rubric for grading this Key Assessment that can be used across multiple sections. (08/31/2018)
Patterns, Algebraic Relationships and Functions - Candidates will be able to describe, analyze, and generalize patterns, algebraic relationships and functions using the tools of algebra and calculus. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. **Revision Notes:** Alignment to Standards: InTASC: Standards 4 and 5 MDE Mathematics Secondary: 1.1, 1.2, 1.3, 1.5.1, 1.5.9, 1.5.12, 1.6, 2.2 **Assessment Year:** AY17-18	**Direct - Exam/Quiz - Standardized -** The Patterns, Algebraic Relationships, and Functions subarea scores on the MTTC Mathematics (EX) Subject Test will be analyzed. **Criteria Target:** 80% of students will score 3 or higher on this subarea.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students made a 3 or higher. (04/21/2018)	**Use of Result:** While there are no concerns about the scores, we will work in the Fall of 2018 to develop a new plan for recruitment into this program. Only two students from this program took the exam this year. (04/21/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes No majors in this program took the exam this year. (One minor in Mathematics Elementary Teaching took the exam and scored a 4 in this subarea.) (04/22/2017)	**Use of Result:** There are no concerns at this time. (04/22/2017)
	Direct - Exam/Quiz - within the course - Candidates in MATH 151 Calculus I are asked to create a function that models a given verbal description, then use calculus to find an optimal solution to a problem. **Criteria Target:** 70% of students will score 4 or higher on the scoring guide. **Related Documents:** Candidates in MATH 151 Calculus I Modeling Scoring Guide.docx	**Finding Reporting Year:** 2017-2018 **Goal met:** No 68% of the students scored 4 or higher. (06/01/2018)	**Use of Result:** A majority of the students were able to find the correct model and locate the extrema, though many of these did not put units on their answers. For those who were not success, the biggest issue was going from a multivariable equation to a single variable function. In the Fall of 2018, we will emphasize model creation in the lecture, give a formative assessment quiz over the section and provide the students with the rubric before the summative assessment. (06/01/2018)
		Finding Reporting Year: 2016-2017	**Use of Result:** The goal was met,

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
		Goal met: Yes 71% scored 4 or higher. (05/05/2017)	we will monitor again in the Fall of 2017. (05/05/2017)
	Direct - Exam/Quiz - within the course - Candidates in MATH 152 Calculus II are asked to find the interval and radius of converge for a power series. **Criteria Target:** At least 70% of students will score 5 or higher on the scoring guide. **Related Documents:** MATH 152 Calculus II Power Series Scoring Guide.docx	**Finding Reporting Year:** 2017-2018 **Goal met:** No 64% of students scored 5 or higher. (06/01/2018)	**Use of Result:** There were no elementary education majors in the class, so the 64% was the overall class percentage. The largest area of difficulty was solving absolute value inequalities algebraically. In the Fall of 2018, faculty will provide an extra algebra review over solving absolute value inequalities and see if this improves student performance. (06/01/2018)
	Direct - Group project, collaborative learning - Candidates in MATH 103 [Number Systems and Problem Solving for Elementary Teachers] are able to state a function given a list of values, such as an arithmetic sequence or other linear function. **Criteria Target:** 70% of students are able to determine the function with 6 or fewer inputs.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 75% of students were able to determine the function in 6 or fewer steps. (50% were able to do so in 4 or fewer steps.) (01/01/2018)	**Use of Result:** There are no concerns at this time. We will reassess in Fall of 2018. (01/01/2018)
Measurement and Geometry - Candidates will be able to apply geometric principles in Euclidean, analytic, transformational and vector geometry to analyze geometric objects, form conjectures, solve problems and prove theorems. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) [Bloom] **Institutional Learning:** ILO2 - Use of Evidence - Students will identify the need for, gather, and accurately	**Direct - Exam/Quiz - Standardized -** The Measurement and Geometry subarea scores on the MTTC Mathematics (EX) Subject Test will be analyzed. **Criteria Target:** 80% of students will score 3 or higher on this subarea.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of majors scored 3 or higher. (04/21/2018)	**Use of Result:** While there are no concerns about the scores, we will work in the Fall of 2018 to develop a new plan for recruitment into this program. Only two students from this program took the exam this year. (04/21/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes No majors in this program took the exam this year. (One minor in Mathematics Elementary Teaching took the exam and scored a 3 in this subarea.) (04/22/2017)	**Use of Result:** There are no concerns at this time. (04/22/2017)

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem., ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. **Revision Notes:** Alignment to Standards: In TASC: Standards 4 and 5 MDE Mathematics Secondary: 1.1, 1.2, 1.3, 1.5.3, 1.5.4, 1.5.5, 1.5.9	**Direct - Exam/Quiz - within the course -** Candidates in MATH 325 College Geometry are asked to construct a geometric object, form a conjecture about the object and then prove their conjectures. **Criteria Target:** 805 of students will score 3 or higher on the scoring **Schedule/Notes:** MATH 325 is an alternate year course. **Related Documents:** MATH 325 Construction Conjecture Proof Scoring Guide.docx	**Finding Reporting Year:** 2016-2017 **Goal met:** No 50% of students earned 3 or more points on a problem in Euclidean geometry. 100% of students earned 3 or more points on a problem in coordinate geometry. (05/01/2017)	**Use of Result:** The students met expectations in coordinate geometry. There were only 4 people in the course. On the problem in Euclidean geometry, two of the students made a false conjecture and were thus unable to prove it. They were more successful correcting the problem outside of class when time wasn't an issue. In the Spring of 2019, we will seek to address this issue by helping students further develop strategies for testing their conjectures before writing proofs. (05/01/2017)
	Direct - Exam/Quiz - within the course - Candidates in MATH 305 Linear Algebra will be able to find eigenvalues, eigenvectors for alinear transformation. **Criteria Target:** 70% of students will earn 7 out of 10 possible points. **Schedule/Notes:** Available Points: Students are able to find the eigenvalues: 4 points. Students are able to find an eigenvector: 3 points. Students are able to find the other eigenvector: 3 points. MATH 305 is an alternate year course.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 73% of students scored 70% or above. (01/01/2018)	**Use of Result:** No concerns at this time. We will assess again in the Fall of 2019. (01/01/2018)
	Direct - Exam/Quiz - within the course - Candidates in MATH 152 will be able to apply integration methods to find area.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 88% of students scored 70% or higher. (05/01/2018)	**Use of Result:** 21 out of 33 students earned a perfect score on this objective, so there are no major concerns. (05/05/2018)
	Criteria Target: 70% of students will score 70% or higher. **Related Documents:** MATH 152 Calculus II Area.docx	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes 86% of students scored 70% or higher. (05/05/2017)	**Use of Result:** There are no concerns with this objective. (05/05/2017)

Student Learning Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
	Direct - Exam/Quiz - within the course - Candidates in MATH 104 [Geometry and Measurement for Elementary Teachers] are able to use similar triangles and the Pythagorean Theorem to solve real world problems. **Criteria Target:** 80% of students are successful.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 93% of the class was successful. (05/01/2018)	**Use of Result:** There are no concerns with this key assessment. (05/01/2018)
Data Analysis, Statistics, Probability, and Discrete Mathematics - Candidates will be able to organize, analyze and interpret data, sets and relations using the tools of statistics, probability and discrete mathematics. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO2 - Use of Evidence - Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem., ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. **Revision Notes:** Alignment to Standards: InTASC: Standards 4 and 5 MDE Mathematics Secondary: 1.1, 1.2, 1.3, 1.4, 1.5.6, 1.5.7, 1.5.11, 1.5.12, 2.2	**Direct - Exam/Quiz - Standardized -** The Data Analysis, Statistics, Probability and Discrete Mathematics subarea scores on the MTTC Mathematics (EX) Subject Test will be analyzed. **Criteria Target:** 80% of students will score a 3 or higher on this subarea.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students made a 3 or higher (04/21/2018)	**Use of Result:** While there are no concerns about the scores, we will work in the Fall of 2018 to develop a new plan for recruitment into this program. Only two students from this program took the exam this year. (04/21/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes No majors in this program took the exam this year. (One minor in Mathematics Elementary Teaching took the exam and scored a 4 in this subarea.) (04/22/2017)	**Use of Result:** There are no concerns at this time. (04/22/2017)
	Direct - Exam/Quiz - within the course - Candidates in CSCI 105 [Introduction to Computer Programming] will be able to present and display data and then document and describe the results. **Criteria Target:** 70% of students will score 70% or above.	**Finding Reporting Year:** 2017-2018 **Goal met:** No 56.5% on Present and Display Data 73.1% on Document and Describe Data (05/01/2018)	**Use of Result:** The ability to Present or Display Data failed to meet expectations. This outcome is also reflected in the Student Learning Outcomes for the overall CSCI 105 course. As a result, both the outcomes related to the School of Education and the outcomes related directly to this course indicate a potential disconnect in the course. The students met the expectations for Document or Describe the Results. This does not reflect the core competency in the topic of the course: programming. For the Fall

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
			2018 semester, a new textbook will be selected to strengthen the emphasis upon programming and data processing. This change is driven not just from this particular assessment, but also the SLO assessment from past offerings of the course. (05/01/2018)
	Direct - Exam/Quiz - within the course - Candidates in MATH 207 [Principles of Statistical Methods] will be able to calculate empirical probabilities given data. **Criteria Target:** 70% of students will score 7 or higher on a 10 point scale.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 73.8% score 7 or above. (05/01/2018)	**Use of Result:** There are no concerns. (05/01/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 79.8% scored 7 or above. (05/01/2017)	**Use of Result:** There are no concerns. (05/01/2017)
	Direct - Group project, collaborative learning - Candidates in MATH 207 [Principles of Statistical Methods will complete a descriptive statistics project. **Criteria Target:** 70% of students scored 70% or above. **Related Documents:** Descriptive Statistics Rubric(2).pdf	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 77.5% scored 70% or above. (05/01/2018)	**Use of Result:** There are no major concerns. In the Fall 2018, there are plans to have at least three meetings with each group to discuss their progress. (05/01/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 90.8% scored 70% or above. (05/01/2017)	**Use of Result:** There are no concerns. (05/01/2017)
Instructional Choices - Candidates make instructional choices that reflect the integrated nature of mathematical concepts and mathematical practices within and among the mathematical domains. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) [Bloom] **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex	Candidates in EDUC 420 [Math Methods for Elementary Teachers] will complete a unit plan. **Criteria Target:** At least 80% of students will score a 3 or higher on each section of the Unit Plan Rubric. **Related Documents:** Unit Plan Assessment.docx	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students scored 3 or higher on each section of the Unit Plan Rubric. (05/01/2018)	**Use of Result:** There are no concerns with student achievement. With regards to this assessment, asking for three key learnings can be challenging. Rather than scoring the unit plan based on how many, the quality of the key learnings should be what is important, so two truly key learnings may be better than a laundry list of key learnings that may not be clearly related to the unit plan. (05/01/2018)

Student Learning Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
ideas in written and oral presentations., ILO2 - Use of Evidence - Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem., ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. , ILO4 - Professional Responsibility - Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a problem, or achieving a goal. **Revision Notes:** Alignment with Standards: InTasc: Standards 6, 7, 8. MDE Mathematics Secondary: 2.2, 2.4, 2.5, 3.1		**Finding Reporting Year:** 2016-2017 **Goal met:** Yes 100% of students scored 3 or higher in each section of the rubric. (05/01/2017)	**Use of Result:** There are no concerns with student achievement. The assessment focuses on the content knowledge needed to structure unit plans and develop student leaning. This allows the instructor to perceive the strength of the teacher candidates' knowledge of the content to be taught. (05/01/2017)

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Bachelor of Science in Mathematics Secondary Teaching and Bachelor of Science in Mathematics Elementary Teaching Program Review**
This documentation is relevant to Question number:	**14 and 15**
Briefly summarize the content of the file and its value as evidence supporting program review:	**It shows assessment and narrative related to program assessment and it shows alignment with standards.**

Bachelor of Science in Mathematics Secondary Teaching and Bachelor of Science in Mathematics Elementary Teaching Program Reviews

Submitted By: Dr. Kimberly Muller, Chair, School of Mathematics and Computer Science

Date Submitted: August 9, 2016

1. Mission/Vision

The Bachelor of Science in Mathematics Secondary Teaching and the Bachelor of Science in Mathematics Elementary Teaching are programs of the School of Mathematics and Computer Science. Throughout this document we will refer to the Bachelor of Science in Mathematics Secondary Teaching degree as M-ST and the Bachelor of Science in Mathematics Elementary Teaching degree as M-ET. The M-ST and M-ET programs have been in place since 1994. Historically, LSSU had a similar program to the M-ST program from 1971 to 1981. You can find a partial history of the program up to 2004 (with some additional narrative and revisions made in 2006) at http://math.lssu.edu/prpe. In addition, this webpage has information on the content standards, pass rates of the accreditation examination up until 2004 and a detailed program philosophy.

An attempt was made initially to create two separate program reviews for these two programs, but after writing several pages of each, it was found that programs were so similar that the two documents were in many sections nearly identical. After the Chair's consultations with Associate Provost Myton and Dean Fiebelkorn on June 20, 2016, it was decided to create one document. Where there are large differences, these will be noted. If a difference is minor a subscript of ST or ET will be used.

The current program objectives for the two programs were developed in 2009 under the leadership of Professor Sherry Duesing. The objectives for the two programs are identical.

Program Objectives

Upon completion of a Bachelor of Science degree in mathematics: secondary teaching (or elementary teaching), from Lake Superior State University, students will be able to:

1. Demonstrate a fundamental and foundational knowledge of mathematics by developing quantitative and abstract reasoning skills in order to build a conceptual understanding of logical structures and axiomatic systems.
2. Demonstrate technical mathematical skills in the areas of algebra, geometry, calculus, and statistics for solving problems.
3. Use their knowledge of the historical background of mathematics in enriching their own lives and the lives of their future students.
4. Use software and other technology to solve problems.
5. Use their acquired skills in the pursuit of a job and/or graduate school.
6. Create mathematical models and use their mathematical and analytical skills to solve real-world problems.
7. Continue to acquire new knowledge for life-long learning in pursuit of their professional and personal goals.
8. Communicate mathematically in their profession and the broader community.
9. Make connections of mathematical ideas to other ideas both inside of and outside of mathematics.

The similarity between the two degrees is largely due to the similarity to the "Content Guidelines/Standards" matrices for the two certification programs that were instituted by the Michigan State Board of Education in 2000. The State of Michigan guidelines can be found at http://www.michigan.gov/mde/0,4615,7-140-5683_6368-24835--,00.html while our specific program matrices can be found on the website http://math.lssu.edu/prpe. The course mappings in the matrices were created by professors, Sherry Duesing, Lorraine Gregory and Brian Snyder in 2006. There are very few differences between the K-8 and 7-12 Mathematics subject areas and both lead to the Mathematics (EX) endorsement. The test objectives for the certification exams (Michigan Test for Teacher Certification – MTTC) can be found at http://www.mttc.nesinc.com/MI_viewFW_opener.asp. There are some specific content differences due to the grade level of the students.

LSSU Mission Statement

Our mission at Lake Superior State University is to help students develop their full potential. We launch students on paths to rewarding careers and productive, satisfying lives. We serve the regional, state, national and global communities by contributing to the growth, dissemination, and application of knowledge.

Our mathematics programs for future elementary and secondary teachers introduce students to a broad range of both pure and applied mathematics, as well as both continuous and discrete, throughout their four years of study. The M-ET degree

also provides those students with the foundational knowledge required of all elementary education majors. The topics are aligned with the Michigan State Board of Education content guidelines as illustrated by the Program Review done in 2006. In the M-ST degree we've had a 100% placement rate for students in this program over the last five years. In the last two years we've had students who graduated in December obtain mid-year full-time employment in the field. For the M-ET, degree we've had very few students over the last five years, but those who graduated had immediate career placement. (For more information see sections 3 and 4 on "Demand" and "Quality".) Because of our emphasis very early in MATH 103_{ET}, MATH 104_{ET}, MATH 215 and MATH 216_{ST} on inquiry-based, student-centered learning and our requirement of passing the licensure exam (MTTC) and student teaching before graduation, our graduates exit LSSU with the ability to both think independently and communicate their ideas effectively. As teachers, our graduates join a workforce that has dissemination as its primary goal.

> *LSSU Vision Statement*
>
> ***Our programs grow and evolve in ways that keep our graduates at the cutting edge of technological and societal advances. As such, we will be viewed by our constituents as:***
>
> - The preferred regional choice for students who seek a quality education which provides a competitive edge in an evolving job market.
> - An institution where relevant concepts are taught by quality faculty, and are paired with practical real-world experience to provide a well-rounded education.
> - An institution which capitalizes on its location to instill graduates with an understanding of environmental issues and an overarching desire to be responsible stewards of the environment.
> - A University that is highly student centered and empowers all students to realize their highest individual potential.

Our program also supports the University Vision in several different ways. One of our program outcomes is that graduates should be able to "use software and other technology to solve problems". Several of our classes support this outcome including Elementary Statistics, Linear Algebra, College Geometry, Mathematical Modeling and Principles of Programming. As for quality faculty, except in rare cases, all of our program courses are taught by faculty who hold a doctorate in a field of pure or applied mathematics, statistics or mathematics education. The rare exceptions include courses where there is a co-teacher with a terminal degree in a related field, such as engineering. All of these faculty members have publications in their respective fields, one had a previous successful career at a tier one university, one has had prior K-12 experience, one has had more than 50 publications since coming to LSSU, two have received teaching awards, and one has co-authored a textbook in his field. Another program outcome is for successful graduates to "create mathematical models and use their mathematical and analytical skills to solve real-world problems." Many of our courses have course objectives tied to this program outcome, including MATH 103_{ET}, 104_{ET}, 151, 152, 207, 251_{ST}, 310_{ST}, and 401_{ST}. In particular, in the M-ST program, MATH 401 has a class project where the students work together to solve a current problem. In 2016 their class project was to design a mathematical model that would specifically help LSSU. One of our greatest areas of strength is the individual attention that our students receive. All of our classes are small with 30 or fewer students. When one compares this with larger state universities, which have large lecture classes for first year students, we are able to provide a uniquely student-centered atmosphere in the classroom. Our introductory proof sequence has 15 or fewer students and is typically taught using inquiry based learning. This is a very student-centered approach where students present the material to each other. In MATH 325, the students work in groups though activities both in the classroom and in the computer lab to form conjectures and build their own axiomatic system. For the elementary education students, MATH103 and 104 are taught using problem-based learning rather than direct instruction. Our program was the preferred regional choice in M-ST for many years. In fact, a large percentage of the area middle school and high school mathematics teachers are LSSU graduates. In 2011-2012, the teacher education programs at LSSU were placed on probation by the Michigan Department of Education. At the time our M-ST and M-ET pass rates had been between 89% (due to one student) and 100% for many years, but our programs took a large hit in enrollment that year and saw continued declines. While we don't think we can claim the status of preferred regional choice currently, our students have had an outstanding record on the certification exam and in job placement for many years. This would be an excellent area to promote as a program of distinction.

Several areas of the Strategic Plan are supported by our program. Some of these are emerging and others are more established.

2.1 LSSU will increase enrollment. For the last two years we have offered a Field Day experience for area high school students where we introduced students to topics in mathematics and computer science using hands-on activities. We also contacted admitted students after they were accepted, made new brochures and power point slides for our programs, increased the visibility of our Pi Day activities and saw a large increase in admitted students for this program. Last year there were 10 admits to these programs compared to 0 the year before and one the previous year. Sadly, this year we have seen a reversal of that trend.

2.5 LSSU will graduate students who have had an exceptionally good university experience. The one-on-one attention that our graduates receive gives them a chance to exceed beyond expectations. Students learn from instructors with a variety of experiences, including K-12 teaching experience and others involved in teacher professional development. They become involved in the content using inquiry based learning and problem solving, not just listening to lectures. Students are prepared for the classroom by extensive field experience and student teaching opportunities.

4.1 LSSU will increase high-impact educational experiences in BS/BA degree programs. Our students learn using inquiry-based learning and problem solving. Our students complete projects in MATH 207, MATH 321, MATH 325, MATH 341_{ST}. They have several hands-on classroom experiences, as well as student teaching.

4.3 LSSU will improve the tracking process of graduate success. We have been tracking our graduates' placements three months after graduation since 2012 and have increased efforts to track them later.

4.5 LSSU will prepare graduates who are ready for professional certifications or licensure. Our students are prepared to take MTTC certification exam since the course work required in the programs correlates to the objectives for the licensure exams (MTTC). The current pass-rate for the secondary and elementary exam in 100% for those majoring (not minoring) in these areas.

4.6 LSSU will increase the number of students participating in professional conferences and workshops. Several of our students have attended Math Teachers' Circle meetings. Three students attended the Michigan Council of Teachers of Mathematics conference July 2015.

6.1 LSSU will define assessment and engage in meaningful, institutionalized assessment activities. Our school has been doing course assessment with well-established objectives for many years. Our program assessment has improved greatly over the last four years.

6.2 LSSU will utilize appropriate and developing technology to facilitate effective and enriched learning experiences across the campus community. This is an area in which we excel. In fact we purchased and used many technologies such as i-Pads, tablets and document cameras before they were more widely available across campus. We also use many educational and commercial software packages in our courses to enhance student understanding of difficult mathematical concepts.

There are several areas that distinguish these programs from our main competitors in the state. One is the small class size, especially at the calculus level. A second is the number of courses that have opportunities for the students to present the material that they are learning to their peers, giving them ample opportunities to practice communicating mathematics before they begin their student teaching. Also, the fact that our program is housed in the mathematics department (as opposed to education) provides a level of mathematical rigor that facilitates a deeper understanding of the core content areas.

2. Productivity

The faculty and adjuncts in mathematics teach a large percentage of classes that are not required by our majors. Because all of the faculty teach courses that are both in the program and out of the program, gauging productivity can be difficult. Because of this we have tried to use several different measures. First, we will take a look at instructional load for courses with the MATH prefix. This includes developmental courses (MATH 087, MATH 088, MATH 102) and general education courses (MATH 110, MATH 111, MATH 131, MATH 207). Of these general education courses only MATH 207 is required in these programs. There is also a course that is taught as service to business and science (MATH 112), courses only required by the Elementary Education and M-ET programs (MATH 103 and MATH 104) and courses that are filled by a variety of majors including Mathematics, M-ET, M-ST, Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering and Physical Science (MATH 151, MATH 152, MATH 251_{ST}, MATH 310_{ST}). The only courses in these programs under review that are not included in other non-teaching programs are MATH 321 and MATH 325. Using data from two consecutive academic years (2014-2015 and 2015-2016) the mathematics faculty load can be broken down as follows:

- Developmental—25.7%
- General Education—36.1%
- Service to business and science—7.3%
- Courses only required for all Elementary Education majors and **M-ET**—3.0%
- **M-ST and M-ET Only**—1.4%
- **M-ST and M-ET** with Heavy Service—18.6%
- B.S. in Mathematics and **M-ST** Only—2.7%
- B.S. in Mathematics, **M-ET and M-ST**—2.1%
- B.S. in Mathematics Only—3.2%

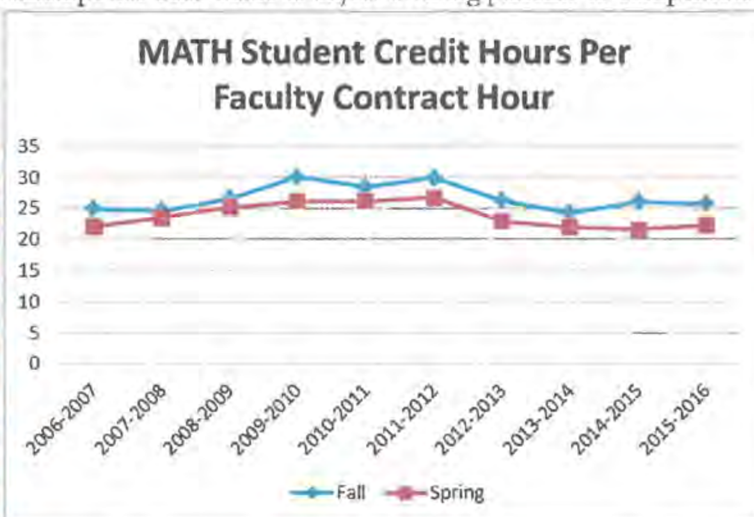
Only 1.4% of our mathematics faculty instructional load is used exclusively for these two programs. That is approximately 3.2 load hours per year. Additionally, only 4.8% of the load is used by this program without also being required for general education or engineering which significantly increases the student credit hour/load hour ratio for those courses. This represents 10.5 load hours per year for these programs, along with the B.S in Mathematics. (This file is in tracdat.) Note

that none of the courses used for the M-ET program are exclusive to that program. In correspondence with Dean Fiebelkorn about whether or not this program should be deleted for low enrollment, one of the reasons she gave for keeping this program was, "Provided we keep the elementary math minor, the elementary education program period, and the secondary math major, then there are no unique courses that are offered only for the elementary math major."

A second measure of productivity is from Professor Collette Coullard's Spring 2015-2016 Cost-Revenue Analysis. In her analysis, based on classroom discussions with Associate Provost David Myton and Interim Vice President of Finance Morrie Walworth, she took into consideration tuition, state funding, the tuition plateau, discounted tuition, State of Michigan Contributions, auxiliary funds, faculty salary, faculty benefits and 50% overhead. The Cost-Revenue analysis for those instructors who predominantly teach mathematics courses was a net revenue of \$951,887 and for the department as a whole was \$1,111,013. In the discussions during Professor Coullard's presentation of her class's research, President Pleger mentioned that one measure of cost effectiveness would be whether or not each faculty member's revenue from student credit hours to instructional load (taking into consideration all of the above variables) made a profit. Each mathematics faculty member does so according to this analysis.

Along those same lines, a third measure of productivity would be the ratio of student credit hours to faculty contract hour. The following table tracks data from 2006-2016. The numbers in blue represent the ratio of student credit hours to faculty contract hours in the Fall and the numbers highlighted in red are from Spring. The average of the Fall ratios is 26.6 with a standard deviation of 2.0 and the average of the Spring ratios is 23.9 with a standard deviation of 1.9. Even though there has been some fluctuation, an attempt has been made to adjust offering patterns to compensate for enrollment declines.

Term	Student Credit Hours	Faculty Contract Hours	Student Credit Hours Per Faculty Contract Hour
Fall 2006	2881	115.66	24.91
Spring 2007	2091	94.66	22.09
Fall 2007	2893	117.66	24.59
Spring 2008	2294	97.66	23.49
Fall 2008	3173	119.66	26.52
Spring 2009	2612	103.66	25.20
Fall 2009	3202	106.70	30.01
Spring 2010	2406	91.96	26.16
Fall 2010	3263	114.96	28.38
Spring 2011	2671	101.96	26.20
Fall 2011	3301	110.66	29.83
Spring 2012	2691	100.63	26.74
Fall 2012	2974	113.63	26.17
Spring 2013	2324	101.23	22.96
Fall 2013	2845	117.26	24.26
Spring 2014	2143	97.63	21.95
Fall 2014	2747	105.63	26.01
Spring 2015	2182	101.13	21.58
Fall 2015	2659	103.33	25.73
Spring 2016	1997	89.63	22.28



Divisions (As Defined in the Load Report Summary)	Instructional Load	Total Contract Hours	Student Credit Hours	Student Credit Hours per Instructional Load	Rank of SCH per ILH	Student Credit Hour per Contract Hour	Rank of SCH per CH
Business Fall	158.36	163.364	2870				
Business Spring	149.09	155.091	2951	18.933	4	18.279	4
CJFS Fall	108.844	109.8439	2459				
CJFS Spring	111.426	108.844	2718.59	23.506	2	23.676	2
Education Fall	60.197	72.1967	635				
Education Spring	64.906	72.6561	532	9.3283	11	8.0565	11
Engineering Fall	128.455	136.475	1413.55				
Engineering Spring	152.003	154.39	1306.44	9.6984	10	9.3514	9
EMS Fall	20.488	20.488	290				
EMS Spring	26	26	205	10.648	8	10.648	8
A & L Fall	233.676	251.671	4181				
A & L Spring	201.95	218.952	3135	16.794	5	15.545	5
Lib Arts Fall	5.333	12.0033	56				
Career Develop Spring	3.6667	11.9967	20	8.4447	12	3.1667	12
MathCS Fall	155.67	159.333	3532				
MathCS Spring	141.9	144.9	2638	20.735	3	20.281	[illegible]
Nursing Fall	210.1	228.067	1913.61				
Nursing Spring	126.23	144.227	1454.6	10.015	9	9.0472	10
PS_CBS Fall	163.7	166.704	4672.9				
PS_CBS Spring	184.45	187.445	5291	28.62	1	28.135	1
RSES Fall	97.1627	106.1597	1150				
RSES Spring	99.198	108.198	1146	11.693	7	10.711	7
Sciences Fall	309.11	338.109	3870				
Sciences Spring	327.38	354.38	5217.66	14.278	6	13.123	6

A fourth measure is the next comparison, to the left, with other academic areas (as separated by the load report summary on the O:\ drive). It was made using the summary for 2015-2016. Because of our heavy service load our ratio of student credit hours per faculty instructional load hours is the 3rd highest division on campus and our ratio of student credit hour per faculty contract hour is also the 3rd highest division on campus. (Instructional load does not include release time and Faculty Contract Hours do. Some areas receive a larger percentage of release time than others.) This data deals with instructional load.

A shortcoming of the above measures is that they show that the faculty members who teach courses in these programs are productive, but they don't show specifically what is happening in the program courses. The next table is an attempt to track course enrollment numbers for the program courses. The courses with bold yellow font have undergone changes to their course offering pattern in the last few years in order to either save money or make the course load easier on students taking multiple mathematics courses.

	Total Enrollment in Courses								
M-ET or M-ST	COURSE	TITLE	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
M-ET	MATH103	Number Sys/Prob Solv Elem Teac	32	20	12	12	24		9
M-ET	MATH104	Geometry/Measurement Elem Teac	32	29	18	18	12	8	8
M-ET, M-ST	MATH151	Calculus I	83	92	97	103	89	59	69
M-ET, M-ST	MATH152	Calculus II	46	54	57	57	67	59	61
M-ET, M-ST	MATH207	Prin of Statistical Methods	220	253	295	268	243	197	192
M-ET, M-ST	MATH215	Fund Concepts of Mathematics	18	25	19	20	19	6	7
M-ST	MATH216	Discrete Math/Problem Solving	14	8	11	11	6	5	5
M-ST	MATH251	Calculus III	39	31	42	24	24	44	47
M-ET, M-ST	MATH305	Linear Algebra	22		9		7		12
M-ST	MATH310	Differential Equations	37	35	38	23	30	39	30
M-ET, M-ST	**MATH321**	**History of Mathematics**	**13**	**20**	**13**	**5**	**9**	**5**	
M-ET, M-ST	**MATH325**	**College Geometry**	**9**		**7**		**5**	**7**	
M-ST	MATH341	Abstract Algebra I		15		8		10	
M-ST	**MATH401**	**Mathematical Modeling**		**16**		**14**	**8**		**8**
M-ET, M-ST	EDSE301	Intro to Special Education				5	9	4	8
M-ET, M-ST (Prior to Fall 2012)	EDUC150	Reflections Learning Teaching	55	64	48				
M-ET, M-ST	EDUC250	Student Diversity and Schools	50	61	43	17	21	17	15
M-ET, M-ST	EDUC301	Educ Psych & Learning Theory	40	42	20	22	15	11	10
M-ET	EDUC330	Reading Elementary Classroom	27	19	13	9	10	4	8
M-ET, M-ST	EDUC350	Int Tech 21st Century Lrn Env					0	11	9
M-ET	EDUC410	Corrective Reading Classroom	28	23	13	6	11	3	7
M-ET	EDUC411	Elem Lang Arts/Literacy Skills	21	26	13	11	14	4	5
M-ST	EDUC415	General Instructional Methods						11	8
M-ET	EDUC420	Math Methods Elem Teachers	27	24	17	6	12	3	7
M-ET	EDUC421	Science Methods Elem Teachers	26	26	15	7	9		8
M-ET	EDUC422	Soc Studies Meth Elem Teachers	27	28	12	9	5	2	5
M-ET	EDUC423	Art Methods-Classroom Teachers				13	15	11	13
M-ET	EDUC424	Hlth/Phy Ed Meth Cl Room Teach				9	12	5	10
M-ST	EDUC431	The Secondary Learner	18	15	20	7			
M-ST	EDUC440	Reading in the Content Area	19	21	22	7	8	6	3
M-ST	**EDUC442**	**Math Methods Secondary Teache**	**10**	**0**	**11**				
M-ST	**EDUC452**	**Dir St Math Meth Sec Teachers**					**1**	**4**	**1**
M-ST	EDUC460	Classroom Management						6	8
M-ET, M-ST	EDUC480	Directed Teaching Seminar	37	28	35	34	17	15	6
M-ET, M-ST	EDUC492	Directed Teaching	37	28	35	34	17	15	6

M-ET and B.S. in Elementary Education	64	49	30	30	36	8	17
M-ET, M-ST, Service and General Education	220	253	295	268	243	197	192
M-ET and M-ST Only	32	20	31	5	15	16	1
M-ET and/or MST with Large Service Component	205	212	234	207	210	201	207
M-ST and/or M-ET, with B.S. in Mathematics	54	64	39	53	40	21	32
M-ST and/or M-ET, with other Education Degree:	412	405	306	196	175	128	136

The other enrollment numbers come from the following general education or program requirements. The following courses are specifically required by other majors (than M-ET or M-ST).

MATH 103 & MATH 104—Elementary Education

MATH 207—General Education, Athletic Training, Biochemistry, Computer Networking, Computer Science, Criminal Justice (Corrections, Criminalistics, Generalist, Homeland Security, Law Enforcement, Loss Control, Public Safety), Electrical Engineering Technology, Environmental Science, Exercise Science, Fire Science, Forensic Chemistry, Geology, Industrial Technology, Manufacturing Engineering Technology, Medical Laboratory Science, Nursing, Parks and Recreation, Physical Science

MATH 151 & MATH 152—Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mathematics, Mechanical Engineering, Physical Science

MATH 251, MATH 310—Computer Engineering, Electrical Engineering, Mathematics, Mechanical Engineering

Other than the courses in dark green, all other courses serve students in multiple majors. For those courses in dark green, two of them are alternate year offerings. This is only 6.3333 load hours over a two year period. Students have a choice between EDUC 442 and EDUC 452, but only EDUC 452 has been offered in recent years because it can be prorated. Our programs have very few expenses that are program specific. The needed software licenses, computers, instructional technologies and paper usage are more than covered by our course fees. It would seem the costs to the university are minimal, especially considering our large service role.

The following table shows the 10-year enrollment data for these two programs. Also included are the enrollments in the Bachelor of Science in Mathematics degree because 10 of the required courses for that program are also in the M-ST program.) We have included the minors because these students contribute to the enrollment in the courses.

	Bachelor of Science in Mathematics Elementary Teaching	Bachelor of Science in Mathematics Secondary Teaching	Bachelor of Science in Mathematics	Minor in Mathematics Elementary Teaching	Minor in Mathematics Secondary Teaching	Minors in Mathematics
Fall 2006	1	13	10	25	3	13
Fall 2007	0	13	8	17	2	11
Fall 2008	3	14	8	15	4	6
Fall 2009	3	12	9	13	3	7
Fall 2010	3	16	13	17	2	5
Fall 2011	0	19	11	14	2	4
Fall 2012	2	12	14	23	6	8
Fall 2013	0	9	12	12	8	14
Fall 2014	1	9	11	9	4	8
Fall 2015	2	10	11	2	3	15

As you can see by looking at the "Fall 2012" line, the fact that the education programs at LSSU were put on probation in 2012 impacted the enrollment in our programs and we have yet to recover. It is concerning that the majors dropped precipitously, but it is equally concerning that the Minor in Mathematics Elementary Teaching did as well. Since most of the courses overlap, our course enrollment and course offering patterns have been impacted. As noted earlier, prior to that year, these were regional programs of choice. We should consider ways that we can return the numbers to their prior levels. We believe that one of the best ways would be to advertise our high pass rates on the MTTC exam.

To be consistent with last year's B.S. in Mathematics program review an attempt was made to use the Ipeds database from the National Center for Educational Statistics to compare our enrollment with the 15 public universities in Michigan but in Ipeds, the data for all education majors was combined in one total and we were unable to separate by discipline.

The table to the right shows degree conferral. The table contains M-ET, M-ST and the B.S. in Mathematics because before 2009, the institutional data was combined for some of these programs. We've separated out the data in those years using Anchor Access and commencement programs, but if you do your own report in Argos, it will combine some of the data.

Academic Year	Bachelor of Science in Mathematics Elementary Teaching	Bachelor of Science in Mathematics Secondary Teaching	Bachelor of Science in Mathematics	Total
2006-2007		2	4	6
2007-2008		3	3	6
2008-2009	1	3	3	7
2009-2010		1	1	2
2010-2011	1	1	4	6
2011-2012		5	2	7
2012-2013		3	3	6
2013-2014			2	2
2014-2015		2	3	5
2015-2016		2	1	3

On a national level, data is collected every decade. According to the Conference Board of Mathematical Sciences 2010 survey at http://www.ams.org/profession/data/cbms-survey/cbms2010, there were a total of 3,614 degrees in mathematics education awarded in 2009-2010. (This is the last year that data is available.) There were 2774 four-year institutions in that

year, giving an **average of 1.3 related mathematics education degrees per four year institution**. (One commercial website seems to indicate that only around 1700 of these have programs in mathematics education bringing the ratio to 2.1, but we were not able to verify this number on a more dependable public site.) Our total degrees awarded for those programs is typically around 2, making us only slightly higher (or lower) than average.

Using Argos to estimate the terms to graduation for these two programs, the average was 9.09 terms for majors in this program over the period from 2009-2014 and 8.30 for LSSU graduates as a whole (more recent data appears to be unavailable in Argos). Since these students need student teaching in order to graduate, this difference is not surprising. In a 2014 report from Al Case in Admissions, the overall FTIC retention rate from Fall 2010-2014 at LSSU was 70.40% and for the M-ST degree it was 83.30%. (No number was provided for M-ET and this report is not available in Argos. We made an attempt to obtain more recent numbers from Annette Hackbarth-Onson in Admissions who referred us to Vice President Morrie Walworth. At the time of this writing, no new data has been made available.)

3. Internal and External Program Demand

External Demand:

Mathematics is a high need area for high school and middle school math teachers. According to the Occupational Outlook Handbook of the Bureau of Labor Statistics there will be a growth of 6% in the demand for high school and middle school teachers from 2014-2024.

According to the National Center for Educational Statistics, 15% of secondary level teachers are Mathematics teachers. Just less than 2% of elementary teachers focus on mathematics while 62% teach several subjects, including mathematics. (Source: https://nces.ed.gov/programs/digest/d13/tables/dt13_209.10.asp, accessed June 28, 2016). The Occupational Outlook Handbook (OOH), issued by the Bureau of Labor and Statistics, projects the job outlook for teachers in all disciplines to "grow about as fast as the average" between 2008 and 2018, an estimated 13% in ten years. Across the country, public interest in the school system is on the rise and the federal government has increased spending for education. The need for highly qualified teachers continues to expand.

A table published by the National Center for Educational Statistics provided information regarding the percentage distribution of public elementary and secondary schools with a teaching vacancy in selected teaching fields, by the school's reported level of difficulty in filling the vacancy, teaching field, and locale: 2011-12. The information regarding mathematics teachers was that the percentage of schools with vacancies was 20% nationwide of which 1.1% could not be filled 2012-13. This was the fourth highest vacancy rate listed. Source: http://nces.ed.gov/surveys/ruraled/tables/c.1.c.-1.asp

Both programs are approved by Michigan Department of Education (MDE) and are two of four possible majors available at LSSU for prospective teachers. In addition, the success of the mathematical education students has consistently remained good. We feel that the decline in enrollment has more to do with the problems caused by probation in 2011-2012 and less to do with demand. The students who have graduated in recent years have all either been employed immediately or had employment offers, but chose to pursue other opportunities.

Internal Demand:

Refer back to page 5 for programs that require the M-ST or M-ET program courses. The largest constituents outside of mathematics are:

- MATH 151 & MATH 152—Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering, Physical Science
- MATH 251, MATH 310—Computer Engineering, Electrical Engineering, Mechanical Engineering

The table and lists on that page best represent internal demand. Another indication of demand is the enrollment of minors in these areas. All students must now take mathematics as part of their general education classes. As a result of this and other programs' requirements, most of the students enrolled in mathematics courses are not students majoring in M-ST, M-ET or the Bachelor of Science in Mathematics.

4. Program Quality

Mathematics introduces students to formal reasoning and, as a result, contributes to development of qualitative and quantitative analytic skills. The math department in its service role, as well as a major department, is proud to have promoted, to continue to promote, and to improve those indispensable skills for the entire LSSU community and all LSSU

graduates. Over the years the department has recruited and retained strong mathematicians and mathematics educators as witnessed by their recent scientific and pedagogical output:

- Dr. Grace Ngunkeng has published 3 refereed articles in the past 3 years, has presented her work at the 2013 Joint Mathematics Meetings, and has attended 6 conferences in the past 3 years.
- Dr. Kimberly Muller has published 4 refereed articles and has presented her scholarly work at 15 meetings or workshops in the past 10 years.
- Dr. Lorraine Gregory has made 6 conference presentations in the past 10 years.
- Dr. Brian Snyder has coauthored a textbook, published 1 refereed article, and attended 9 conferences in the past 10 years.
- Dr. Collette Coullard has published 5 refereed articles and made 2 conference presentations in the past 10 years.
- Dr. George Voutsadakis has published 44 research articles and participated in 6 conferences in the past 10 years.

It has developed a regional reputation and has strongly contributed to outreach activities promoting mathematics and mathematics education and, thus, increased the University's visibility and service in the community. Some examples of our state and regional involvement are:

- Dr. Brian Snyder just finished a year as chair of the Michigan Section of the Mathematical Association of America,
- Dr. Collette Coullard, Dr. Lorraine Gregory and Dr. Kimberly Muller, serve on the Eastern Upper Peninsula Math and Science Center Advisory Board,
- Dr. Collette Coullard and Dr. Kimberly Muller serve on the planning committee for the Eastern Upper Peninsula Math Teachers' Circle,
- The School of Mathematics and Computer Science hosted the Michigan Section of the Mathematical Association of America's annual meeting in 2013,
- Dr. Lorraine Gregory, Dr. Kimberly Muller and Dr. Brian Snyder have taught professional development workshops in 4 different regions across the state,
- Dr. Lorraine Gregory has been involved in several professional development activities for K-12 teachers in the Upper Peninsula, and the state, the most recent being two preconference professional development for MCTM, July 2015,
- Dr. Lorraine Gregory has served as the VP for 4 year colleges for the Michigan Council of Teachers of Mathematics,
- The School of Mathematics and Computer Science has held two Field Day experiences for area high school students, an event we hope to repeat as an annual recruiting effort,
- The School of Mathematics and Computer Science holds an annual Pi Day and math bowl for area middle school and high school students.

Moreover, some of our majors have been among the highest GPA graduates and have been awarded University-wide distinctions, many with regular placement on the Dean's list and graduating cum laude, magna com laude or summa cum laude. Of the program's graduates over the last seven years, 42.9% graduated cum laude, 14.3% graduated magna cum laude, and 14.3% graduated summa cum laude. The average GPA was 3.56. Two have been awarded Faculty Association university-wide scholarships based on overall academic excellence.

Several graduates have established and continue to distinguish themselves in their professions. We are providing three examples below. In addition to the quotes that we have included, we are grateful to these graduates for providing valuable feedback that can be used to strengthen our programs. Please note that two of these graduates received mid-year placement when a district was in a bind to fill a vacant position. However, they were both asked to return the following year to the same placement because of their excellent work.

The first example is Andrew Doerr who graduated in December of 2014. Mr. Doerr was able to obtain a mid-year placement as a mathematics teacher and golf coach at Sacred Heart Academy in Mount Pleasant. When asked about his time here, he replied, "LSSU's Math Education program prepared me to teach a variety of classes. Going in to LSSU, I was not nearly as confident with the material that I was going to be teaching as I am now. The professors were there for me in and out of the classroom, and were always available for when I needed extra assistance. I am very appreciative of the professors and the people that I met at LSSU, and they definitely have had an impact on who I am today."

Chris Ogren, who graduated from the M-ST program in 2013, worked at Kalamzoo Central High School as a 9th grade math teacher from October 2013-August 2015. In the Fall of 2015 he returned to his hometown to teach at Escanaba High School as a Geometry and AP Statistics teacher. When asked about his time here, Mr. Ogren said "I feel that at Lake

Superior State, I received an education that taught me all of the math I will need for being a teacher. I learned to not only memorize the necessary math skills, but also to think like a mathematician. I believe that the math faculty at LSSU did a great job of breaking math down to its fundamentals, and then building up to the more complex ideas. The program had a great balance of classes that challenged me on multiple levels. I especially look back and appreciate the things I learned in Math 215, College Geometry, History of Math, and Math Modeling. Most of my math classes were helpful, but those 4 are the classes I find myself referencing to students in my everyday teaching."

One of our most recent graduates, Jessica Keilholtz, accepted a mid-year placement at the middle school in Cedarville after graduating in December of 2015. They asked her to return next fall and she has accepted the position. Ms. Keilholtz said, "my content knowledge was strong enough that my only worry was classroom management and I had enough people to have my back that I made it through alright." She also indicated that her student teaching position in Brimley taught her to "handle a lot of situations so I felt well prepared." She said that, "The class that helped me the most would be the college geometry class. Being able to define shapes and show how to create them using technology was very useful."

Through feedback from these students, one area where we could support them more is outside of the mathematical content area. For example Ms. Keilholtz relied on her new colleagues to teach her where to find educational resources. Finding new approaches to teaching difficult topics was sometimes a challenge for her. There are many websites that provide these educational resources and/or tips. This could perhaps be added to the Methods course or to a series of seminars.

The Mathematics Education program was originally approved by the Michigan Department of Education in 1998. It was reapproved in 2006. In 2012, 6 programs in education were suspended by the state of Michigan and others were discontinued. Mathematics was not one of these programs. While the pass rate for the suspended programs on the state licensure exams was low, the pass rate for mathematics has remained high, typically above 90% for secondary education and recently, 100%. This compares to the state pass rate for secondary mathematics of 96.5%. There have been too few elementary mathematics majors taking the test (3 or fewer). More specific data is in the Program Assessment section. Following the suspension of programs in 2012, the School of Education sought out and completed accreditation by the national accrediting body for schools of education – The Council for the Accreditation of Educator Preparation (CAEP). This was successfully granted in October 2013. The School of Education continues to succeed, with recent ratings from the Department of Education being among the highest in the state. (http://www.lssu.edu/education/ accessed June 29, 2016)

Our programs compare favorably in its depth and quality to other peer mathematics programs. Two important documents for comparing our programs to those of others are the **Curriculum Guide to Majors in Mathematical Sciences**, published in 2015 by the Mathematical Association of America's Committee on Undergraduate Programs in Mathematics (CUPM) and **The Mathematical Education of Teachers II, (METII)** published by the Conference Board of Mathematical Sciences in 2012.

In 2015 the CUPM released its new **Curriculum Guide to Majors in the Mathematical Sciences**. It has four cognitive recommendations and nine content recommendations for programs in mathematics. Since these recommendations are brand new, we were impressed with how well our programs already fit. We will list those goals and briefly explain how we meet them. In some cases, for the sake of brevity, the recommendations are linked to our program outcomes. The first set of recommendations is for general mathematics programs, but we highlight them in order to support our earlier claim, that the placement of our programs within the department of mathematics is an added strength to the quality and rigor of our program.

Cognitive Recommendation 1: Students should develop effective thinking and communication skills. Program Outcome 8.

Cognitive Recommendation 2: Students should learn to link applications and theory. Program Outcome 6.

Cognitive Recommendation 3: Students should learn to use technological tools. Program Outcome 4.

Cognitive Recommendation 4: Students should develop mathematical independence and experience open-ended inquiry. Program Outcome 7. Specifically our use of inquiry-based learning in multiple mathematics courses and our student teaching experience.

Content Recommendation 1: Mathematical sciences major programs should include concepts and methods from calculus and linear algebra. MATH 151, MATH 152, MATH 251_{ST}, MATH 305, MATH 310_{ST}, MATH 401_{ST}

Content Recommendation 2: Students majoring in the mathematical sciences should learn to read, understand, analyze, and produce proofs at increasing depth as they progress through a major. MATH 103_{ET} , MATH 104_{ET}, MATH 215, MATH 216, MATH 321, MATH 325, MATH 341

Content Recommendation 3: Mathematical sciences major programs should include concepts and methods from data analysis, computing, and mathematical modeling. MATH 103_{ET} , MATH 104_{ET}, MATH 207, MATH 305, MATH 401_{ST}, CSCI 103_{ET}, CSCI 105, CSCI 121_{ST}

Content Recommendation 4: Mathematical sciences major programs should present key ideas and concepts from a variety of perspectives to demonstrate the breadth of mathematics. Our program has a mixture of theoretical and applied topics.

Content Recommendation 5: Students majoring in the mathematical sciences should experience mathematics from the perspective of another discipline. CSCI 105, PHYS 221_{ST}, CHEM 115_{ST}, NSCI 101_{ET}.

Content Recommendation 6: Mathematical sciences major programs should present key ideas from complementary points of view: continuous and discrete; algebraic and geometric; deterministic and stochastic; exact and approximate.

Continuous: The majority of the calculus sequence
Discrete: MATH 216_{ST}, parts of MATH 152, parts of MATH 401_{ST}
Algebraic: MATH 103_{ET}, MATH 305, MATH 341_{ST}
Geometric: MATH 104_{ET}, some topics in the calculus sequence, some topics in MATH 305, MATH 321, MATH 325 and MATH 401_{ST}
Deterministic: MATH 310_{ST}, some topics in MATH 401_{ST}
Stochastic: MATH 207, some topics in MATH 401_{ST}
Exact: Most of the calculus sequence
Approximate: Some topics in the calculus sequence, some topics in MATH 401_{ST}

Content Recommendation 7: Mathematical sciences major programs should require the study of at least one mathematical area in depth, with a sequence of upper-level courses. We don't require this.

Content Recommendation 8: Students majoring in the mathematical sciences should work, independently or in a small group, on a substantial mathematical project that involves techniques and concepts beyond the typical content of a single course. MATH 321, MATH 325, MATH 401_{ST}

Content Recommendation 9: Mathematical sciences major programs should offer their students an orientation to careers in mathematics. Students in this area are typically only interested in teaching. However, this is an area that could use improvement.

Coursework is important for the formation of a successful teacher. However, "upper-division courses typical of a mathematics major have minimal impact on the quality of a teacher's instruction, as measured by student performance." (MET II p. 53) MET II recommends that courses for prospective teachers should provide teachers with opportunities for the full range of mathematical experiences. These recommendations are as follows:

Recommendation 1: Prospective teachers need mathematics courses that develop a <u>solid understanding of the mathematics they will teach.</u> The list of courses outlined above illustrate the depth of knowledge required of students. However, not all of the courses examine the mathematics from a teacher's perspective. Notable exceptions are MATH 103_{ET}, MATH 104_{ET}, MATH321, MATH325 and the methods courses, in the context of preparing lessons and learning activities.

Recommendation 2: Coursework that allows time to engage in reasoning, explaining, and making sense of the mathematics that prospective teachers will teach is needed to produce well-started beginning teachers. Although the quality of mathematical preparation is more important than the quantity, the following recommendations are made for the amount of mathematics coursework for prospective teachers.

i) ***Prospective elementary teachers should be required to complete at least 12 semester-hours on fundamental ideas of elementary mathematics, their early childhood precursors, and middle school successors.*** MATH 103_{ET}, MATH 104_{ET} provide 10 contact hours (8 credits) of elementary and middle school mathematics content. In addition, MATH 325 reviews many definitions used in elementary mathematics, then builds on to those concepts quickly. MATH 215 and MATH 216_{ST} covers counting and the properties of integers and rational numbers.

ii) ***Prospective middle grades (5–8) teachers of mathematics should be required to complete at least 24 semester-hours of mathematics that includes at least 15 semester-hours on fundamental ideas of school mathematics appropriate for middle grades teachers.*** MATH 103_{ET}, MATH 104_{ET} provide 10 contact hours (8 credits) of elementary and middle school mathematics content. In addition, MATH 305 and MATH 325 review many definitions used in middle school mathematics, then builds on to those concepts quickly. MATH 215 and MATH 216_{ST} covers counting and the properties of integers and rational numbers.

iii) ***Prospective high school teachers of mathematics should be required to complete the equivalent of an undergraduate major in mathematics that includes three courses with a primary focus on high school mathematics from an advanced viewpoint.*** These courses include the MATH 151, MATH 152, MATH 207, MATH 215, MATH 216_{ST}, MATH 251_{ST}, MATH 305, MATH 310_{ST}, MATH 341_{ST} and MATH325.

Recommendation 3: Throughout their careers, teachers need opportunities for continued professional growth in their mathematical knowledge. Our students are prepared to begin teaching, and our faculty members are actively involved with professional development locally and in various locations in the State. Through our roles as advisors for the region's Math and Science Center, we know that there are many opportunities for teachers in the state to continue their professional development.

Recommendation 4. All courses and professional development experiences for mathematics teachers should develop the habits of mind of a mathematical thinker and problem-solver, such as reasoning and explaining, modeling, seeing structure, and generalizing. Courses should also use the flexible, interactive styles of teaching that will enable teachers to develop these habits of mind in their students. The authors of MAT II cite the Standards for Mathematical Practice included with the Common Core State Standards (CCSS-M), notably problem solving, reasoning and modeling mathematics. As described earlier in this document, our students have multiple opportunities to observe these Practices in their classrooms, especially when inquiry, proof and problem solving form a basis for the instruction.

Recommendation 5. At institutions that prepare teachers or offer professional development, teacher education must be recognized as an important part of a mathematics department's mission and should be undertaken in collaboration with mathematics education faculty. More mathematics faculty need to become deeply involved in PreK–12 mathematics education by participating in preparation and professional development for teachers and becoming involved with local schools or districts. The number of faculty who have or are currently involved in Professional Development indicates the level of importance placed on mathematics education PreK to college level. Moreover, one faculty member, Dr. Lorraine Gregory, has experience teaching in elementary and high schools, has a Doctorate in Education, and is actively involved in the School of Education as well as the mathematics department.

Recommendation 6. Mathematicians should recognize the need for improving mathematics teaching at all levels. Mathematics education, including the mathematical education of teachers, can be greatly strengthened by the growth of a mathematics education

community that includes mathematicians as one of many constituencies committed to working together to improve mathematics instruction at all levels and to raise professional standards in teaching. All faculty in the Mathematics Department are involved in the education of our students and the development of the mathematics education degree program. In addition, our faculty, with cooperation from the EUPISD and the EUP Math and Science Center, began a Math Teachers' Circle in 2013. A Math Teachers' Circle is a professional development community of middle school and high school math teachers, together with mathematicians in higher education and industry who get together to do math.

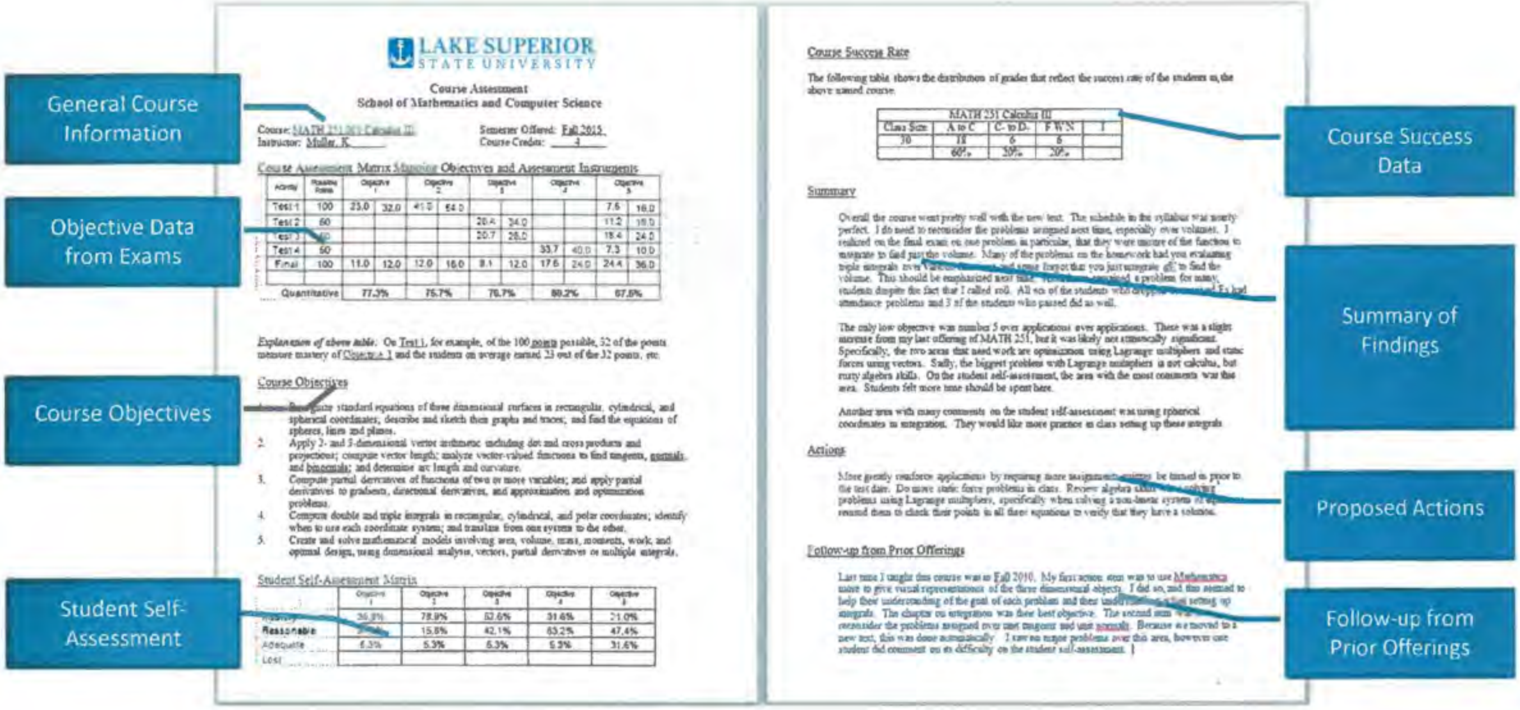
Finally, many of our classes are using technology in state-of-the-art classrooms and labs. Our School purchased many of these technologies for CAS 119, CAS 205, CAS 207, CAS 209A, CAS 210 and CAS 303 before they were more widely available on campus. Document cameras have been available for several years now, before they appeared in all classrooms across campus, and are used for a variety of purposes including displaying the content currently being discussed, student work on problems, student presentations, etc. TI84 calculators are extensively used in several classes, especially MATH207. Software specifically for educational purposes is available such as Geometer's Sketchpad. Besides technology, the department maintains a large collection of manipulatives such as place-value blocks, Algeblocks, tiles, geoboards, 2 and 3 dimensional shapes, etc. to assure that future teachers are aware of the place of these items in a rich mathematics educational experience.

5. Assessment

Our School has a well-established assessment strategy for all of its programs which began in 2008 with the establishment of a School Assessment Committee under the leadership of now Professor Emeritus Sherry Duesing. The Assessment Committee formed subcommittees by discipline and created measurable outcomes for all courses and programs by 2009 and created a mapping by 2010. All of these objectives are located on the N: drive, though some have been edited in Tracdat since that time. Those objectives were then reviewed by Professor Duesing and Dr. Gregory to ensure that the outcomes were properly worded using established terminology in the field of Education.

Course Assessment

In 2009, we created a two-page template for course objective assessment which recorded our data and a summary of how we planned to use this data to strengthen our courses, which would of course strengthen our programs as well. You can locate these old reports, beginning with assessment from 2009, on the N: drive under Assessment. Before Tracdat, we had a well-established routine of completing our course assessment documents and steadily improving our courses. We feel our progress in this regard was well-ahead of the University as a whole. Course proposals were sent to the Curriculum Committee making changes to MATH 310 and MATH 325. In the summer of 2015, in preparation for writing a previous program review the chair of the School of Mathematics and Computer Science reviewed the School's assessment on the N: drive and in Tracdat and found that many of the faculty had continued under the old process while also entering data into Tracdat. These faculty upload the School document into Tracdat as evidence using "related document". Some faculty only completed the School document, but did not enter their data into Tracdat. Some faculty entered assessment data into Tracdat, but no longer completed the School document. In the Fall of 2015, with the endorsement of Dr. David Myton, Associate Provost, the School voted to return to using the School's assessment template, with improvements that were more in line with the information that Tracdat usually required, such as a section that specifically requests "Actions" and a section for "Follow-up" on prior actions to complete the assessment loop.



On January 22, 2016, after Dr. Myton made some changes in Tracdat to align with our assessment template, Dr. Myton wrote, "Please thank your faculty for their assessment work. Your School is now the campus leader in terms of green checks and absence of red flags - congratulations!" In addition to Tracdat, many assessment reports can be found on the School's N: drive for easier viewing.

Program Assessment

The School has mapped course objectives to the program objectives. In most cases these course objectives are used to measure the program objectives. In one case the objective is measured by student placement after graduation. For those objectives where course outcome data is used, the numbers were calculated using the last semester/year of offering during the last two year cycle. Except for a few select cases of alternate year offerings, we used the data from 2015-2016. As you can see from the next table, in most cases the targeted threshold for the objective is met. Those boxes are green. There are three objectives where the numbers are lower that the target of 90%. Those boxes are red. To provide more context for how these numbers were calculated, inside the 6 courses in the M-ET program that have course outcomes aligned with Program Objective 1, there were 24 outcomes mapped to that objective. Of those 24 outcomes, 21 of the 24 were assessed as meeting the desired success rate during course assessment, giving an 87.5% percentage of course outcomes meeting the desired standard. If one more objective had met the desired standard, the objective overall would have met its 90% threshold. (Although the table shows that there is possibly some room for improvement, a quick look back at prior offerings shows that many of the course outcomes that did not meet the desired standard for this last offering, have met that standard recently. If we had chosen to do so, we could have used the "best" data instead of the most recent.) One should also note that the large majority of the objectives that did not meet the desired standard are in courses that are largely populated by students who are not majors in mathematics, M-ET or M-ST, so these numbers are likely not representative of our majors.

	Program Objectives	M-ET Courses	M-ST Courses	Targeted Threshold	Percentage of M-ET Course Objectives that Met Target	Percentage of M-ST Course Objectives that Met Target
1	Demonstrate a fundamental and foundational knowledge of mathematics by developing quantitative and abstract reasoning skills in order to build a conceptual understanding of logical structures and axiomatic systems.	MATH 103, MATH 104, MATH 215, MATH 305, MATH 321, MATH 325	MATH 215, MATH 216, MATH 305, MATH 341, MATH 321, MATH 325, MATH 401	90% of related objectives to hit targeted threshold	87.5%	85.7%
2	Demonstrate technical mathematical skills in the areas of algebra, geometry, calculus, and statistics for solving problems.	MATH 103, MATH 104, MATH 151, MATH 152, MATH 207, MATH 305, MATH 321, MATH 325	MATH 151, MATH 152, MATH 207, MATH 251, MATH 305, MATH 310, MATH 321, MATH 325	90% of related objectives to hit targeted threshold	84.5%	76.9%
3	Use their knowledge of the historical background of mathematics in enriching their own lives and the lives of their future students.	MATH 103, MATH 104, MATH 321	MATH 321	90% of related objectives to hit targeted threshold	100.0%	100.0%
4	Use software and other technology to solve problems.	MATH 103, MATH 104, MATH 207, MATH 305	MATH 207, MATH 305, MATH 401	90% of related objectives to hit targeted threshold	100.0%	100.0%
5	Use their acquired skills in the pursuit of a job and/or graduate school.			At least 80% of the respondents should be employed or in graduate school within a year of graduation.	100.0%	100.0%
6	Create mathematical models and use their mathematical and analytical skills to solve real-world problems.	MATH 103, MATH 104, MATH 207, MATH 151, MATH 152	MATH 151, MATH 152, MATH 251, MATH 310, MATH 401	90% of related objectives to hit targeted threshold	95.1%	80.0%
7	Continue to acquire new knowledge for life-long learning in pursuit of their professional and personal goals.	MATH 215, EDUC 480, EDUC 492	MATH 215, MATH 216, MATH 341, MATH 401, EDUC 480, EDUC 492	90% of related objectives to hit targeted threshold	100.0%	100.0%
8	Communicate mathematically in their profession and the broader community.	MATH 103, MATH 104, MATH 215, MATH 321, MATH 325	MATH 215, MATH 321, MATH 325, MATH 341	90% of related objectives to hit targeted threshold	100.0%	100.0%
9	Make connections of mathematical ideas to other ideas both inside of and outside of mathematics.	MATH 103, MATH 104, MATH 207	MATH 207, MATH 151, MATH 152, MATH 401	90% of related objectives to hit targeted threshold	100.0%	100.0%

All education students must pass the MTTC licensure exam prior to student teaching. This is perhaps a better measure of whether or not these targeted graduates are meeting program outcomes. Secondary education mathematics majors take the secondary mathematics exam. Our pass rate has remained high with 100% of the M-ST majors attempting the exam passing it from 2012-2015. On the other hand, elementary mathematics majors need to first pass the elementary education exam, and may become highly qualified without taking/passing the elementary mathematics exam. Currently, the pass rate for the M-ET majors is also 100%. The same exam is taken both by students majoring in mathematics as those minoring in mathematics, so some of the students included in the table below are minors, who take many of the same courses as those who are majoring in mathematics. The majors are in blue. All but one of the minors in the secondary program were still successful, but there is less success among the minors in elementary education.

	Test Code 22 - Secondary 89 - Elementary		Test Date	Result	Score (provided only for Fail; cut score is 220)	Subareas: Mathematical Processes and Number Concepts	Patterns, Algebraic Relationships, and Functions	Measurement and Geometry	Data Analysis, Statistics, Probability, and Discrete Mathematics
Tester 1	22	major	10/13/2012	P		2	4	2	2
Tester 2	22	minor	10/13/2012	P		4	3	4	4
Tester 3	22	minor	1/5/2013	P		3	4	3	3
Tester 4	22	minor	4/13/2013	F	202	1	2	2	3
Tester 5	22	major	4/13/2013	P		4	4	3	4
Tester 6	22	minor	7/13/2013	P		2	4	2	4
Tester 7	22	minor	10/5/2013	P		4	4	3	3
Tester 8	22	major	1/4/2014	P		2	3	2	4
Tester 9	22	major	10/11/2014	P		4	4	4	4
Tester 10	22	major	11/22/2014	P		3	3	3	3
Tester 11	22	major	4/18/2015	P		4	4	4	4
Tester 12	22	major	7/11/2015	P		3	4	3	3
Tester 13	89	minor	4/14/2012	P		4	4	4	4
Tester 14	89	minor	4/14/2012	F	189	3	1	2	1
Tester 15	89	minor	7/14/2012	F	192	3	1	1	2
Tester 16	89	minor	7/14/2012	P		4	4	4	4
Tester 17	89	minor	7/14/2012	F	213	2	2	2	3
Tester 18	89	major	4/13/2013	P		4	3	3	2
Tester 19	89	minor	4/13/2013	P		4	3	3	2
Tester 20	89	minor	4/12/2014	P		4	2	2	3
Tester 21	89	minor	4/12/2014	F	206	3	2	2	1
Tester 22	89	minor	10/10/2015	P		4	4	4	4

1 = Examinee answered few or none of the questions correctly (scaled subarea score of 100-179)
2 = Examinee answered some of the questions correctly (scaled subarea score of 180-219)
3 = Examinee answered many of the questions correctly (scaled subarea score of 220-259)
4 = Examinee answered most or all of the questions correctly (scaled subarea score of 260-300)

6. Opportunity Analysis

Recruitment

Our School developed several new initiatives to increase enrollment in the past year including a **Mathematics and Computer Science Field Day** for area high school students, calling and writing potential students, developing new pamphlets and power point presentations on our programs and increasing our presence on social media. We expected it to take several years to see any increase based on our efforts, but our school shows a remarkable 58.1% increase in admits already in 2015 (the largest increase shown in the data compiled by Joe Barrs at that time). We did not see the same increases this year for these two programs. While we no longer have access to reports from Joe Barrs, we are basing this on the number of students attending orientation. From the data pre-2011, we have a market for these two degrees in the region. We need to find new ways to market our students' overwhelming success from these two programs both on the certification exams and in job placement. A major STEM recruitment push makes perfect sense right now, and we believe our school is poised to attract those attentive to the job predictions. Note that our programs are much less expensive to run than many other programs, and we have the capacity to substantially increase enrollment with little or no marginal cost. We have requested changes to the tour guide notes for admissions that highlight our programs. While it seems these changes have not yet be made, we have seen other positive changes since the arrival of Annette Hackbarth-Onson and are hopeful that our programs will be highlighted in the future. We will continue to increase our efforts in recruitment, and we will continue to point out this opportunity for non-academic departments to support our efforts.

Facilities

Our facilities requirements are minimal. We share a lab with computer science and the computers are updated on a five year rotation using course fees. The course fees for MATH103 and 104 contribute to the collection of manipulatives used in those courses.

Potential

We have streamlined our course offerings so that courses exclusively for these programs are offered only every 2 years. We also changed the course offering pattern so that students would be less likely to need several of intensive mathematics courses at once. Still, these courses typically run with an enrollment of 5-10 students, which leaves room to recruit up to 20 additional students, at no marginal cost to LSSU. We would also like to see an increase in the number of minors for these two areas.

7. Optional

While our program is not zero-cost it does pay for itself as evidenced in other sections. Most mathematics programs across the U.S. are small when compared with overall offerings because it takes a comparatively rare gift for a student to succeed in such a program. Please do not underestimate the value of our strong ties to the K-12 community. Through our joint work with area teachers we have many opportunities to interact with regional teachers and students to promote LSSU and what we have to offer. Through workshops, advisory boards, projects, we interact with teachers regularly. The school district comes to us when they have a teaching vacancy to ask for recommendations. This is a tie to the people who interact daily with our potential students that is both priceless and only costs us time. Usually this time is spent disseminating knowledge on a subject that we love.

Appendix Cover Sheet

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Degree Audit**
This documentation is relevant to Question number:	**15**
Briefly summarize the content of the file and its value as evidence supporting program review:	**It shows the current curriculum for this degree.**

B.S. Mathematics: Elementary Teaching

Lake Superior State University
Degree Audit Sheet (EX endorsement)

Name________________________ **ID#** __________________ **Advisor**______________

Expected Date of Graduation ________________ **Math Dept. Approval** ______________

Enter semester (i.e. F17) and grade (i.e. B) for each class at LSSU, for transfer credits enter BOTH: 'TR' and the grade.
The Certification GPA for the math major, the EPP and PES will include all grades from all institutions.

Elementary Mathematics Major **Sem/Grade**
[min. grade=C; min GPA=2.70, max 33 credits

Course	Cr	Sem	Grade
CSCI105 Intro to Computer Program	3		
CSCI106 Web Page Design and Dev	3		
MATH103 Number Systems & Prob	4		
MATH104 Geometry & Measurement	4		
MATH151 Calculus I	4		
MATH152 Calculus II	4		
MATH207 Princ. Statistical Methods	3		
MATH215 Fund. Concepts of Math	3		
MATH305 Linear Algebra	3		
MATH321 History of Mathematics	3		
MATH325 College Geometry	3		
*EDUC420 Elementary MATH Metds	2		

Elementary Planned Program [EPP] **Semest/Grade**
[min. grade = 'C'; min. GPA = 2.70; max cr = 49]

Course	Cr	Sem	Grade
MATH103 Num Syst & Problem Solv	4		
MATH104 Geometry & Measurement	4		
MATH207 Princ. Stat. Methods	3		
BIOL104 Survey General Biology	4		
NSCI101 Conceptual Physics	4		
NSCI102 Intro Geology	4		
POLI110 American Government	4		
GEOG201 World Reg Geography	4		
HIST131 US History I	4		
HIST321 Michigan History	2		
ENGL222 English Grammar	3		
ENGL335 Children's Literature Class	3		
ENGL180 Intro. Literary Studies	3		
CHLD225 Emergent Literacy	3		

General Education Requirements (36-42 credits)
□ *Check if MACRAO or GE-Cert completed*

Course	Cr	Sem	Grade
ENGL110 First year composition I	3		
ENGL111 First year composition II	3		
Communication (COMM101 rec)	3		
*Humanities elective (ENGL180)	3		
Humanities elective	3-4		
*Social Sci elec (e.g. GEOG201	4		
*Social Sci elec (e.g. POLI110)	4		
*Natural Science elect (e.g. NSCI110)	4		
*Natural Science elect (e.g. NSCI102)	4		
*Math elective (e.g. MATH207)	3-5		
*Diversity elective (e.g. EDUC250)	41		

Professional Education Sequence [PES]
[min. grade = B- incl. transfers; max cr = 48]

Course	Cr	Sem	Grade
EDUC101 Self as Learner	1		
EDUC250 Student Diversity & Schools	4		

Admission to Teacher Education required to continue:

Course	Cr	Sem	Grade
EDSE301 Intro to Special Education	3		
EDUC301 Ed. Psych. Learning Theory	3		
EDUC330 Reading Elem Classroom	3		
EDUC350 Integrating Technology	3		
EDUC410 Corrective Reading	3		
EDUC415 Gen Instructional Methods	2		
EDUC411 Elem Lang Arts Methods	2		
EDUC420 Elementary Math Methods	2		
EDUC421 Elemen Science Methods	2		
EDUC422 Elem Meth Social Studies	2		
EDUC423 Arts Methods	2		
EDUC424 Health/Phys Ed Methods	2		
EDUC460 Classroom Management	2		

Admission to Student Teaching required for following:

Course	Cr	Sem	Grade
EDUC480 Directed Teaching:Sem	2		
EDUC492 Directed Teaching	10		

Graduation Criteria include:

□ Residency: 50% of 300/400 courses earned at LSSU
□ Total credits in excess of 124, no minor required
□ GPA OVERALL & major & EPP 2.70 (B-) or higher
□ No courses in major or EPP below "C" (2.00)
□ No education course below "B-" (2.70)

Certification requires a passing grade on the MTTC Elementary Education exam (test #103)

Mathematics Endorsement (EX) requires a passing grade on the MTTC Mathematics (Elementary) exam (#089)

Dean ______________________

* indicates electives met by other program requirements

Effective Fall 2018

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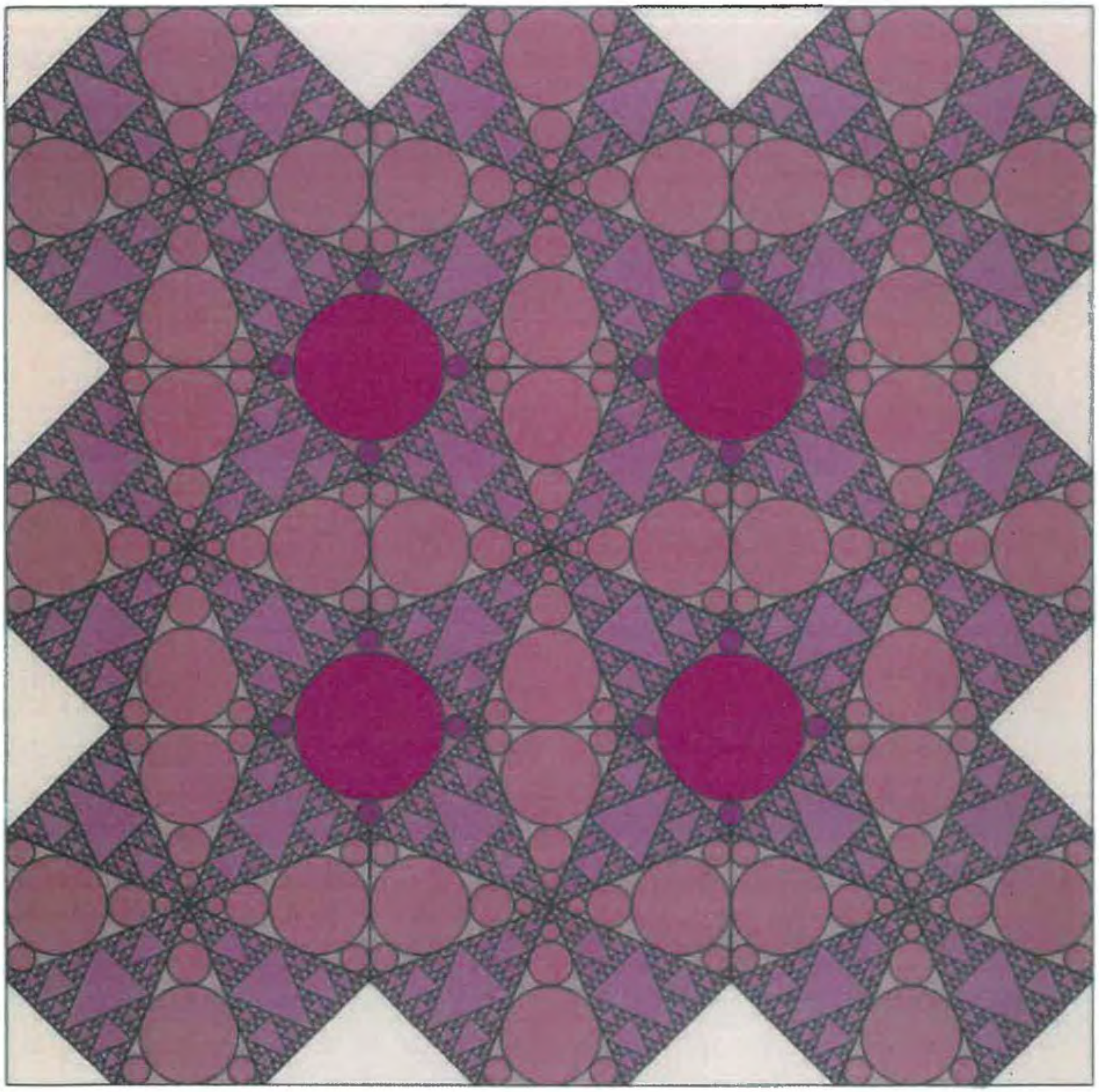
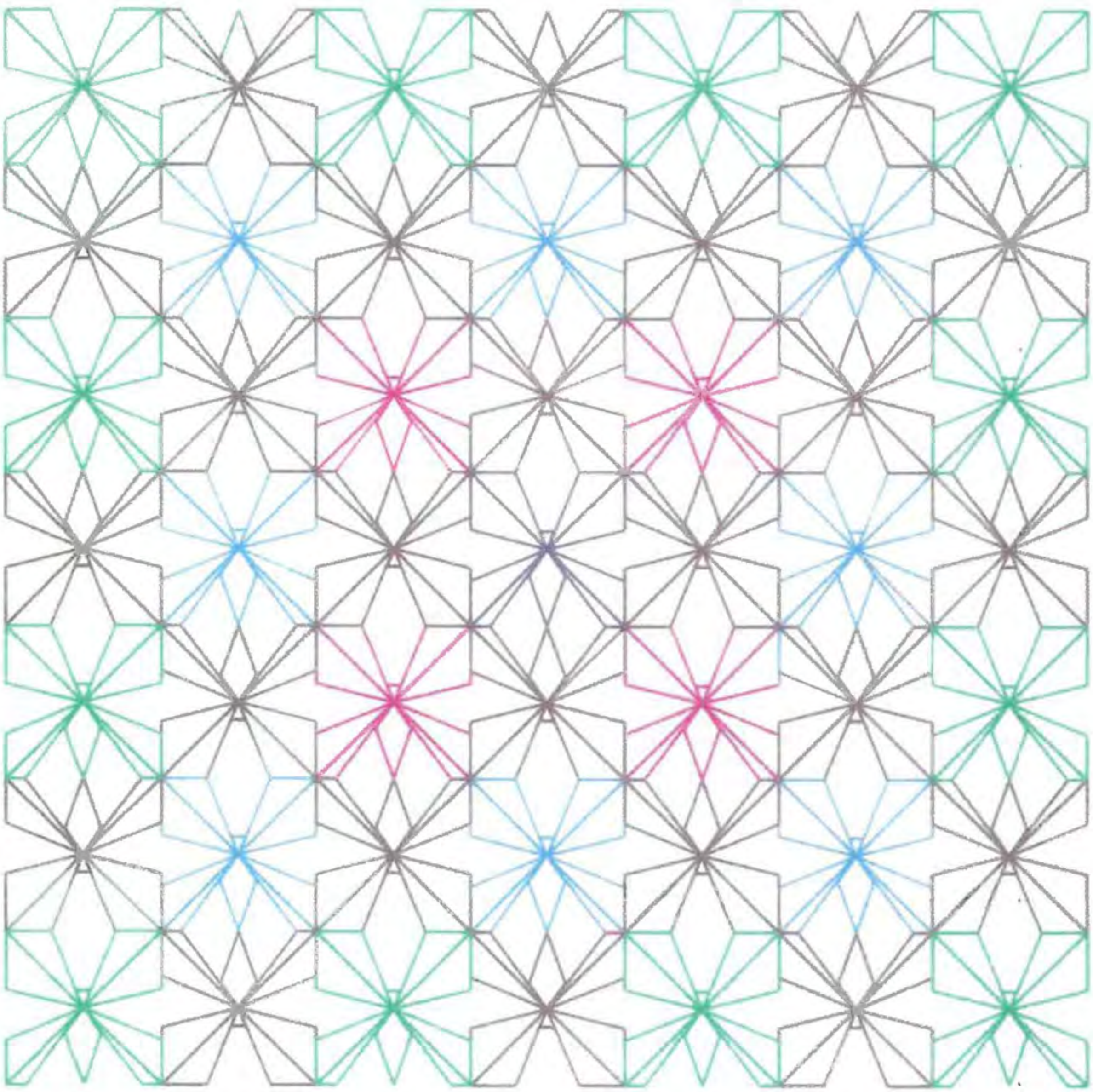
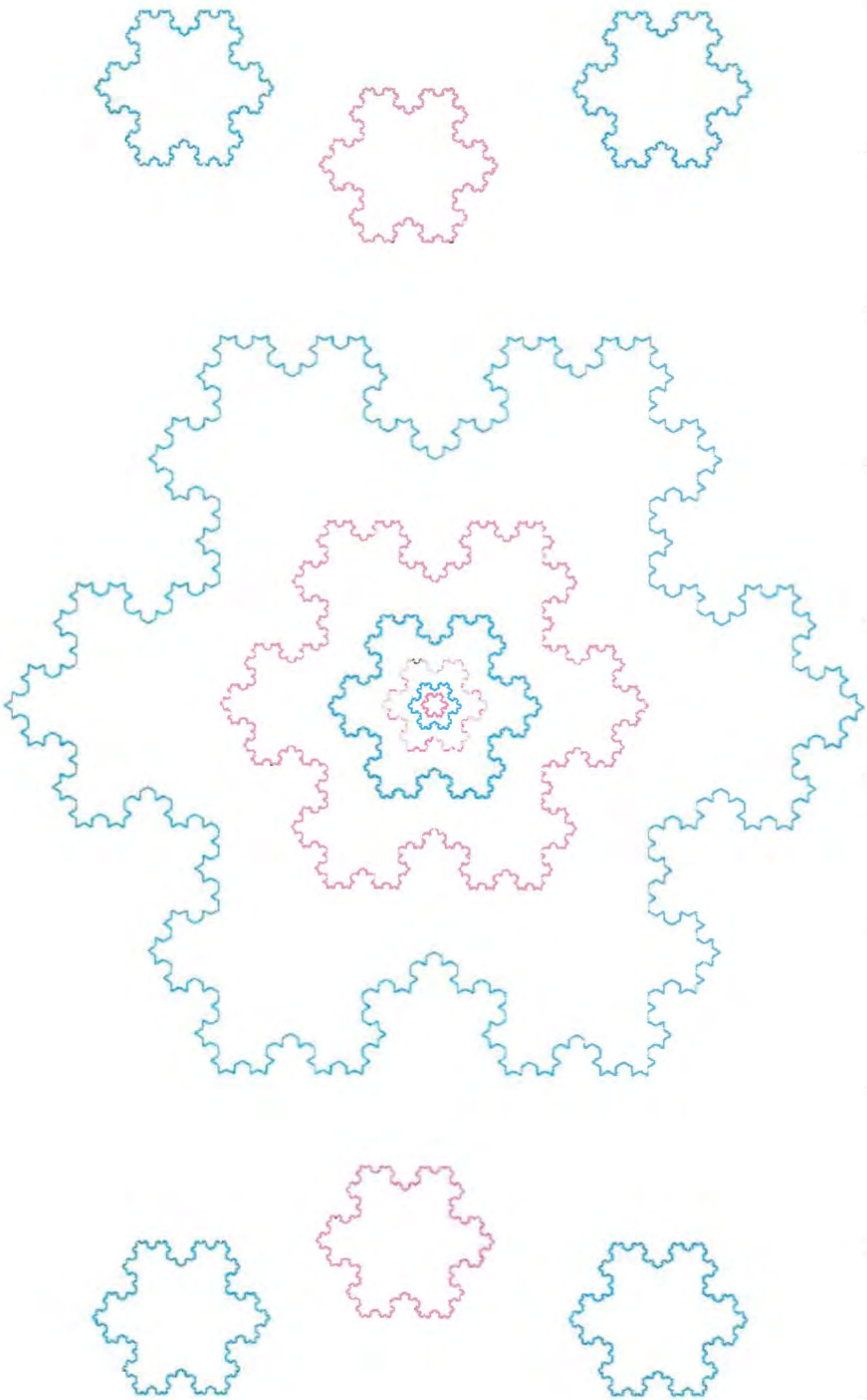
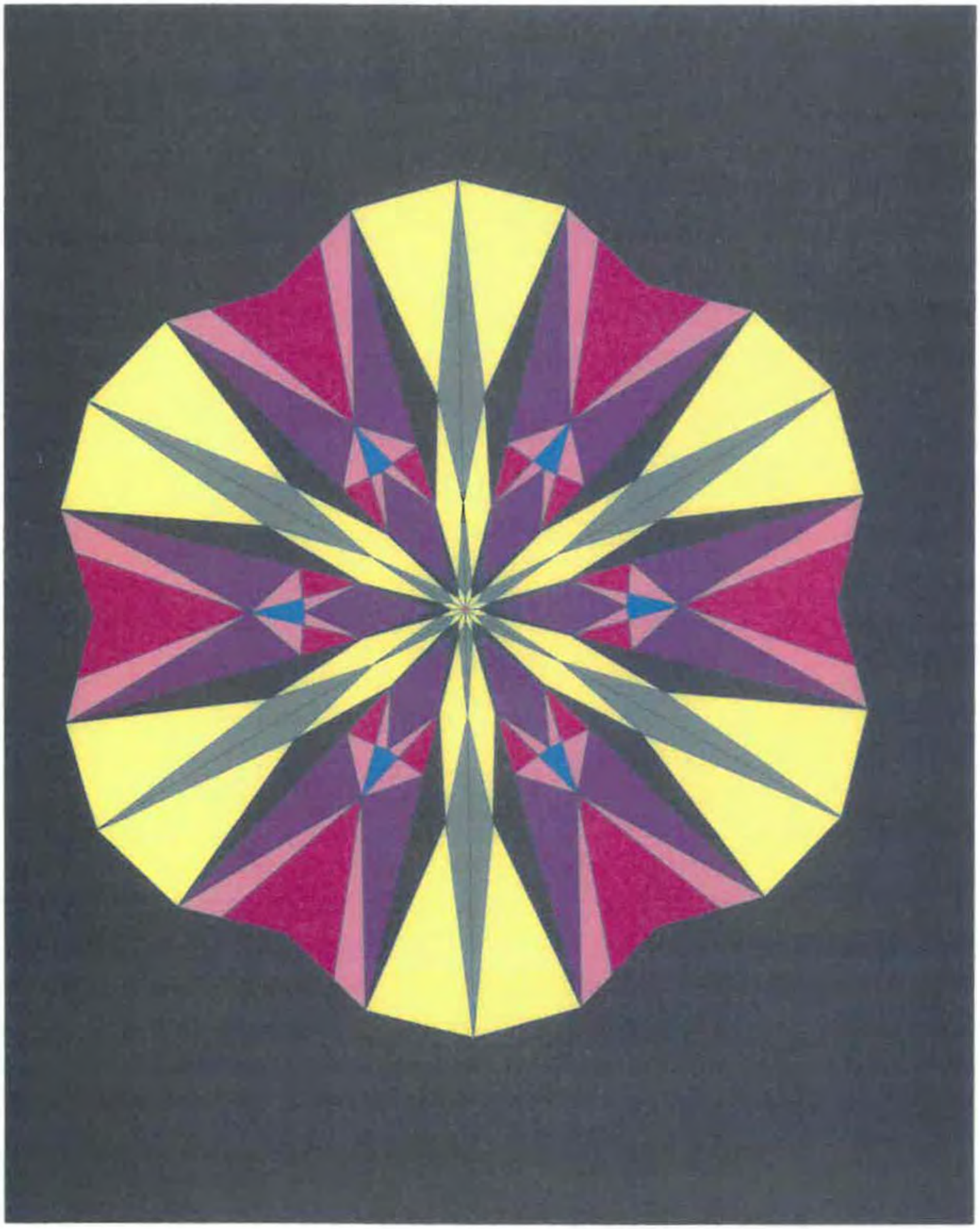
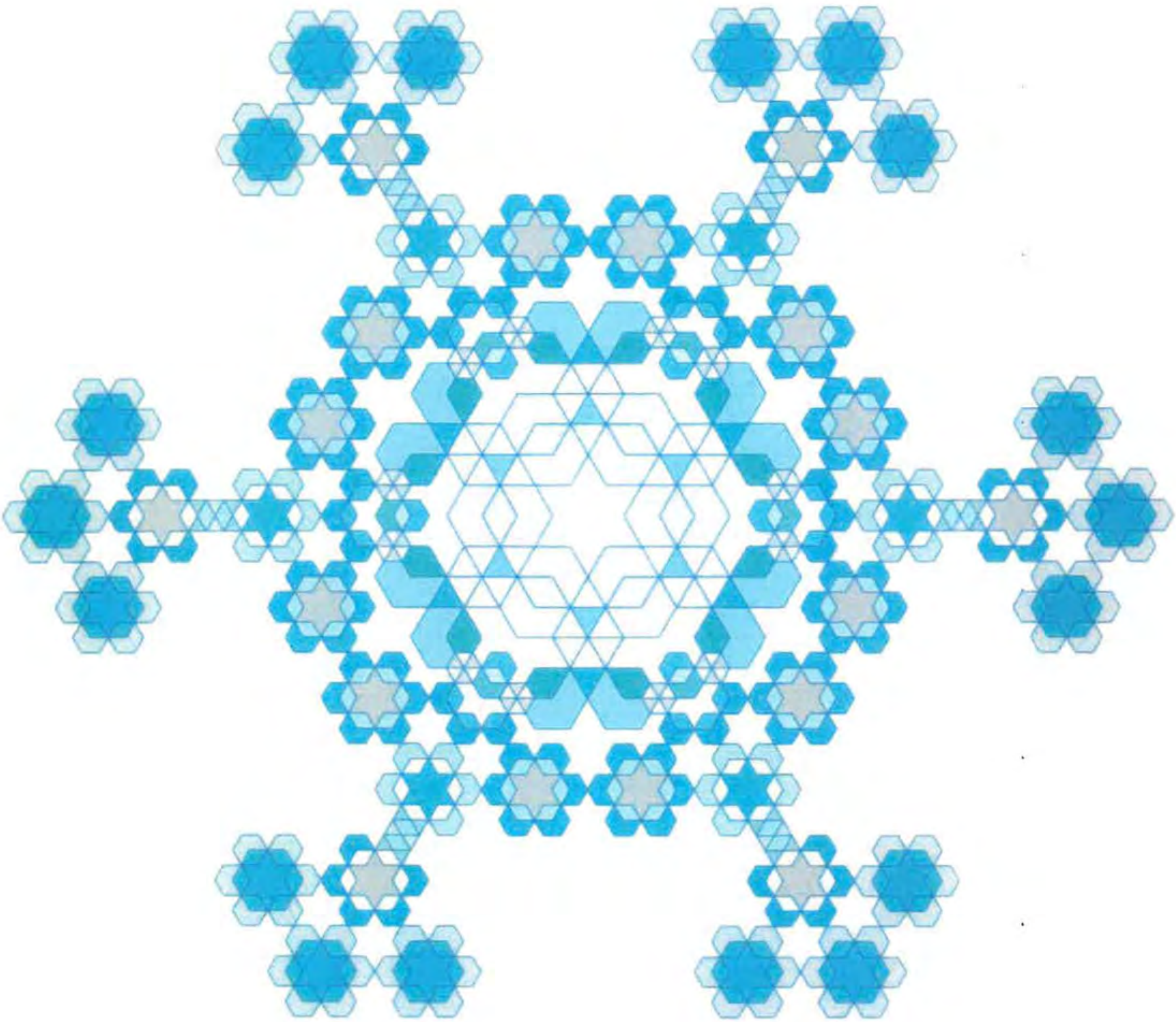
School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**MATH 325 Project Examples**
This documentation is relevant to Question number:	**16**
Briefly summarize the content of the file and its value as evidence supporting program review:	**It shows examples of students creative works related to transformational geometry and symmetry.**

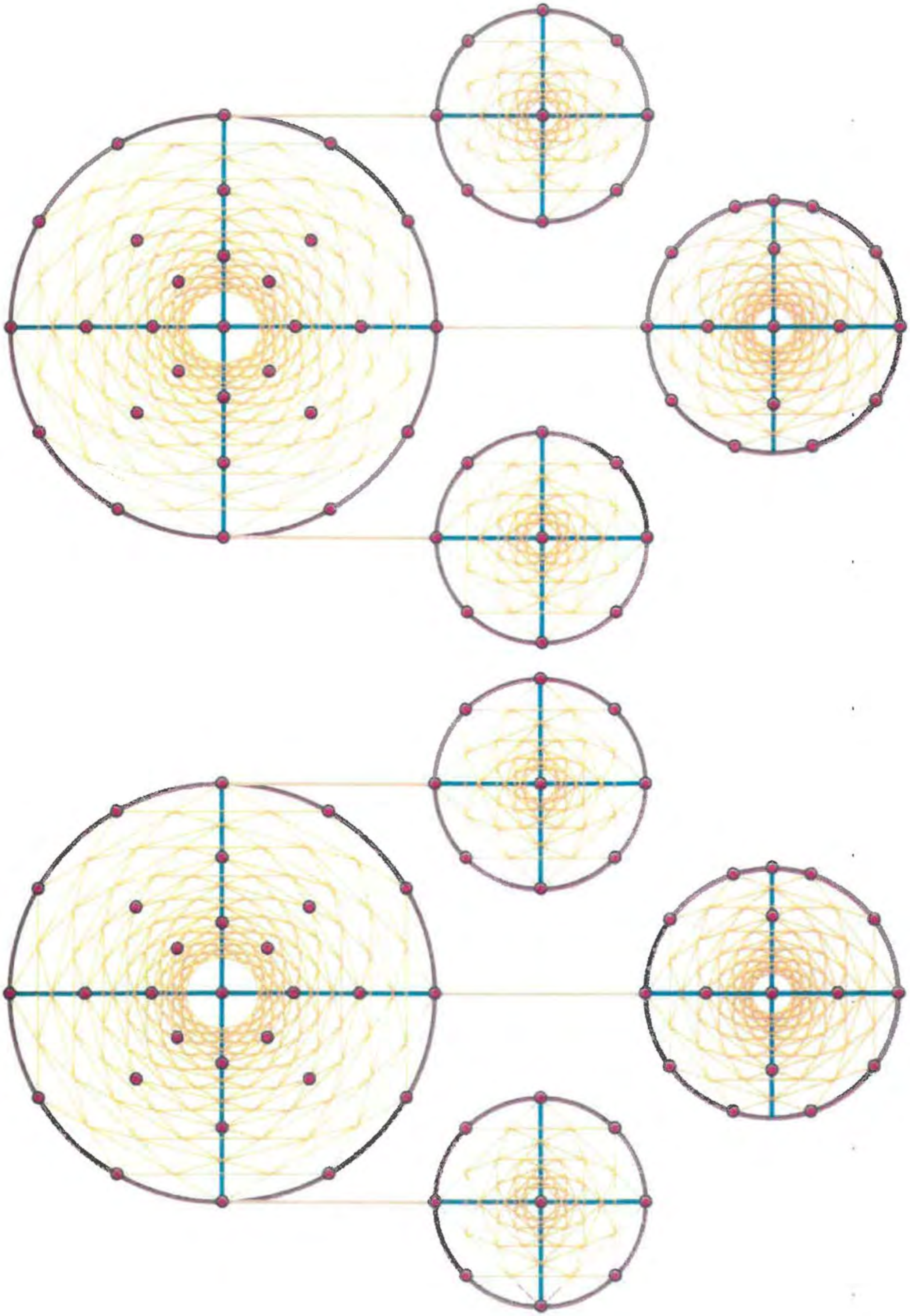


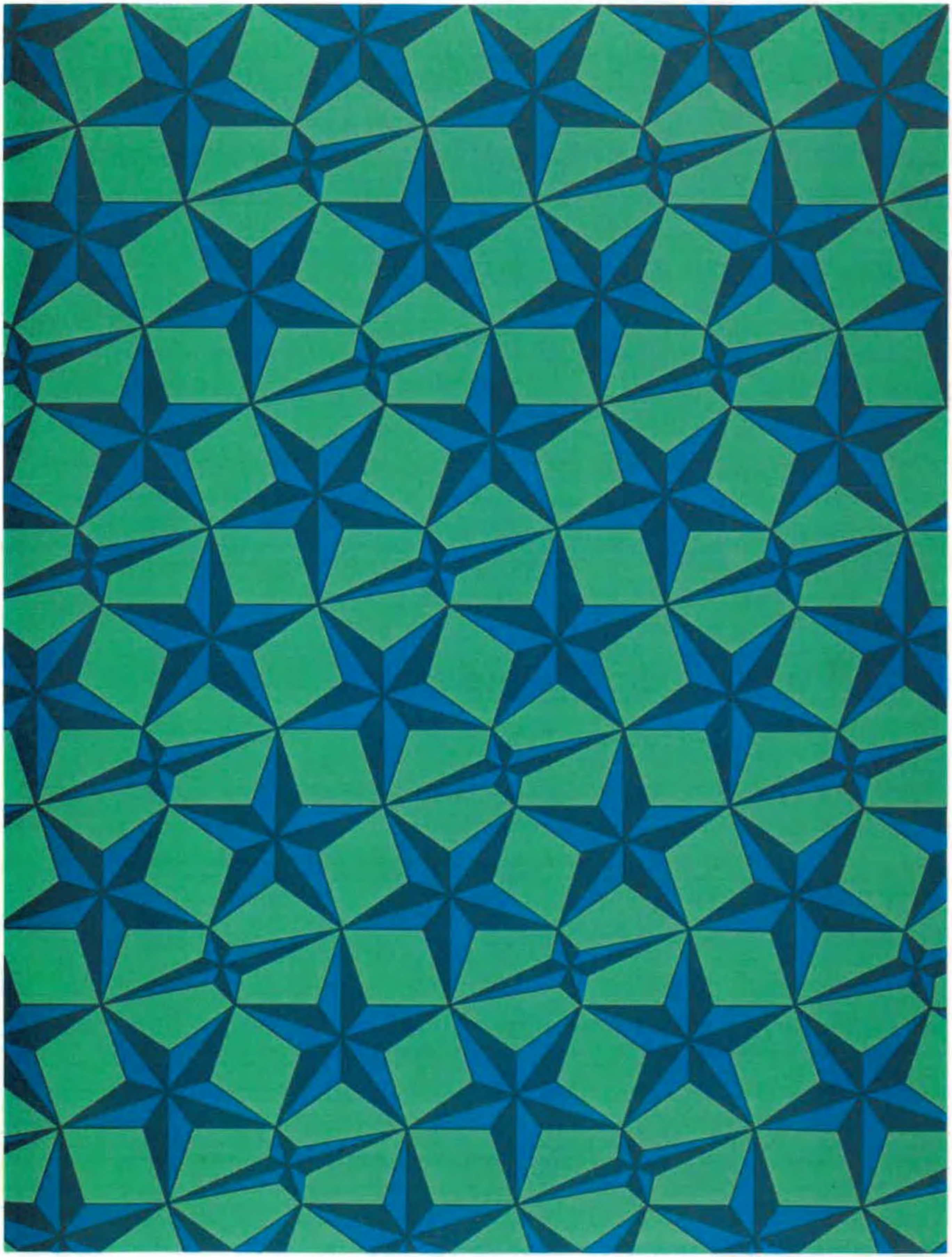












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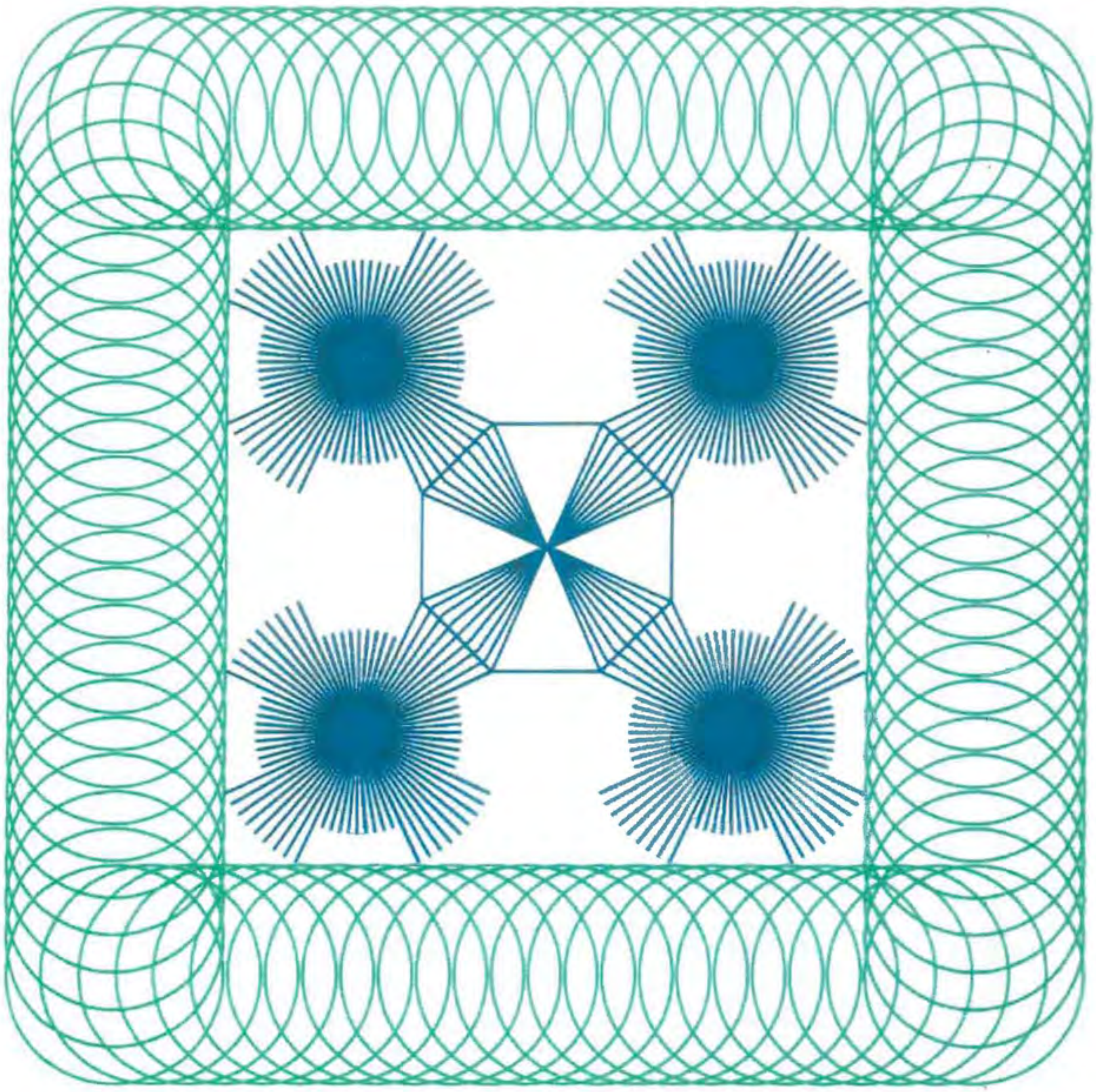
School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**MATH 325 portfolio Example**
This documentation is relevant to Question number:	**16**
Briefly summarize the content of the file and its value as evidence supporting program review:	**It shows an example of a student's portfolio. The student collects his/her best work and reflects on the learning process.**



[redacted]

Math 325

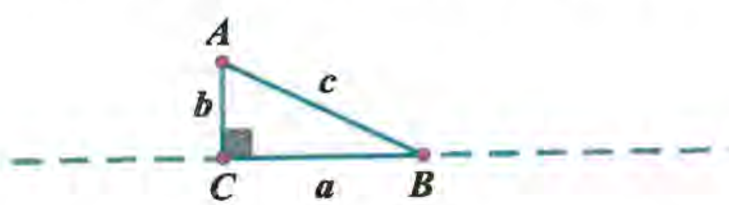
Portfolio

1. Construct ΔABC such that $\angle C$ is a right angle.
   a. Draw a vertical segment, $\overline{AC}$, with the segment tool.

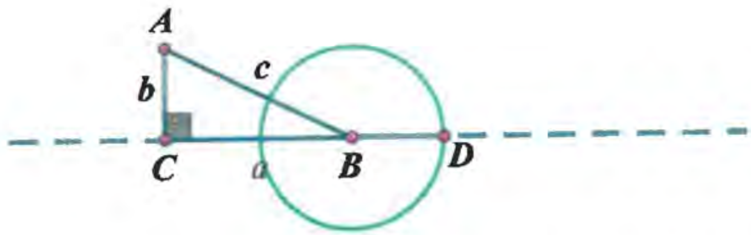
   b. Click $\overline{AC}$ and click C. On the menu click Construct and in the drop-down-menu click Perpendicular line.

   c. Construct segment $\overline{BC}$ by clicking C and a random spot on the perpendicular line using the segment tool.

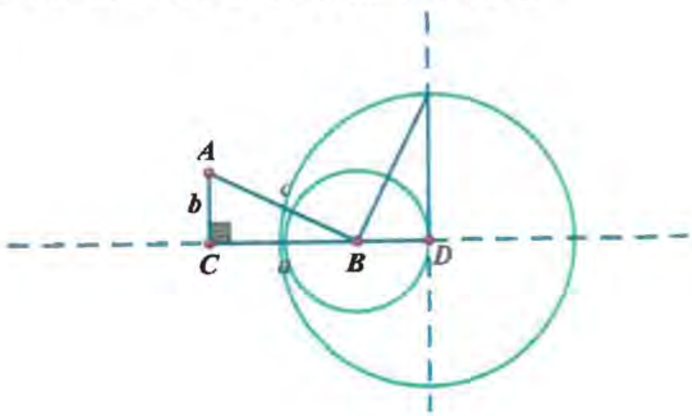
   d. Construct segment $\overline{AB}$. Select each segment and label them lower case letter of their opposite angle. Mark your $\angle C$ as a right angle with the marker tool.



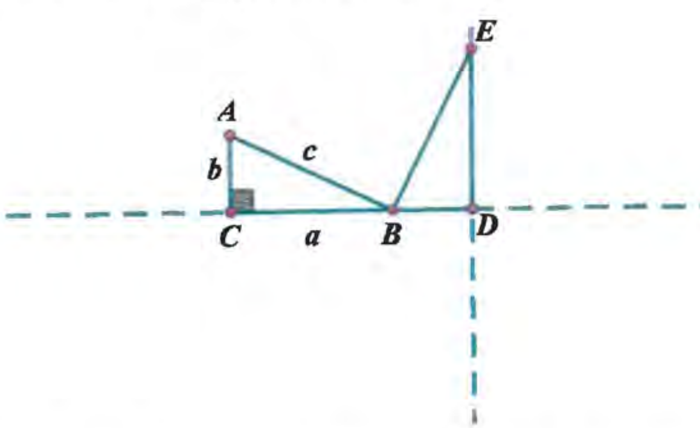
2. Construct ΔBDE such that $\overline{BD} \cong \overline{AC}, \overline{DE} \cong \overline{BC}$ and $\angle D$ is a right angle.
   a. Construct $\overline{BD}$ by clicking $\overline{AC}$ and point B, Construct-Circle by Center+Radius. Point D will be the intersection of ⊙B and $\overleftrightarrow{CB}$, construct segment $\overline{BD}$. So that D does is not the intersection between $\overline{BC}$.



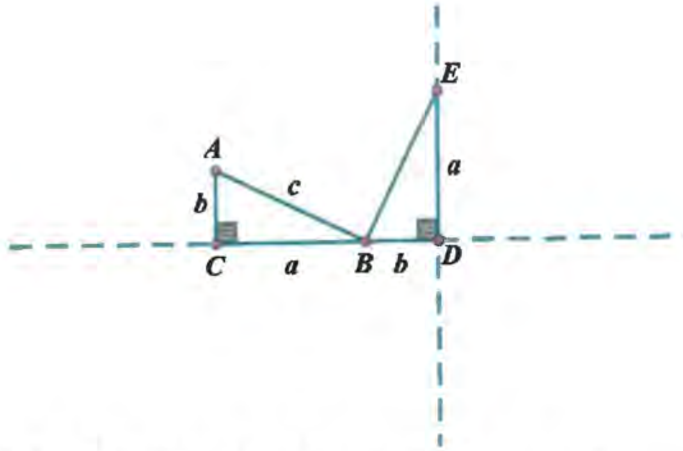
b. Construct $\overline{DE}$ by selecting point D and $\overleftrightarrow{CB}$, Construct-Perpendicular Line. Select D and $\overline{BC}$, Construct-Circle by Center +Radius. Point E is the intersection of $\odot D$ and $\overleftrightarrow{ED}$. Connect point E to B in a segment as well.



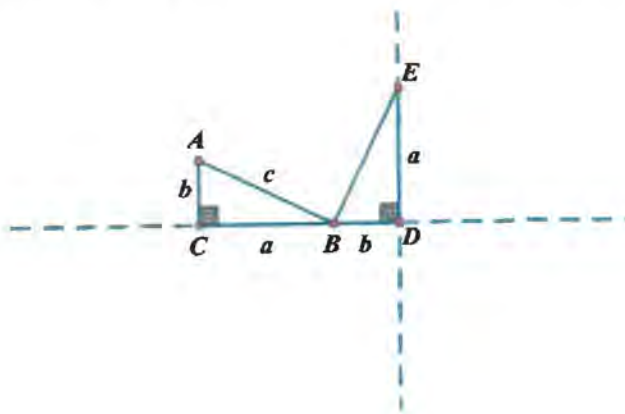
c. Select all circles, Display-Hide Circles.



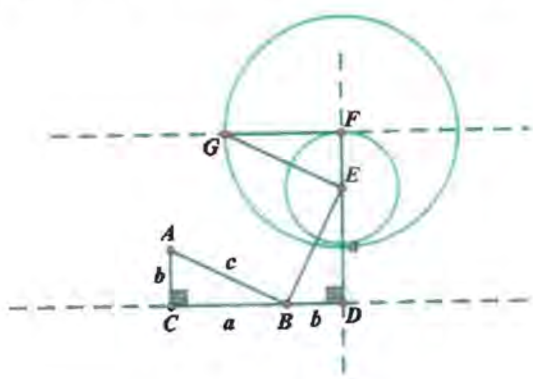
d. Label sides by their congruencies with a and b. Mark your $\angle D$ as a right angle with a marker tool.



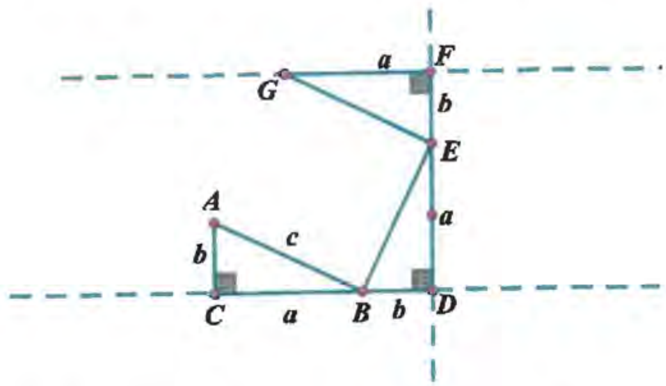
3. Construct ΔEFG such that $\overline{EF} \cong \overline{AC}, \overline{FG} \cong \overline{BC}$ and $\angle F$ is a right angle.
   a. Select $\overline{AC}$ and point E, Construct-Circle by Center+Radius. Label the intersection of $\odot E$ and $\overleftrightarrow{ED}$ point F. Construct segment $\overline{EF}$.



   b. Construct $\overline{FG}$ by selecting point F and $\overleftrightarrow{ED}$, Construct-Perpendicular Line. Select F again and $\overline{CD}$, Construct-Circle by Center +Radius. Label the intersection of $\odot F$ and this perpendicular line G. Construct $\overline{FG}$ and $\overline{GE}$.

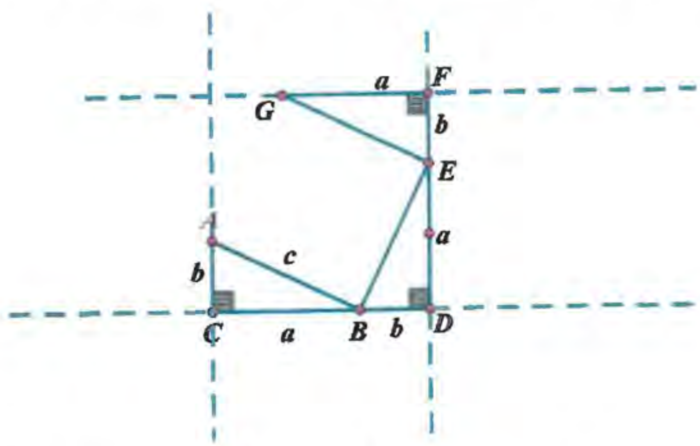


c. Select all circles, Display-Hide Circles. Label sides by their congruencies with a and b. Mark your $\angle F$ as a right angle with a marker tool.

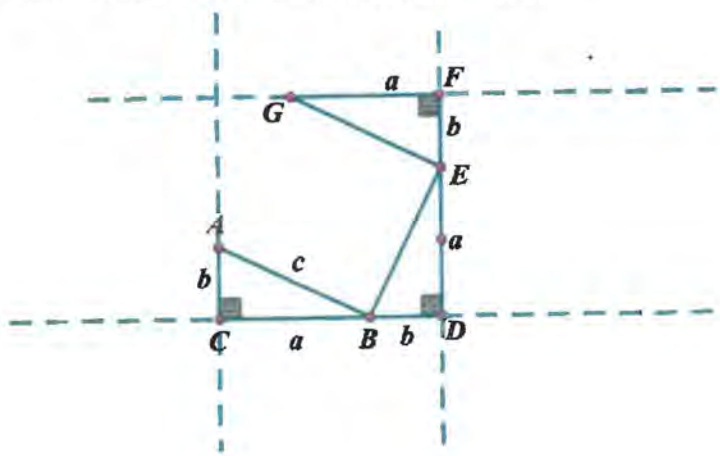


4. Construct ΔAGH so that H lies on the intersection of $\overleftrightarrow{FG}$ and $\overleftrightarrow{CA}$.

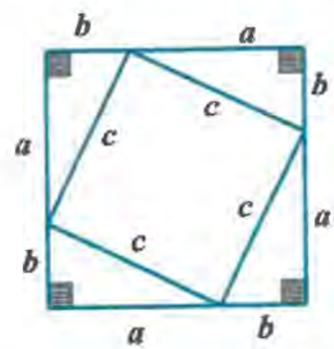
a. Construct $\overleftrightarrow{AC}$ by using your line tool and selecting point A and then C.



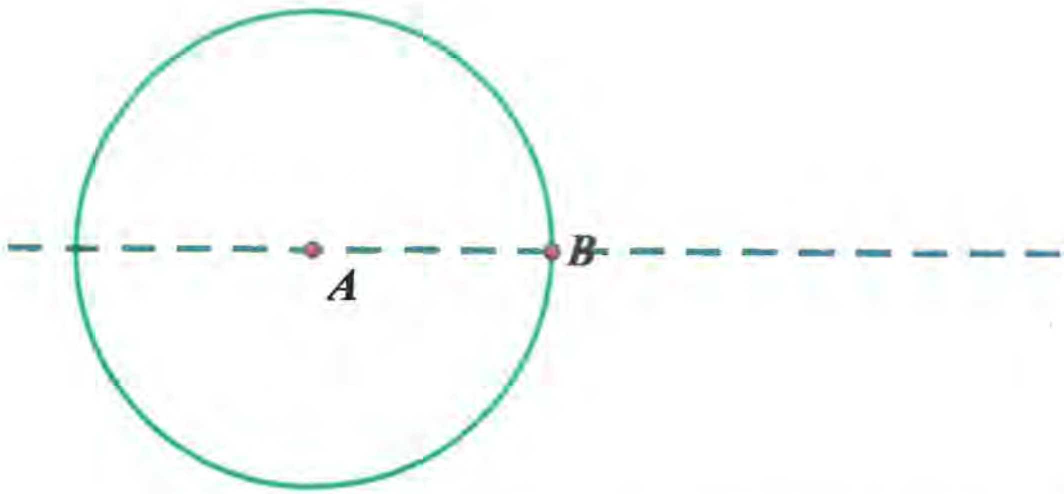
b. Label the intersection H. Construct $\overline{HG}$, $\overline{AH}$, and $\overline{AG}$.



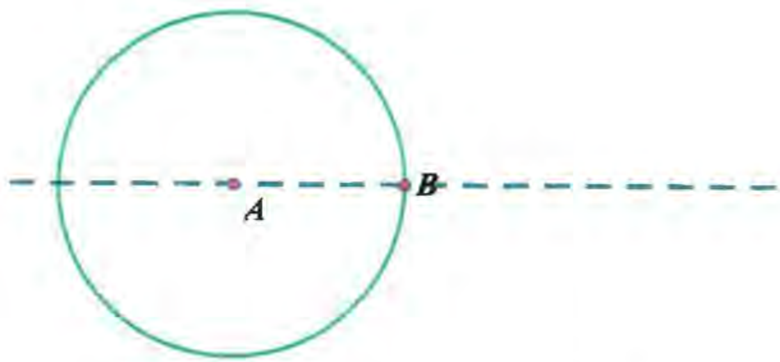
5. Proving sides $\overline{HG} \cong b$ and $\overline{AH} \cong a$.
    a. Since $\angle F \cong \angle D \cong 90°$ and 90°+90°=180°, by Thm 10 $\overleftrightarrow{HF} \parallel \overleftrightarrow{CD}$.
    b. With transversal $\overleftrightarrow{HC}$, using Thm 10 we know $\angle H + \angle C$=180°. By substitution $\angle H$°+90°=180°. By CN 3, $\angle H$ =90°.
    c. From this we can deduce that CHFD is a rectangle. By Corollary 15 we know that $\overline{CD} \cong \overline{HF}$ and $\overline{FD} \cong \overline{CH}$.
    d. $\overline{DF} = a + b, \overline{CH} = b + \overline{AH}$, by substitution $a + b = b + \overline{AH}$. By CN3, $a = \overline{AH}$.
    e. $\overline{CD} = a + b, \overline{HF} = a + \overline{GH}$. By substitution, $a + b = a + \overline{GH}$, by CN3 $\overline{GH} = b$.
6. Proving $\overline{AG} \cong \overline{EG} \cong \overline{BC} \cong c$.
    a. By SAS $\Delta ABC \cong \Delta BED \cong \Delta EGF \cong \Delta GAH$
    b. By CPOCT $\overline{AG} \cong \overline{EG} \cong \overline{BC} \cong c$.
    c. Label new congruencies with respect to *a, b* and *c*. Next hide lines and points.



7. Construct a square with sides *a*+*b*.
    a. Place a point A and select a segment length of *a*. Construct –Circle by Center+Radius. Construct a line through the center. Label one intersection of the circle and the line B.

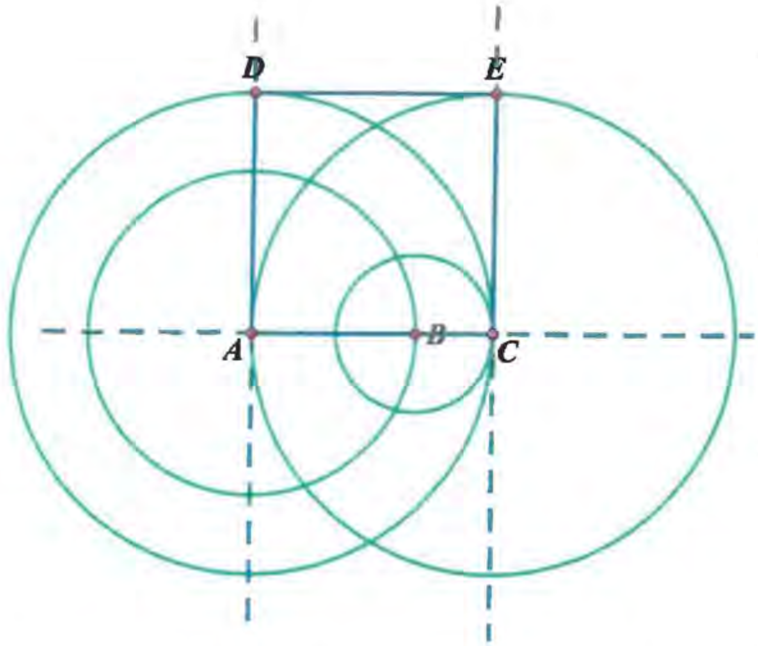


b. Select B and a segment of length *b*. Construct-Circle by Center+ Radius. Construct the segment from the center of the first circle to the final intersection of the last, point C. $\overline{AC} = a + b$.

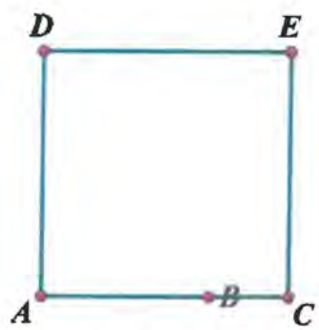


c. Select the $\overline{AC}$ and both points A and B. Construct + Circle by Center + Radius. Select the same segment and points. Construct – Perpendicular Lines. Construct the segment $\overline{AD}$ formed by the intersection of $\odot A$ and the perpendicular line through A. Similarly, construct $\overline{CE}$. Then connect D and E with a segment.

Note: We know ACED is a square throught the following: based on Thm 10 and 14 we can deduce that all angles are right, therefore it is a rectangle. Since $\overline{DA} \cong \overline{EC} \cong \overline{AC}$, and we can conclude that through the definition of a rectangle $\overline{DE} \cong \overline{AC}$ and through substitution creating them all to be equivalent and thus forming a square.

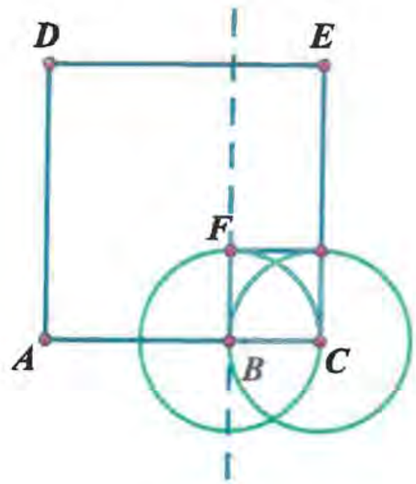


d. Hide all lines and circles so only ACED is shown. Leave point B as we know $\overline{AB} = a$ and $\overline{BC} = b$, as we will use this later.

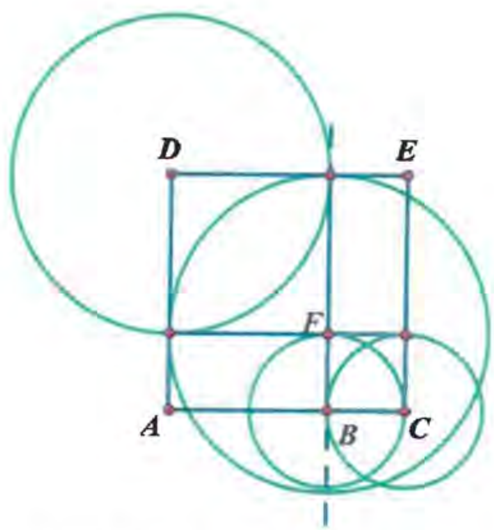


e.

8. Construct the interior of ADEC such that there are two squares; one with side lengths of a and another with side lengths of b.
   a. Construct segment $\overline{BC}$ and allow it to remain selected, then select C and B, Construct- Circles by Center + Radii. Select B and $\overline{EC}$, Construct –Parallel Line. Connect all intersections and label the corner of this new square that is within ADEC point F.

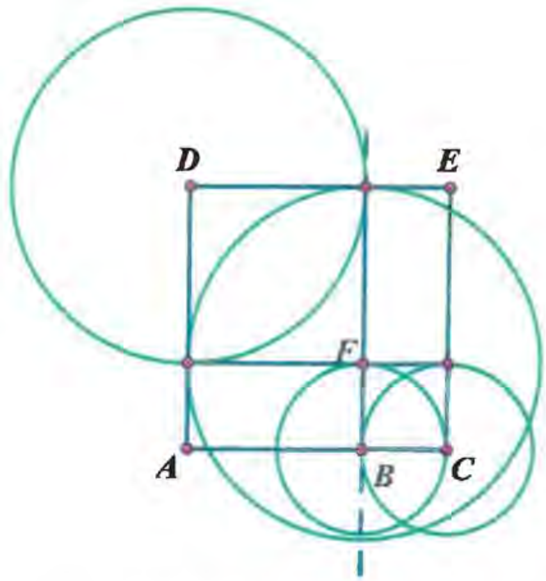


b. Since the line you constructed is parallel to $\overline{EC}$, and $\overline{EC} \parallel \overline{AD}$, by Thm 10, the line is also parallel to $\overline{AD}$ through CN 1. By creating $\overline{AB}$ and using it as a radius, select the point F and point D, construct Circle by Center+ Radius. Construct the segments that are formed from the centers of the circles and their intersections on ADEC.

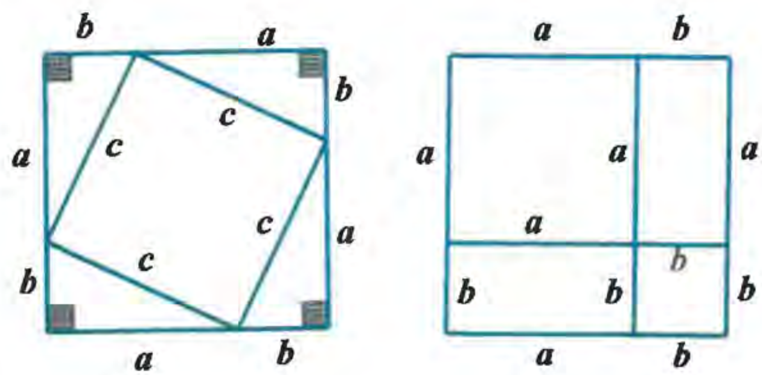


c. Hide all circles, points, and the line; label all segments within and on the square with respect to a and b.

Note: All distances between two outer sides of the square are equivalent to $a+b$ therefore, if on part of it is a, then the other part must be b by CN3.



9. Observe the two figures side by side. We now prove that $a^2+b^2 = c^2$. Note the area of each individual sections of the square.



a. We assume the area of a square is $A = bh$. A triangles area is $A=\frac{1}{2}bh$.
b. The total area of these two squares is equivalent as they both have equivalent bases of $a+b$ and heights of $a+b$.
c. Within the first figure we have four triangles each having and area of $A=\frac{1}{2}ab$. Thus, the total area for all four triangles is $2ab$. The second part is a square of $A=c^2$. Therfore the entire area of the first square we constructed: $A=2ab+c^2$.
d. Within the second figure we have two rectangles with $A=ab$, thuse one part of the area is $2ab$. We also have a square with $A=b^2$. The final part of this is the second

figure's interior is a square with $A=a^2$. Thus, we know the area of the second square $A=2ab+a^2+b^2$.

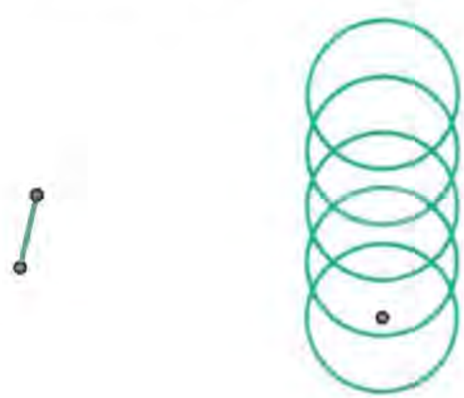
e. Since the total areas of the squares are equivalent, we can use substitution to find that : $2ab+a^2+b^2=2ab+c^2$ and then by CN 3: $a^2+b^2=c^2$, as desired.

1. Using the Straightedge tool, construct a segment.

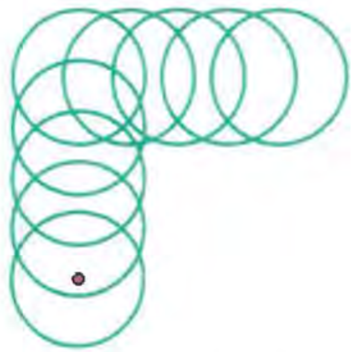
2. Using the point tool construct a point.

3. Select the segment and point and then select Construct-Circle by Center+Radius

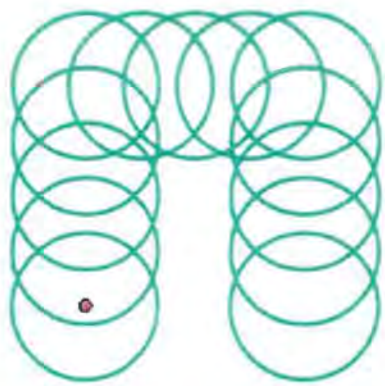
4. Select the circle and Transform-Translate repeatedly at 90° until you reach a desired side length for your square. The length at which you translate is your choice. Personally, I chose 1cm for this since the distance shows overlapping.



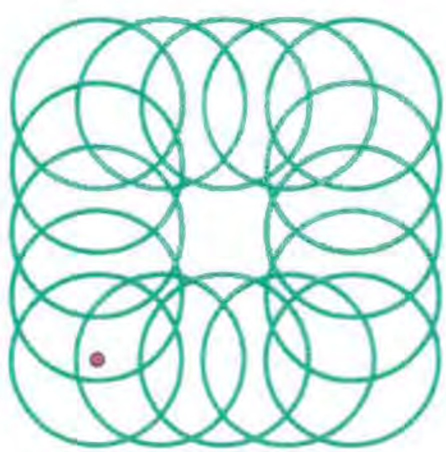
5. Transform-Translate, but this time choose either 0° or 360° to form the second side of your square, repeat this until the length of this side is equivalent to that of the other side. In other words the amount of circles will be the same.



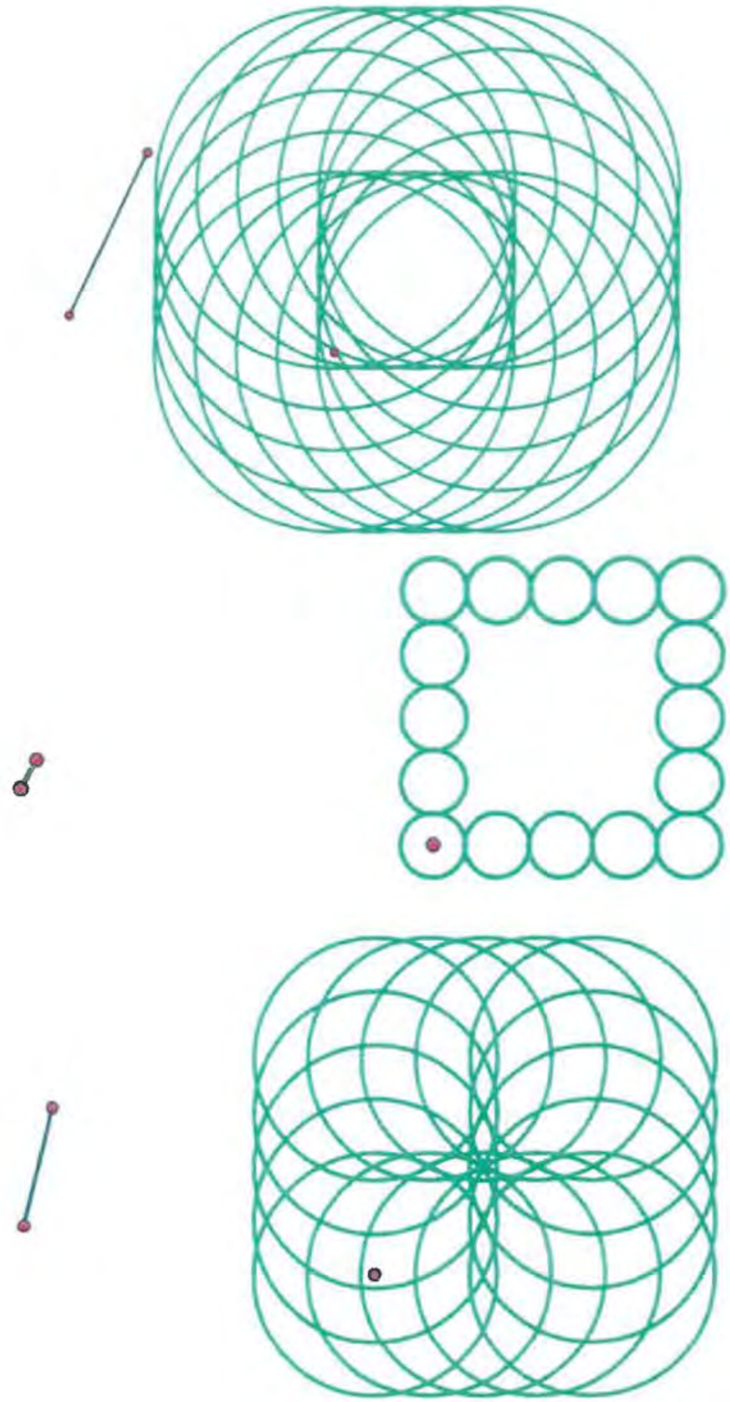
6. Transform-Translate at 270°, repeating until the length of this side is equivalent to the other two.



7. Transform – Translate at 180° until you connect the last circle and close your square.



8. The advantage of setting a radius in the beginning is that you can now use this segment to alter the radius of all the circles and create many different images simply.



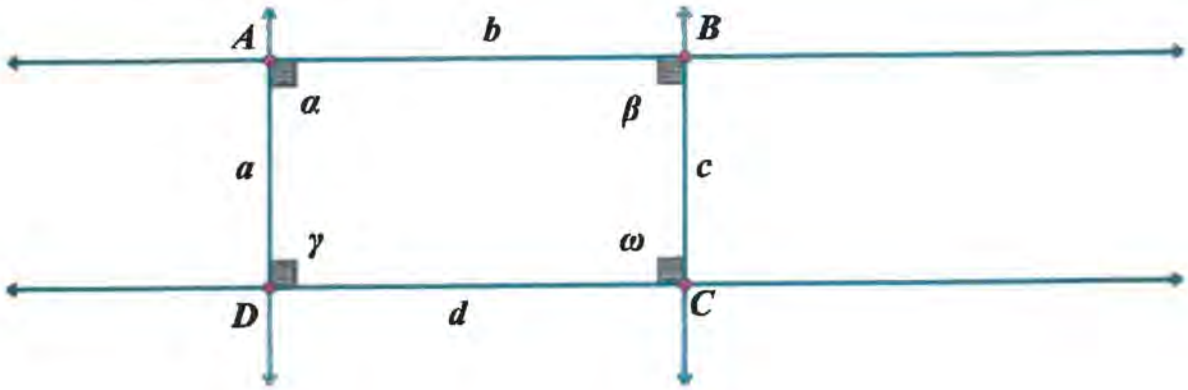
9. Hide the center of the original circle and the segment once you've picked a radius you like, now you have a symmetrical and robust construction of a border or a unique shape.

After the very first proof I realized many things about proof writing, after all this was the first official geometric proof that I've ever written. I started to write my proof immediately without even thinking about it and this lead to many mistakes because I would go back and realize I didn't give reasoning for certain things. After a few fails I chose to just figure it out first and then write the proof, this first proof really helped me to understand how I wanted to format my proofs and helped me to find the strategy behind solving proofs that works for me. One thing that I did really notice was the fact that this proof was wordy. I almost went into too much evaluation of the proofs and realized this as my proof writing progressed.

Theorem: A rectangle is a parallelogram.

Given: Let points A, B, C, D form the rectangle given for the proof. By definition of a rectangle, ABCD is a quadrilateral with all interior angles right (90°).

The points of the rectangle make up segments $\overline{AD}, \overline{AB}, \overline{BC}$, and $\overline{CD}$. By applying Axiom 2, all of these line segments can be indefinitely extedned to form lines. For sake of simplicity, let us name the lines and segments as seen below:



[Strategy: Proving $b \parallel d$.]

Lines b and d are both intersected by line c, by construction since c goes through points B and C, B intersecting line b, and C intersecting line d. The two interior angles are β and ω, both known to be right angles by definition of a rectangle. Right angles, by definition, are equivalent to half of a straight angle; thus, $\beta+\omega=180°$. Since the interior angles β and ω add up to a straight line, by the Corollary to Axiom 5/ Playfair, we know $b \parallel d$.

[Strategy: Proving $a \parallel c$.]

Lines a and c are intersected by line b, by construction since line b goes through points A and B, B intersecting line c, and A intersecting line a. The two interior angles of this intersection are α and β, both known to be right angles by definition of a rectangle. By this knowledge it is also known that $\alpha+\beta=180°$. Since these two interior angles add up to a straight angle, we know $a \parallel c$, by the Corollary to Axiom 5/Playfair.

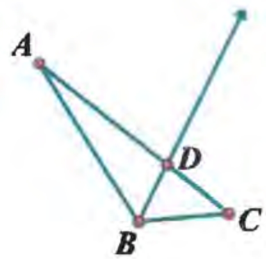
[Strategy: Showing ABCD is a parallelogram.]

We now can deduct that since lines b and d are both parallel to one another and $\overline{AB}$ lies on line b, while $\overline{CD}$ lies on line d, that $\overline{AB} \parallel \overline{CD}$. Since $a \parallel c$, and $\overline{AD}$ lies on a while $\overline{BC}$ lies on line b we can deduce that $\overline{AD} \parallel \overline{BC}$. The definition of a parallelogram is that the two opposite sides of a quadrilateral are parallel to one another on both sets of sides. In rectangle ABCD this means $\overline{AB} \parallel \overline{CD}$ and $\overline{AD} \parallel \overline{BC}$. Which we just proved and we have now determined that a rectangle is a parallelogram, as desired.

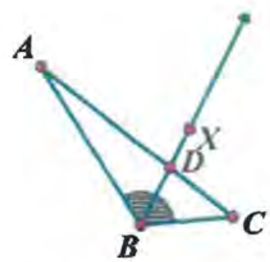
The next set of proofs was on angle bisectors, this was an if and only if proof, but broken into two proofs. I found that it was very helpful to see this proof in two different ways. If and only if proofs are really unique because you always know that if one is true the other is and that makes everything easier trying to prove something that uses this theorem. These proofs are much easier to write knowing that you have to prove it both ways and picking the easier one first. After that the harder ones start to fall into place.

Theorem: Any point on an angle bisector is equal distance from the two sides of an angle.

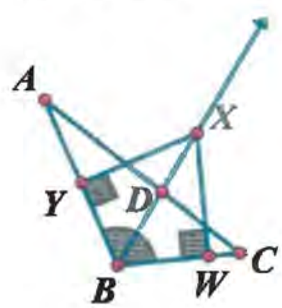
Given: Let there be ΔABC, construct the bisector of ∠ABC and label it $\overrightarrow{BD}$, with D as the intersection along $\overline{AC}$. See figure below.



By construction, ∠ABD ≅ ∠CBD. Assume, without loss of generality that there lies a point X on $\overrightarrow{BD}$. See image below.



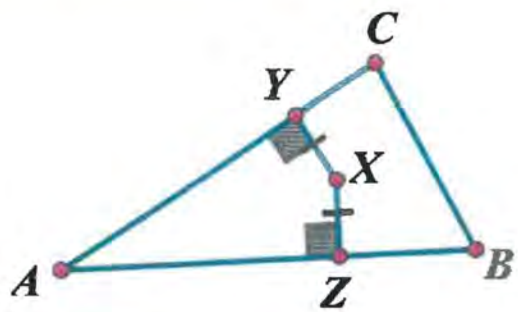
Construct $\overline{XY}$ so that Y is the intersection along $\overrightarrow{AB}$ and $\overline{XY} \perp \overrightarrow{AB}$. Construct $\overline{XW}$ so that W intersects $\overrightarrow{BC}$ and $\overline{XW} \perp \overrightarrow{BC}$, we can do this by Thm 23. Note that the measurements of $\overline{XW}$ is the distance from X to $\overline{BC}$ and the length of $\overline{XY}$ is the distance from X to $\overline{AB}$. See below.



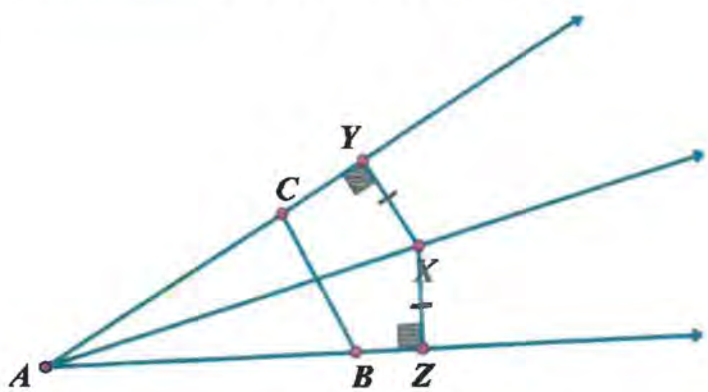
By reflexive property, $\overline{BX} \cong \overline{BX}$. By construction, and Axiom 4, $\angle BWX \cong \angle XYB \cong 90°$. $\Delta WBX \cong \Delta YBX$ by Thm 17. Thus, by CPOCT, $\overline{WX} \cong \overline{YX}$. This means that X is equal distance from side $\overline{AB}$ and $\overline{BC}$, as desired.

Theorem: Any point an equal distance from the two sides of an angle, lies on the angle bisector of that angle.

Given: Let there be ΔABC. Construct an arbitrary point X that is equal distance from $\overline{AB}$ and $\overline{AC}$. That is, the perpendicular segment between X and $\overrightarrow{AB}$ is congruent to the perpendicular segment between X and $\overrightarrow{AC}$. Label these intersections Y and Z, see below.



Note that since X is arbitrary it can also lie past $\overline{BC}$. This is shown in the following figure. By Axiom 1, construct $\overline{AX}$. (By Axiom 2, $\overrightarrow{AB}$ and $\overrightarrow{AC}$ are extended.)

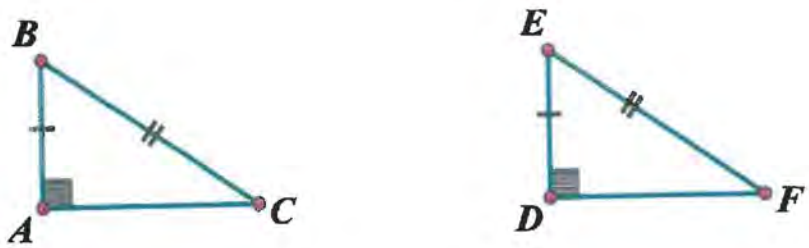


By the reflexive property $\overline{AX} \cong \overline{AX}$; by Thm 18, $\Delta AXC \cong \Delta AXB$ since they are both right triangles with $\overline{AX}$ as their hypotenuse and $\overline{ZX} \cong \overline{YX}$ as given. By CPOCT $\angle BAX \cong \angle CAX$. In other words, $\angle BAC$ is split into two equal parts making $\overrightarrow{AX}$ its angle bisector. And X, of course, lies on $\overrightarrow{AX}$, as desired.

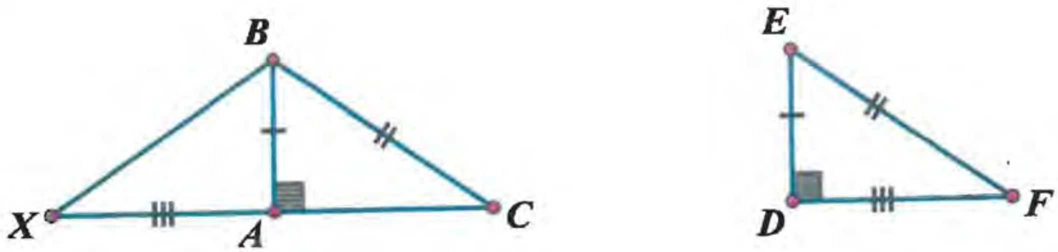
When looking at these two proofs back to back, they were similar in two different ways. One of which was that they both had to do with right triangles, and another was that there was a trick to proving it that wasn't originally in the theorem. The trick was to add an additional triangle with certain specifications. The Hypotenuse-Leg Theorem was a little more difficult to think of adding another triangle, because you already had two. Once I constructed X so that I could prove the equivalencies it all fell into place. It took quite a while to figure this out, but the upside is after I did it once, the thought of doing it in the Converse of Pythagorean Theorem came easier.

Theorem: If ΔABC and ΔDEF have right angles at $\angle A$ and $\angle D$, and $\overline{AB} \cong \overline{DE}$ and $\overline{BC} \cong \overline{EF}$, then $\Delta ABC \cong \Delta DEF$.

Given: $\angle A \cong 90°$ and $\angle D \cong 90$, thus by substitution $\angle A \cong \angle D$. Also $\overline{AB} \cong \overline{DE}$ and $\overline{BC} \cong \overline{EF}$. See image below.



Construct point X on the opposite side of $\overrightarrow{AC}$ so that $\overline{AX} \cong \overline{DF}$. Connect X to B. See image below.



[Strategy: Proving $\Delta ABX \cong \Delta DEF$]

Since $\angle XAB$ and $\angle BAC$ form a straight line, $\angle BAC + \angle BAX = 180°$, by substitution $90° + \angle BAX = 180°$, by CN 3 $\angle BAX = 90°$. By CN 1, $\angle BAX \cong \angle BAC$. By SAS, $\Delta ABX \cong \Delta DEF$.

[Strategy: Proving $\angle X \cong \angle C$]

By CPOCT, $\overline{BX} \cong \overline{EF}$. By substitution, $\overline{BX} \cong \overline{BC}$. By Thm 8, ΔBCX is isosceles; therefore $\angle X \cong \angle C$.

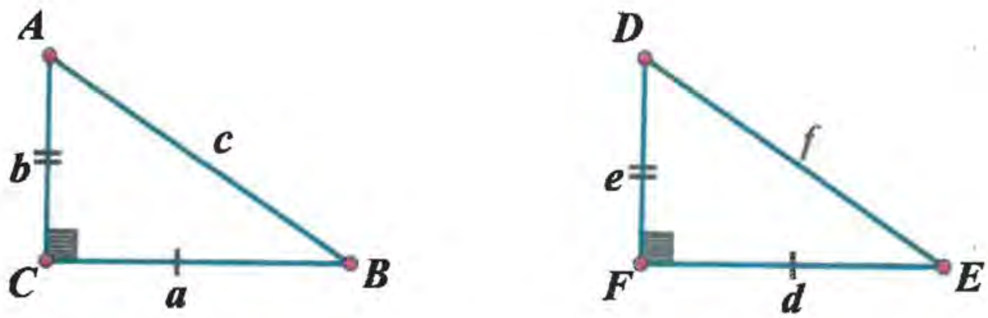
[Strategy: Proving $\Delta ABC \cong \Delta DEF$]

By CPOCT, $\angle X \cong \angle F$. By substitution, $\angle C \cong \angle F$. By AAS ($\angle A \cong \angle D$; $\angle C \cong \angle F$; $\overline{BC} \cong \overline{EF}$), $\Delta ABC \cong \Delta DEF$, as desired.

Theorem: If ΔABC has sides a, b, and c (labeled opposite of the angle), such that $a^2 + b^2 = c^2$, then $\angle C = 90°$.

Given: Let there be ΔABC such that $a^2 + b^2 = c^2$, named opposite their angle.

Construct ΔDEF so that $\angle F = 90°$, label sides lower case of their opposite angle, and $a \cong d$ and $b \cong e$. See below.



[Strategy: Proving $\Delta ABC \cong \Delta DEF$]

By Thm 22, since ΔDEF is a right angle triangle we know $d^2 + e^2 = f^2$. By substitution, $a^2 + b^2 = f^2$. Also by substitution, $c^2 = f^2$. From this we deduce that $c = f$. Therefore, by SSS, $\Delta ABC \cong \Delta DEF$.

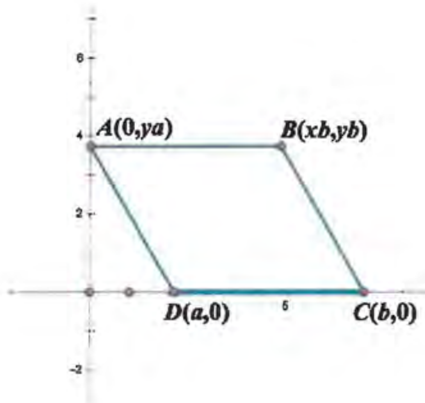
[Strategy: Proving $\angle C = 90°$]

By CPOCT for $\Delta ABC \cong \Delta DEF$, $\angle C \cong \angle F$. Thus, by substitution, $\angle C = 90°$ as desired.

The following set of proofs was very interesting to switch gears into. The advantage of using coordinate based proofs verses Euclidian was that you actually have coordinates on the xy-plane to work with, even if the coordinates are technically arbitrary. These coordinates really helped in that from that point it was usually just algebra. By using algebra and formulas to prove things it felt more definite at the end than a Euclidian proof, even though the Euclidian proof was still definite as well.

Theorem: The diagonals of a rhombus are perpendicular bisectors of one another.

Given: Let rhombus ABCD be positioned in the xy-plane so that A lies on the y-axis, and both C and D lie on the x-axis with arbitrary x-values a and b. See figure below y_a, y_b, and x_b are unknown.



[Strategy: Finding y_a, y_b, and x_b]

By definition of a rhombus, we know $\overline{AB} \parallel \overline{CD}$. Since $\overleftrightarrow{CD}$ has a slope of zero, so does AB which makes y_a=y_b.

Using the distance formula for points C and D we find: $d = \sqrt{(b-a)^2 + (0)^2} = \sqrt{(b-a)^2} = (b-a)$

By definition of a rhombus, we know all sides are congruent; therefore, all distances betweenthe two vertices of a side are (b-a).

Applying the distance formula and substitution to A and B we find: $b - a = \sqrt{(0-x_b)^2 + (y_a - y_b)^2}$

Since y_b=y_a, y_a-y_b=0. $b - a = \sqrt{{x_b}^2} = x_b$. Therefore, B=(b-a,$y_a$).

Applying the distance formula to A and D: $b - a = \sqrt{(0-x_b)^2 + (0-y_a)^2}$

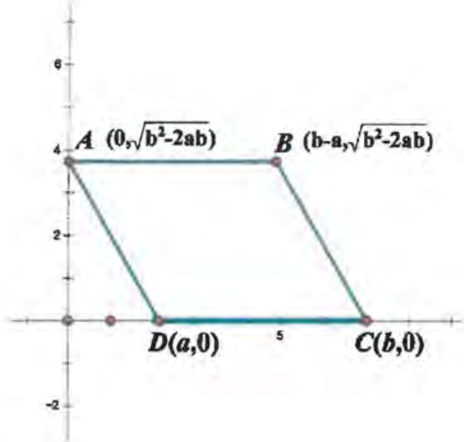
$$(b-a)^2 = a^2 + {y_a}^2$$

$$b^2 - 2ab + a^2 = a^2 + {y_a}^2$$

$$b^2 - 2ab = {y_a}^2$$

$$\sqrt{b^2 - 2ab} = y_a$$

By CN1 $\sqrt{b^2 - 2ab} = y_b$. Therefore, $A = \left(0, \sqrt{b^2 - 2ab}\right)$. See newly marked figure below.



[Strategy: Proving $\overline{AC} \perp \overline{BD}$]

Name the slopes of $\overline{AC}$ and $\overline{BD}$, m_1 and m_2 respectively. By using the equation of a slope we find:

$$m_1 = \frac{\sqrt{b^2-2ab}-0}{0-b} = \frac{\sqrt{b^2-2ab}}{-b}$$

$$m_2 = \frac{\sqrt{b^2-2ab}-0}{(b-a)-a} = \frac{\sqrt{b^2-2ab}}{b-2a}$$

By Thm 5.5, if $m_1 \cdot m_2 = -1$, then $\overline{AC} \perp \overline{BD}$.

$$m_1 \cdot m_2 = \frac{\sqrt{b^2-2ab}}{-b} \cdot \frac{\sqrt{b^2-2ab}}{b-2a} = \frac{b^2-2ab}{-b(b-a)} = \frac{b(b-2a)}{-b(b-2a)} = -1$$

Therefore, by Thm 5.5, $\overline{AC} \perp \overline{BD}$.

[Strategy: Proving the intersection of $\overline{AC}$ and $\overline{BD}$ is the midpoint of $\overline{AC}$.]

Applying point-slope formula with point C and slope m_1 we find the equation for $\overleftrightarrow{AC}$.

$$y = \frac{\sqrt{b^2-2ab}}{a}(x-b)$$

Similarly we find the equation for $\overleftrightarrow{BD}$ with slop m_2 and point D.

$$y = \frac{\sqrt{b^2-2ab}}{b-2a}(x-a)$$

We know that they intersection shares the same y-coordinate so using substitution we find the intersection of $\overleftrightarrow{AC}$ and $\overleftrightarrow{BD}$ is $\left(\frac{b}{2}, \frac{\sqrt{b^2-2ab}}{2}\right)$.

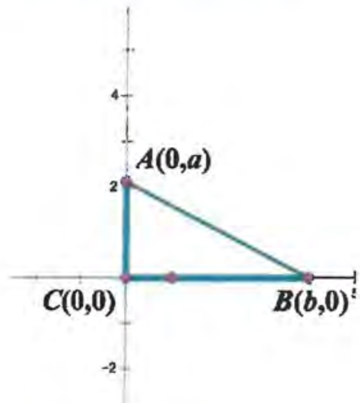
By applying Thm 5.1 we find the midpoint of $\overline{AC}$. Midpoint$_{AC}$=$\left(\frac{0+b}{2}, \frac{\sqrt{b^2-2ab}+0}{2}\right) = \left(\frac{b}{2}, \frac{\sqrt{b^2-2ab}}{2}\right)$ which is the same coordinate as the intersection.

[Strategy: Proving the intersection of $\overline{AC}$ and $\overline{BD}$ is the midpoint of $\overline{BD}$]

By applying Thm 5.1 to BD we get its midpoint. Midpoint$_{BD}$=$\left(\frac{(b-a)+a}{2}, \frac{\sqrt{b^2-2ab}+0}{2}\right) =$ $\left(\frac{b}{2}, \frac{\sqrt{b^2-2ab}}{2}\right)$ which is the same coordinate as the intersection, as desired.

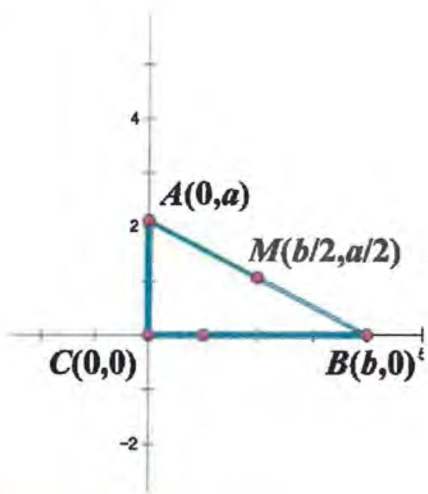
Theorem: The midpoint of the hypotenuse of a right triangle is equidistant from all vertices.

Given: Let ΔABC, with right angle C, be positioned in the xy-plane with C= (0,0). From this we have arbitrary points of A=(0, a) and B=(b, 0). See below.



[Strategy: Finding the midpoint of the hypotenuse.]

The hypotenuse in ΔABC is $\overline{AB}$. Naming the midpoint M and applying Thm 5.1, we get $M = \left(\frac{0+b}{2}, \frac{a+0}{2}\right) = \left(\frac{b}{2}, \frac{a}{2}\right)$. Plot this point as below.



[Strategy: Proving M is equidistant from A, B, and C.]

Name the distance from: A to M= d_1, B to M = d_2, and C to M=d_3. Using the distance formula:

$$d_1 = \sqrt{\left(0 - \frac{b}{2}\right)^2 + \left(a - \frac{a}{2}\right)^2} = \sqrt{\left(\frac{-b}{2}\right)^2 + \left(\frac{a}{2}\right)^2} = \sqrt{\frac{b^2}{4} + \frac{a^2}{4}} = \sqrt{\frac{b^2 + a^2}{4}} = \frac{1}{2}\sqrt{a^2 + b^2}$$

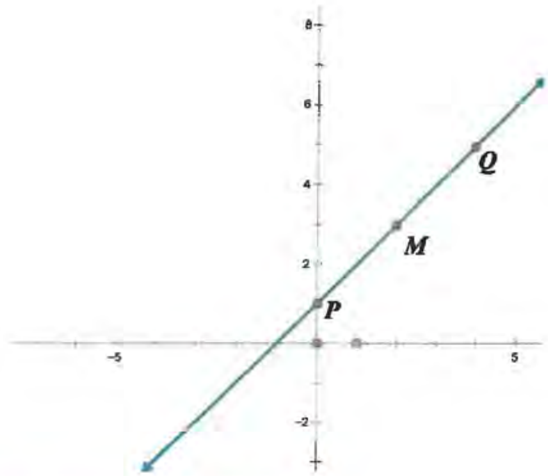
$$d_2 = \sqrt{\left(b - \frac{b}{2}\right)^2 + \left(0 - \frac{a}{2}\right)^2} = \sqrt{\left(\frac{b}{2}\right)^2 + \left(\frac{-a}{2}\right)^2} = \sqrt{\frac{b^2}{4} + \frac{a^2}{4}} = \sqrt{\frac{b^2 + a^2}{4}} = \frac{1}{2}\sqrt{a^2 + b^2}$$

$$d_3 = \sqrt{\left(0 - \frac{b}{2}\right)^2 + \left(0 - \frac{a}{2}\right)^2} = \sqrt{\left(\frac{-b}{2}\right)^2 + \left(\frac{-a}{2}\right)^2} = \sqrt{\frac{b^2}{4} + \frac{a^2}{4}} = \sqrt{\frac{b^2 + a^2}{4}} = \frac{1}{2}\sqrt{a^2 + b^2}$$

By CN1, $d_1 = d_2 = d_3$, as desired.

Theorem: The midpoint of the segment between points P(x_p, y_p) and Q(x_q, y_q) is the point M$\left(\frac{Xp+Xq}{2}, \frac{Yp+Yq}{2}\right)$.

Given: Line $\overleftrightarrow{PQ}$ contains points P(x_p, y_p) and Q(x_q, y_q). We show that point M$\left(\frac{Xp+Xq}{2}, \frac{Yp+Yq}{2}\right)$ is the midpoint. In order to satisfy this definition M must both lie on $\overleftrightarrow{PQ}$ and be equal distance from P and Q.



[Strategy: Proving M is equal distance from P and Q]

Construct $\overleftrightarrow{PQ}$ on the xy-plane. Draw M.

We want to show the distance from P to M equals the distance from M to Q. By applying the distance formula $d = \sqrt{(x_2-x_1)^2+(y_2-y_1)^2-2|x_2-x_1||y_2-y_1|\cos 90°}$. The 90° is set in place since we are in the xy-plane. Since $\cos 90° = 0$, we are left with: $d = \sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$. Applying $(x_1, y_1) = (x_p, y_p)$ and $(x_2, y_2) = \left(\frac{Xp+Xq}{2}, \frac{Yp+Yq}{2}\right)$.We can find the distance between P and M. Let us label that distance z.

$$Z = \sqrt{\left(\frac{Xp+Xq}{2} - x_p\right)^2 + \left(\frac{Yp+Yq}{2} - y_p\right)^2}$$

$$Z = \sqrt{\left(\frac{Xp+Xq-2Xp}{2}\right)^2 + \left(\frac{Yp+Yq-2Yp}{2}\right)^2}$$

$$Z = \sqrt{\left(\frac{Xq-Xp}{2}\right)^2 + \left(\frac{Yq-Yp}{2}\right)^2}$$

$$Z = \sqrt{\frac{Xq^2-2XqXp+Xp^2+Yq^2-2YpYq+Yp^2}{4}}$$

Applying $(x_1, y_1) = (x_q, y_q)$ and $(x_2, y_2) = \left(\frac{Xp+Xq}{2}, \frac{Yp+Yq}{2}\right)$we get the distance between M and Q, Let us name this distance W.

$$W = \sqrt{\left(\frac{Xp+Xq}{2} - x_q\right)^2 + \left(\frac{Yp+Yq}{2} - y_q\right)^2}$$

$$W = \sqrt{\left(\frac{Xp+Xq-2Xq}{2}\right)^2 + \left(\frac{Yp+Yq-2Yq}{2}\right)^2}$$

$$W = \sqrt{\left(\frac{Xp-Xq}{2}\right)^2 + \left(\frac{Yp-Yq}{2}\right)^2}$$

$$W = \sqrt{\frac{Xp^2 - 2XqXp + Xq^2 + Yp^2 - 2YpYq + Yq^2}{4}}$$

The result of W is equivalent to the result of Z, thus W=Z, by substitution. In other words the distances from P to M and from M to Q are equivalent.

[Strategy: Proving M lies on $\overleftrightarrow{PQ}$.]

Line $\overleftrightarrow{PQ}$ has the equation using point-slope form of $y - y_1 = m(x - x_1)$. By definition of slope we get the equation $m = \frac{y_2-y_1}{x_2-x_1}$. Using $(x_1, y_1) = (x_q, y_q)$ and $(x_2, y_2) = (x_p, y_p)$ we get $m = \frac{y_p-y_q}{x_p-x_q}$. Choosing point P we get the equation $y - y_p = \frac{y_p-y_q}{x_p-x_q}(x - x_p)$. In order to prove M lies on $\overleftrightarrow{PQ}$ we must show that it satisfies the equation:

$$\frac{y_p+y_q}{2} - y_p = \frac{y_p-y_q}{x_p-x_q}\left(\frac{x_p+x_q}{2} - x_p\right)$$

$$\frac{y_q-y_p}{2} = \left(\frac{y_p-y_q}{x_p-x_q}\right)\left(\frac{x_q-x_p}{2}\right)$$

$$(x_p - x_q)(y_q - y_p) = (y_p - y_q)(x_q - x_p)$$

$$x_py_q - x_py_p - x_qy_q + x_qy_p = y_py_q - y_px_p - y_qx_q + y_qx_p$$

$$0 = 0$$

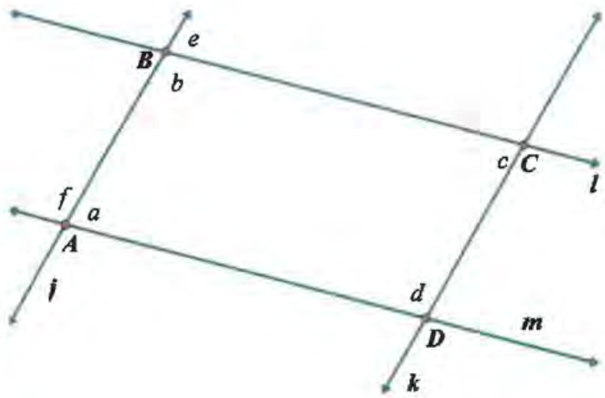
Everything cancels out with each other so M satisfies the equation for $\overleftrightarrow{PQ}$, as desired.

If quadrilaterals are parallelograms, that creates a whole new set of rules. These different proofs were all subsections of a theorem and it was actually more helpful to disregard the original order of these. I, personally skipped b and came back to it because proving that the opposite sides were congruent before proving that the diagonals bisected each other because I wanted to use the theorem for b in my proof. This saved a lot of time when proving part c.

Theorem: If a quadrilateral is a parallelogram, then the opposite angles are congruent.

Given: Quadrilateral ABCD is a parallelogram, by definition we know $\overline{AB} \parallel \overline{CD}$ and $\overline{AD} \parallel \overline{BC}$.

Using Axiom 2, extend all segments and label them $j, k, l,$ and m as seen below. Also name all angles as labeled.



[Strategy: Proving $a = c$.]

Using j as a transversal of $l \parallel m$, $a = e$, by Thm 10c. By Thm 10b, transversal l of $k \parallel j$, $e = c$. By CN1, $a = c$.

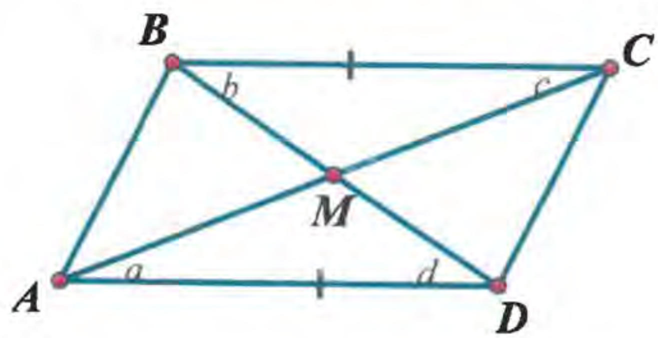
[Strategy: Proving $b = d$.]

By Thm 10b, using transversal j of $l \parallel m$, $b = f$. Using transversal m of $\parallel j$, $f = d$, by Thm 10c. By CN 1, $b = d$, as desired.

Theorem: If a quadrilateral is a parallelogram, then the diagonals bisect each other.

Given: Let quadrilateral ABCD be a parallelogram, by definition we know $\overline{AB} \parallel \overline{CD}$, and $\overline{BC} \parallel \overline{AD}$. By Thm 26c we know $\overline{BC} \cong \overline{AD}$.

Construct diagonals $\overline{AC}$ and $\overline{BD}$, label their intersection M and all angles are named as below.

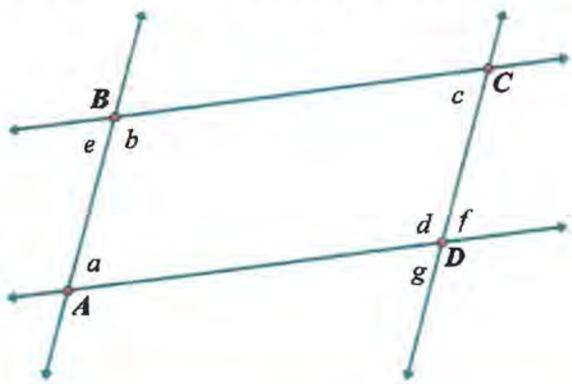


We want to show that $\overline{AM} \cong \overline{MC}$ and $\overline{BM} \cong \overline{MD}$ to prove M is the bisection of both diagonals. Using $\overline{BD}$ as transversal of $\overline{BC} \parallel \overline{AD}$, by Thm 10b, b=d. B Thm 10b, using transversal $\overline{AC}$ and $\overline{BC} \parallel \overline{AD}$, c=a. By SAS, $\Delta BCM \cong \Delta DAM$. By CPOCT, $\overline{CM} \cong \overline{AM}$, likewise, $\overline{BM} \cong \overline{DM}$, as desired.

Theorem: If a quadrilateral is a parallelogram, then the opposite sides are congruent.

Given: Quadrilateral ABCD is a parallelogram, by definition we know $\overline{AB} \parallel \overline{CD}$ and $\overline{AD} \parallel \overline{BC}$.

Using Axiom 2, extend all segments. Name angles as labeled below.

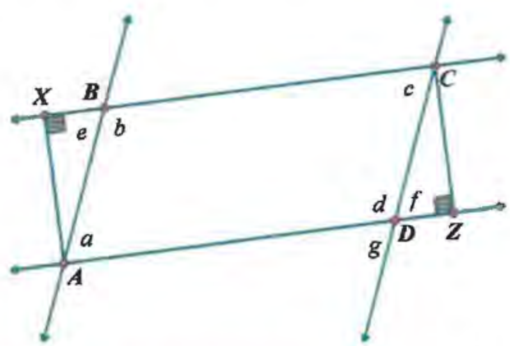


[Strategy: Proving opposite sides are congruent if ABCD is a rectangle.]

By the Corollary 15 we know opposite sides of a rectangle are congruent.

[Strategy: Proving $\overline{AB} \cong \overline{CD}$, assuming ABCD is not a rectangle]

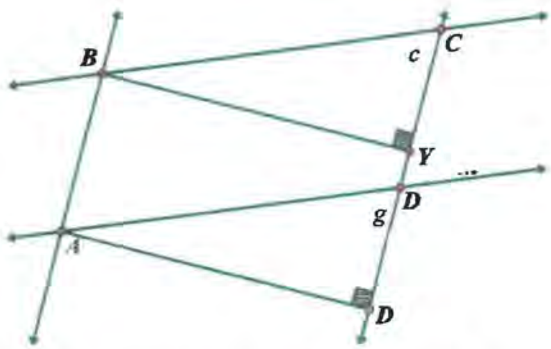
Construct $\overline{AX}$ such that $\overline{AX} \perp \overleftrightarrow{BC}$ and X lies on $\overleftrightarrow{BC}$. Likewise, construct Z on $\overleftrightarrow{AD}$ so that $\overline{CZ} \perp \overleftrightarrow{AD}$. See image below.



By Thm 14, $\overline{AX} \cong \overline{CZ}$. By definition of perpendicular, $\angle CZD \cong \angle AXB \cong 90°$. By Thm 10b, using transversal $\overleftrightarrow{AB}$ and $\overleftrightarrow{BC} \parallel \overleftrightarrow{AD}$, e = a. By Thm 10 c, using transversal $\overleftrightarrow{AD}$ of $\overleftrightarrow{AB} \parallel \overleftrightarrow{CD}$, a=f. By CN1 e=f. By Thm 17 $\Delta CZD \cong \Delta AXB$. By CPOCT, $\overline{AB} \cong \overline{CD}$.

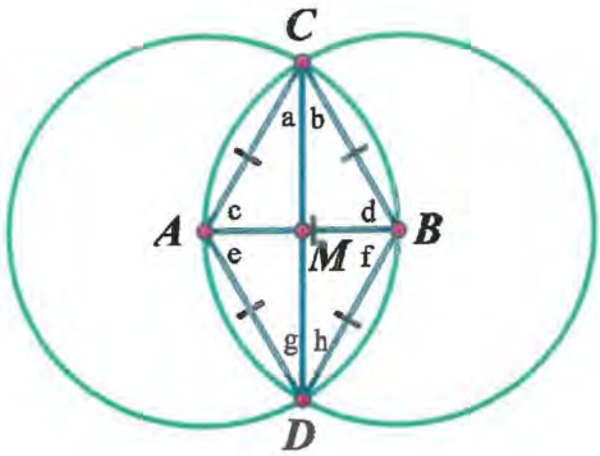
[Strategy: Proving $\overline{BC} \cong \overline{AD}$, assuming ABCD is not a rectangle]

Construct $\overline{BY}$ such that $\overline{BY} \perp \overleftrightarrow{CD}$ and Y lies on $\overleftrightarrow{CD}$. Similarly, construct T on $\overleftrightarrow{CD}$ so that $\overline{AT} \perp \overleftrightarrow{CD}$. See image below.



By Thm 14, $\overline{AT} \cong \overline{BY}$. Using $\overleftrightarrow{CD}$ as transversal of $\overleftrightarrow{BC} \parallel \overleftrightarrow{AD}$, c=g, by Thm 10c. By definition of perpendicular, $\angle ATD \cong \angle BYX \cong 90°$. By Thm 17 $\Delta ATD \cong \Delta BYC$. By CPOCT $\overline{BC} \cong \overline{AD}$, as desired.

The best part about proving the construction of a midpoint with a compass and a straight edge was that we had already done it in the very beginning, knowing it was possible and how to do it was very helpful since we were able to know what was to come from it. Writing this proof would have been much more difficult had we not already constructed it and messed around with it in lab.



Due to ΔABC having congruent sides it is an iscoceles triangle. By Thm 5 the base angles c and d of ΔABC are congruent. Likewise, ΔABD has two congruent sides forming an isosceles triangle with base angles e and f. Thm 5, $e \cong f$.

[Strategy: Proving $\Delta ADC \cong \Delta BDC$]

By CN2, $c + e \cong d + f$. Following this $\Delta ADC \cong \Delta BDC$ by SAS. {S₁: $\overline{AD} \cong \overline{BD}$, A: $a \cong b$, S₂: $\overline{AC} \cong \overline{BC}$. }

[Strategy: Proving $\Delta ACM \cong \Delta BCM$]

Since $\Delta ADC \cong \Delta BDC$ we can deduce that $a \cong b$, by CPOCT. By CN 4, we are aware that $\overline{CM} \cong \overline{CM}$. Thus $\Delta ACM \cong \Delta BCM$ by SAS. {S_1: $\overline{AC} \cong \overline{BC}$, A: $a \cong b$, S_2: $\overline{CM} \cong \overline{CM}$.}

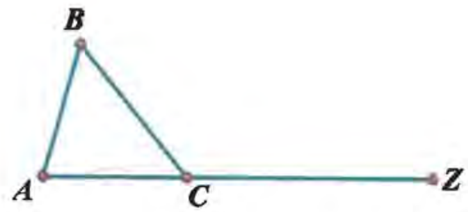
[Strategy: Proving M is the midpoint of $\overline{AB}$]

By CPOCT for $\Delta ACM \cong \Delta BCM$, we deduce that $\overline{AM} \cong \overline{BM}$. By definition of midpoint, the M must split $\overline{AB}$ into two equal line segments. As previously discovered M dissects $\overline{AB}$ into congruent segments $\overline{AM}$and $\overline{BM}$. Thus, we can conclude that we did in fact construct a midpoint of segment $\overline{AB}$, as desired.

These two proofs are about exterior angles, exterior angles are a weird concept to grasp because it's so blatantly clear that the exterior angle will be larger. The hint our book gave us assisted me greatly. When proving that the exterior angle is equivalent to the two interior angles, it was very helpful because we already knew it was bigger; but to place a value on that was very simplistic and yet made everything come together in the end. Thinking about it later on, had we done the proof which proved the equivalence of the exterior angle and skipped that the exterior angle was larger, I think that it would have been a waste. I think this because the exterior angle theorem really helped in later proofs just in the concept of altering the original figure and adding to it.

Theorem: An exterior angle of a triangle will have a greater measure than either of the non-adjacent interior angles

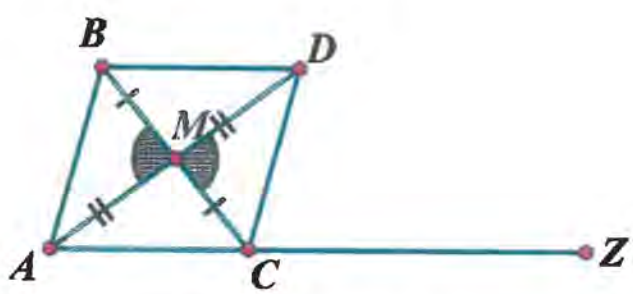
Given: Let there exist a triangle, let us name ABC. One of its segments we extend to a point, namely Z.



From the illustration above we see the exterior angle is $\angle BCZ$. We show both $\angle ABC$ and $\angle CAB$ are smaller than the exterior angle.

[Strategy: Proving $\angle ABC < \angle BCZ$]

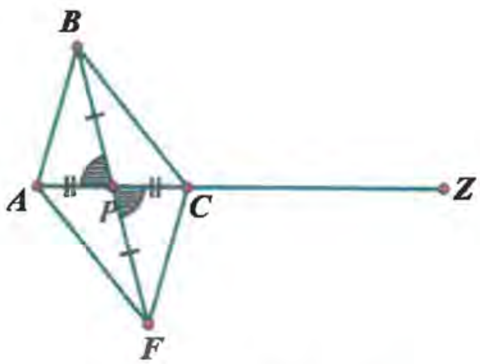
To begin this proof, using Thm 6, construct a midpoint M on $\overline{BC}$. Create line segment $\overline{AD}$ such that M is also the midpoint of $\overline{AD}$. Form line segments $\overline{BD}$ and $\overline{CD}$. Observe in the figure below that we have constructed four triangles.



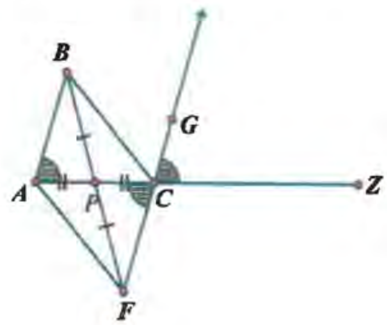
Above, the following congruencies are marked $\overline{BM} \cong \overline{CM}$, by definition of a midpoint; $\overline{AM} \cong \overline{DM}$, by construction; $\angle AMB \cong \angle CMD$ by the Vertical Angle Theorem. Thus, by SAS, $\Delta AMB \cong \Delta DMC$. By CPOCT, $\angle ABC \cong \angle BCD$. Since $\angle BCD$ is part of $\angle BCZ$, we know, by CN 5, that $\angle BCD < \angle BCZ$. Thus, by CN 1, $\angle ABC < \angle BCZ$.

[Strategy: Proving $\angle BAC < \angle BCZ$]

Reverting back to our original triangle we are going to use Thm 6 to construct a midpoint P on $\overline{AC}$. Similar to the previous strategy we will construct $\overline{BF}$ so that P is also the midpoint. See below.



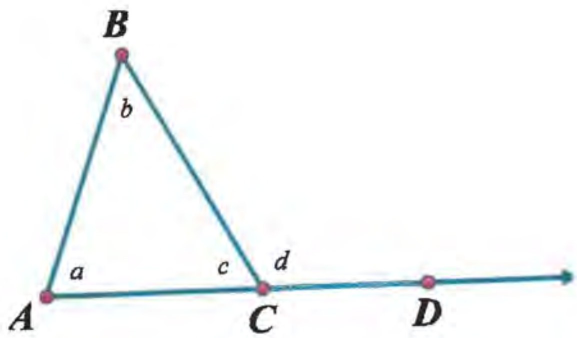
Again, above congruencies are marked as follows $\overline{AP} \cong \overline{CP}$, by definition of a midpoint; $\overline{BP} \cong \overline{FP}$, by construction; by the Vertical Angle Theorem $\angle APB \cong \angle FPC$. $\Delta APB \cong \Delta CPF$ by SAS. By CPOCT we know $\angle BAP \cong \angle FCP$. Next, let us extend $\overline{CF}$ pas C to a point, namely G.



$\angle PCF \cong \angle GCZ$, by the Vertical Angle Theorem. Additionally, since $\angle GCZ$ is a part of $\angle BCZ$, by CN 5, we can deduce that $\angle GCZ < \angle BCZ$. Applying CN 1 $\angle BAC < \angle BCZ$. Which finalizes our proof that the interior angles non-adjacent to the exterior angle are smaller than the exterior angle, as desired.

Theorem: An exterior angle of a triangle will have a measure equal to the sum of non-adjacent interior angles.

Given: Let there be ΔABC, extend $\overrightarrow{AC}$, by Axiom 2, to a point D and name angles as labeled below.

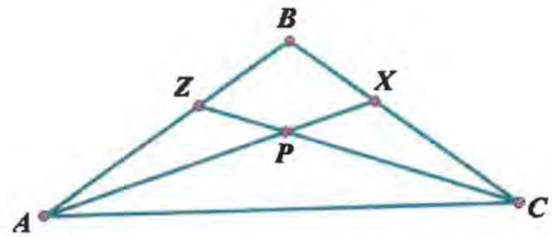


By supplementary angles c+d=180°. By Thm 12, a+b+c=180°. By substitution, a+b+c =c+d. By CN 3, a+b=d, as desired.

This final set of proofs was on Cevians. These were by far my favorite to prove. It was really unique to work with different cases where just because one was didn't necessarily mean the whole proof was true. By this I mean proving the left and then the right was false verses saying just because it isn't on the left means it isn't anywhere except coinciding with Y'. On top of this, the medians were really nice to work with because it clarified the Cevian Theorem for me. Honestly, I feel doing the proof of the medians actually explained what the Cevian Theorem's formula meant more than the original theorem.

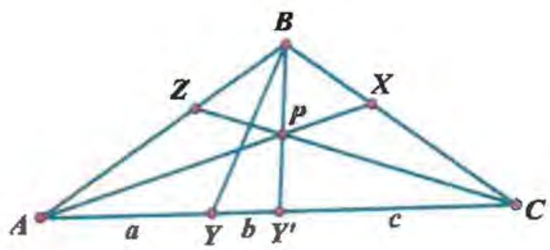
Theorem: In ΔABC, with Cevians AX, BY, and CZ, if $\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY}{YA}=1$, then the Cevians are concurrent.

Given: Let there be a triangle ABC so that $\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY}{YA}=1$. Construct the cevians AX and CZ. See below.



Suppose, FSOC, that the Cevian $\overline{BY}$ does not go through P. Construct $\overline{BY'}$ so that it goes through point P. Let there be, two cases: Case 1, the order on $\overline{AC}$, is A,Y,Y',C; Case 2, the order on $\overline{AC}$ is A, Y', Y, C.

Case 1: Construct Cevian $\overline{BY}$ so that Y lies to the left of Y'. Label measurements as below.



By Ceva's Thm, $\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY'}{Y'A}=1$, it was given that $\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY}{YA}=1$. By substitution $\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY'}{Y'A}=\frac{AZ}{ZB}\cdot\frac{BX}{XC}\cdot\frac{CY}{YA}$. Through algebra this simplifies: $\frac{CY'}{Y'A}=\frac{CY}{YA}$. By substitution in the measurements from our figure: $\frac{c}{a+b}=\frac{b+c}{a}$. Through algebra:

$ca=(a+b)(b+c)$

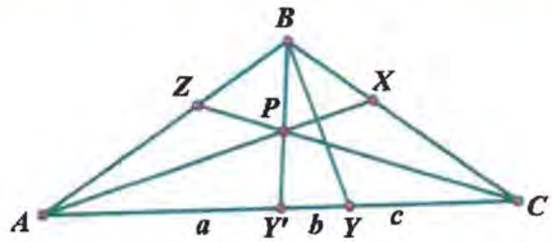
$ca=ab+ac+b^2+bc$ By algebra

$0=ab+b^2+bc$ By CN3

$0=b(b+a+c)$ By Algebra

b+a+c = $\overline{AC}$, which cannot be zero. Therefore, b must be zero in order to satisfy the equation. If b=0 then there is no distance between Y and Y'. In other words, they coincide so Y cannot lie to the left of Y'.

Case 2: Construct Cevian $\overline{BY}$ sp that Y lies to the right of Y'. Label measurements as below.



Similarly to case one we reach this point:

$\frac{AZ}{ZB} \cdot \frac{BX}{XC} \cdot \frac{CY'}{Y'A} = \frac{AZ}{ZB} \cdot \frac{BX}{XC} \cdot \frac{CY}{YA}$

$\frac{CY'}{Y'A} = \frac{CY}{YA}$ By algebra

$\frac{c}{a+b} = \frac{b+c}{a}$ By substitution

$ca = (a+b)(b+c)$ By algebra

$ca = ab + ac + b^2 + bc$ By algebra

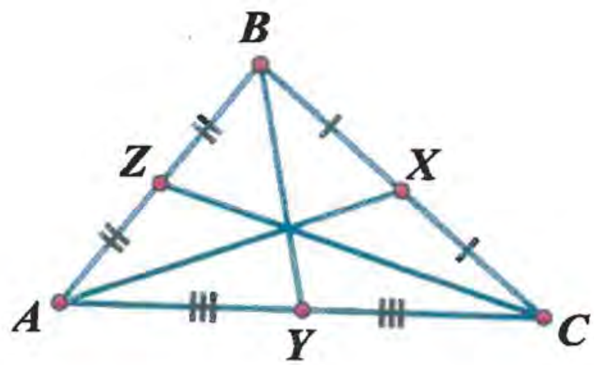
$0 = ab + b^2 + bc$ By CN3

$0 = b(b + a + c)$ By Algebra

Through similar logic of Case 1: we deduce that Y and Y' coincide because b=0; therefore, Y cannot lie to the right of Y' either. The only location left for Y is at Y' In other words, Y'=Y so $\overline{BY}$ goes through P, as desired.

Thereom: IfΔABC has medians $\overline{AX}, \overline{CZ},$ and $\overline{BY}$, then these medians are concurrent.

Given: ΔABC with medians $\overline{AX}, \overline{CZ},$ and $\overline{BY}$. See figure below: marked congruencies are by construction and defintions of median.



$\overline{BZ} \cong \overline{AZ}$, thus $\frac{BZ}{AZ} = 1$; $\frac{AY}{YC} = 1$ since $\overline{AY} \cong \overline{CY}$; $\overline{BX} \cong \overline{XC}$ so $\frac{BX}{XC} = 1$. By substitution we get: $\frac{BZ}{AZ} \cdot \frac{AY}{YC} \cdot \frac{BX}{XC} = 1 \cdot 1 \cdot 1$. By Thm 36, since $\frac{BZ}{AZ} \cdot \frac{AY}{YC} \cdot \frac{BX}{XC} = 1$, $\overline{BX}, \overline{XA}$, and $\overline{CZ}$ are concurent, as desired the medians of ΔABC are concurrent.

A Final Reflection:

I'm very thankful that I took this geometry class as an elective because I've been able to work on thinking more abstractly throughout this course. Working in labs was very entertaining and helped to make the proofs of the chapter come to me easier sometimes because I observed it through an activity. Compared to the typical geometric proofs that I did in high school geometry, these proofs actually make me feel as though I accomplished something. I always enjoyed geometry in high school as well as trigonometry, but I had never noticed how beautiful it actually is. Stepping back and proving things that are already known makes everything a bit more definite and I appreciate it. After taking this class I feel that I've developed my proof writing strategy as well as the strategies I use when I become stuck on certain topics.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**MATH 207 Project**
This documentation is relevant to Question number:	**16**
Briefly summarize the content of the file and its value as evidence supporting program review:	**This shows the assignment description, rubric and two final three final papers for a statistical project where students collect and analyze data.**

MATH 207 Statistical Analysis Project

The purpose of this project is for you to determine questions that can be answered with the statistical knowledge you will gain throughout the semester, and then use statistics to develop an answer for your questions. The questions should be about something of interest to you and your group. The statistical analysis should provide at least partial answers to your questions. A good project also results in more questions for future study.

Part 1: Experimental Design (5 points) Due start of class Thursday, September 6

a. Determine at least 2 questions to analyze statistically. Keep in mind that you will need to collect data with at least three variables, including at least two quantitative variables and at least one qualitative variable, with a suggested sample size of 40.

b. Describe how you will determine a sample and collect data for each question. Submit your questions and your data-collection plan for approval ***before*** collecting your data.

Part 2: Meet With Professor (5 points) Schedule: Start Thursday, September 6
Meet by 5:00 p.m. Friday, September 14

This meeting is for you to discuss your proposed questions and data-collection methods, and to end up with approval of one question and associated data-collection methods.

Part 3: Data Collection and Data Description (20 points) Due Tuesday, October 2

When your questions and sampling method have been approved, collect your data. Analyze your data by determining and producing appropriate graphs for your data, creating visuals of the data and determining the descriptive statistics for your data and investigating possible correlations in your data. Include text that succinctly explains each visual and also points out the interesting aspects of your data that each visual reveals.

Note: Your analysis will be accepted only if prior approval was given for the data-collection method.

Part 4: Inferential Statistics (10 points) Due Tuesday, November 27

Apply inferential statistics to your data. Write a description of the question(s) and the inferences (confidence intervals and hypothesis tests) you can make, including a description of the mathematical work. Describe in words what you now know about your population(s). Include the question(s), the data you used and you conclusions.

Part 5: Final Report (10 points) Due Thursday, December 6

Your final report puts all 3 parts together into one well-formatted and well-written document that you can be proud of.

MATH207 Descriptive Statistics Project — Rubric
Group members:

Points	Excellent	Good	Fair	Unacceptable
Sampling Method	A simple random sample, or chose a population to suit the situation	Used students from a class or location which may exclude some of the population	Voluntary sample	Made up values to make it look like a sample
Questions	Easy to understand, quick to answer, responses were analyzable	Easy to understand, quick to answer, some responses not analyzable	Not all easy to understand or quick to answer	confusing, poorly worded questions, not analyzable
Graphs	Histograms, etc appropriate for the type of data and correctly drawn	Histograms, etc. appropriate for the data, but some errors in accuracy	Graphs not appropriate for the type of data	No graphs
Descriptive Statistics	One or more measure of center for each set of data, appropriately used, and standard deviation and outliers discussed if appropriate for the level of measurement	Some measures of center but not all, appropriately used, or discussion of standard deviation and outliers not complete	Some measures of center for each set of data, or standard deviation and outliers discussed not complete	No measures of center or standard deviation included
Discussion	Problem described, and results discussed which responded to the problem	Some description but limited discussion of the answer to the problem	Some description but problem not discussed	No discussion or description

Math 207 Experimental Design **Fall 2018**

Due Start of Class Thursday September 6, 2018

Directions: Please type your answers, save the document to your own computer or jump drive, print it out, proofread, and submit in class. *No data collection will begin before the plan has been approved.*

Your Name:

Full names and email addresses of other members of your group:

1. Determine a question that can be answered with a statistical analysis.

2. Who are the individuals or objects of interest?

3. Specify the variables. Be sure to include at **least one** qualitative and **at least two** quantitative variables.

4. If this design is approved, what sampling method or methods will be used? See page 25 of our text. State the name of the sampling method and explain how you will carry out finding the sample.

5. If you use a survey, list the questions you will ask. Review ch1 and carefully word your questions so you will get answers that can be used for analysis.

6. If you are taking direct measurements, describe how you will take these measurements.

7. Some data collection schemes require permission from the Institutional Review Board (IRB). After reading the policy at http://www.lssu.edu/irb/policy.php, will you need permission for your analysis?

MATH 207
Prof. Grace
April 26th, 2018

Statistical Analysis | University Student Daily Water Consumption

[redacted]

Our Main Questions:

- How much water does does an average student at Lake Superior State University drink every day?
- Does bringing a water bottle to class help students increase their water consumption?

Our Survey:

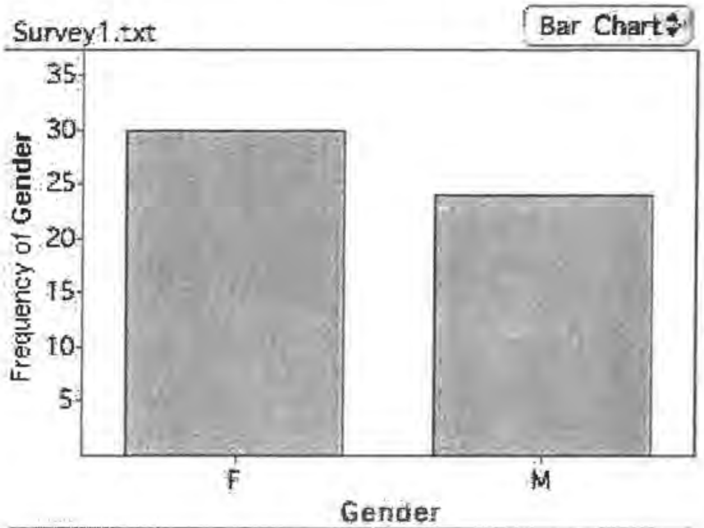
We surveyed a total of 110 students between two classes on Lake Superior State University's main campus. The two general classes surveyed were: Spring 2018 BIOL 132 and Spring 2018 CHEM 116. Of the 110 surveyed as a simple random sample, we ensured randomness by selecting half (55) at random and recorded the results. Our survey consisted of the following questions:

- What is your gender?
- Do you bring a water bottle to class?
- How much water (in cups) do you drink daily?
- How much water (in cups) do you think you *should* drink daily?
- Do you drink a different beverage more than you drink water?
- If so, what is that beverage?
- If so, how much (in cups), if any, of that beverage do you drink daily?

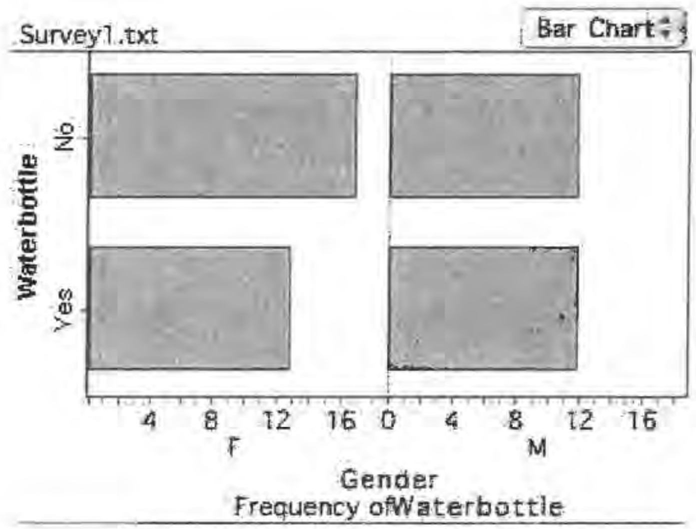
These questions gave us 7 answers for each survey: 4 qualitative and 3 quantitative. The suggested sample size for this project was 40 to ensure that we obtained a sample size greater than that of the requirement for the central limit theorem. The individuals of interest in this survey are general students that attend Lake Superior State University. It is important to note that this survey may have included a little bit of convenience sampling however it was hard to avoid without any funds or any aspirations for a larger sample size. It was convenient, however I believe there was a good pool of students that were surveyed at the campus that provided a variety of results.

The Data:

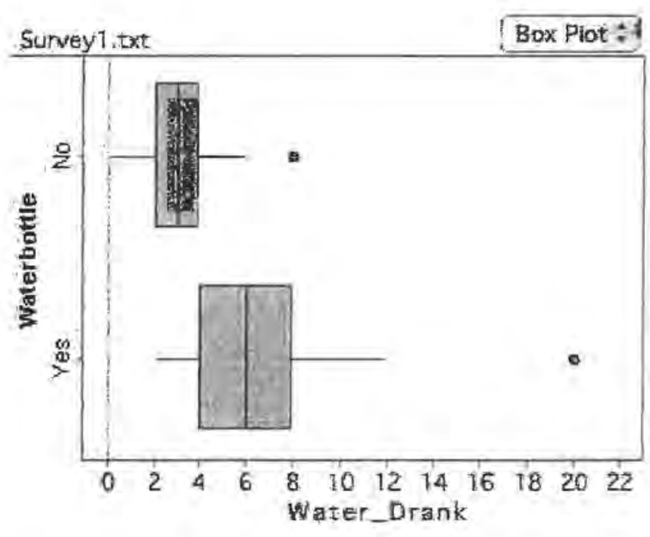
The data below was collected via survey and was input into the software *Fathom*. The program *Fathom* was used to create multiple graphs that compare two or more variables. Following each graph, there will be a description and interpretation.



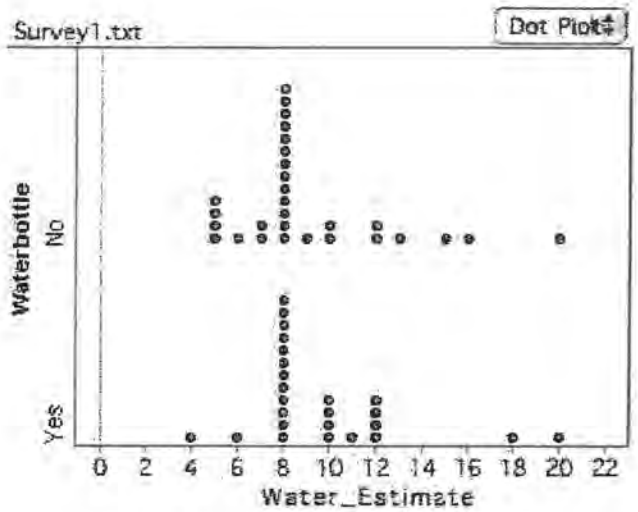
This graph displays the population that was surveyed. The information here shows how many males and females took the survey. Out of 55, 30 females and 25 males participated. These results were put in their own graph to display that the sample was not primarily males or females, but contained an average mix of each gender.



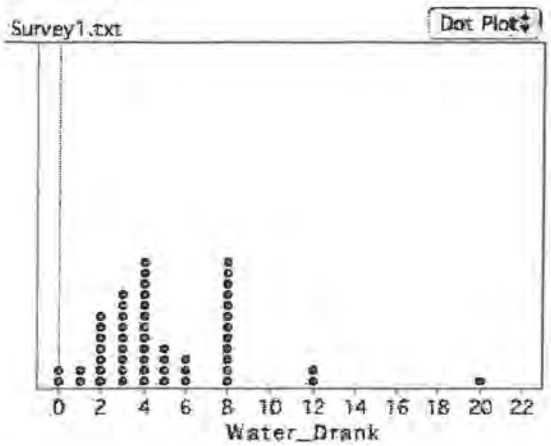
For this graph, it looks at each gender and the trends of bringing a water bottle if you are male or female. Given females, more females didn't bring water bottles; given males, the same number of males did or didn't bring a water bottle to class. This just shows that primarily it doesn't matter if you are male or female, both genders were very close to equal when it came to bringing a water bottle to class or not.



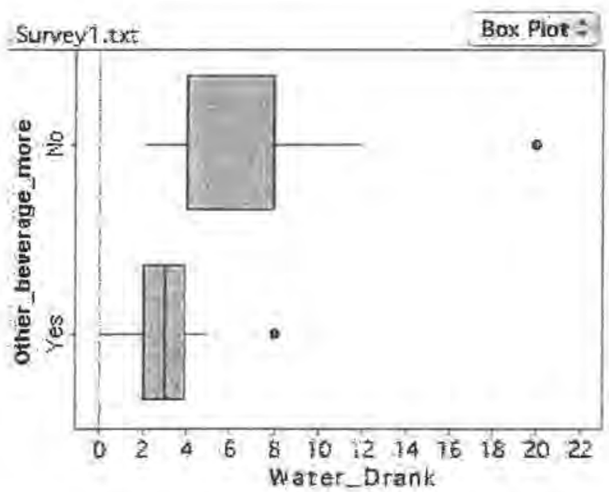
For this box plot, it compares how much water students drank if they brought a water bottle to class or not. This shows that the students who brought a water bottle to class drank on average 3 more cups of water per day than those who didn't. This is a very important statistic to support our questions at the very beginning. Does bringing a water bottle to class help students drink more water? Here it is prevalent that if you were to bring a water bottle class, you are more likely to drink on average 6 cups a day compared to just 3. There are two outliers to note on this box plot. For the students who did not bring a water bottle to class, an outlier of 9 cups of water drank per day was recorded. For the students that did bring a water bottle to class, there was an outlier of someone who drank 20 cups of water per day. The highest amount drank by students who didn't bring a water bottle (not taking account the outlier) was 6 cups. The highest amount for students who bring water bottles to class (not taking account the outlier) was 12 cups.



This dot plot shows that the majority of people think that individuals should drink 8 cups of water per day. Furthermore, those who did not bring a water bottle and those who did bring a water bottle appear to think the same thing. This makes us think that people are educated about how much to drink, but that doesn't effect if they bring a water bottle or not. It has always been portrayed by the government that people should drink 8 cups of water per day for awhile and that is always what we have known. 8 cups of water per day is a good starting point, but additional water may be needed to compliment a higher calorie diet. These facts aside, it is interesting to see that the students who don't bring a water bottle are educated enough to know how much water they need to drink, but still do not bring a water bottle to class or drink enough water.



This dot plot shows us simply that most people drink less than 8 cups per day, with the most frequent (mode) being 8 cups per day and 4 cups per day. This dot plot is quite interesting because as we saw in the graph above, the majority of the sample knew that you should drink about 8 cups per day. This shows us that a lot of people drink 8 cups per day, but a lot of people also drink 4 cups per day. Two people even said that they do not drink any cups of water per day and one person said they drink 20 cups per day. This all compiles into an average of 4.65 cups per day.



This box plot connects how much water students drink versus if they consume other beverages more than water. It appears that the more water students drink, that they are more likely to consume water as their primary drink. This is a very logical conclusion because if you drink water as your primary drink, you will almost definitely drink more water than someone who doesn't primarily drink water. It is also an important concept for a population to know: if you make a deliberate point to drink primarily water, it will promote healthier consumption levels.

Data Summary:

These graphs display that average students drink around 5 cups of water per day. Also, it looks like bringing a water bottle to class helps water consumption. Out of all our data, it seems most students are well educated that you should drink around 8 cups of water per day. Some of the other beverages that students drink more than water are soda, coffee, tea, sports drink, milk, beer, juice, lemonade, and vitamin water. The most important connection to make from these graphs is that if you bring a water bottle to class, on average, you should drink more water than someone who does not bring a water bottle to class. The comparative box plots that support this conclusion are listed as the third graph from the top. This graph was an instrumental part in determining our conclusion for our project.

Inferential Statistics:

Confidence interval for a parameter of our data:

For our study, out of the 55 people in the sample, 25 of them brought their water bottles to class. The point estimate (p^) of this is 45.5%. A 95% confidence interval for this data would be **$.323 < p < .586$.** We got this confidence interval by using 1-proportion Z Interval function on the TI-84 Plus graphing calculator. From this, we are 95% confident that the true proportion of students who bring water bottles to class at LSSU falls between 32.3% and 58.6%.

Confidence interval for the mean of our data:

The mean of our data for water drank by students who bring their water bottle to class was 5.9 cups with a standard deviation of 1.0 cups. We constructed a confidence interval for our mean using Z Interval test function on the graphing calculator. The confidence interval for our mean is **$5.63 < \mu < 6.16$.** We are 95% confident that the true mean of water drank by students who bring their water bottle to class falls between 5.63 cups and 6.16 cups.

Hypothesis testing of our data and an online data source:

According to a survey by NCBI Bahlagi et al in 2011, the mean of water drank per day for university students is 7.92 cups per day. Our sample has a mean of water drank for LSSU students at 4.65 cups per day with a standard deviation of 1.7 cups. We tested the Null Hypothesis of H_0: μ=7.92 and our alternative hypothesis is H_1 : $\mu \neq 7.92$ to test that the mean water drank by college students is different using our study. We used Z Test function on the graphing calculator to find the **p value = 1.4 x 10^{-57}**. We decided that since the p value is less than our level of significance of 0.01, we will reject the Null Hypothesis (H_0). We have sufficient evidence at 5% level of significance to conclude that the mean water drank by college students is different from 7.92 cups per day.

Conclusion:

The purpose for this statistical analysis was to analyze these questions statistically and be able to confidently answer them with a background of statistical data.

a. How much water does does an average student at Lake Superior State University drink every day?

b. Does bringing a water bottle to class help students increase their water consumption?

We have come to conclude that for our first question (a): on average, general students that attend Lake Superior State University drink a little less than 5 cups of water per day. This number is quite low considering that these same students generally know that people should consume on average 8 cups of water per day.

We have also come to conclude for our second question (b): Bringing a water bottle to class does help students consume more water than students who do not bring their water bottle to class. This conclusion is supported by the box plot on page 3 that suggests students who bring a water bottle to class drink on average 3 more cups of water per day. This is also supported by the logical explanation that having more water available to you during all times of the day (including class) is helpful for students consuming water more often.

LSSU College Student Habits:

Exercise, Media, Screen Hours, and Weight

Statistics Project

MATH 207

Instructor: Grace Ngunkeng

By:

[redacted]

SURVEY EXAMPLE:

Statistics Project

Survey Questions

1) In what way do you spend most of your time in front of a screen watching a show or movie (television, Netflix, Hulu, DVDs, other)?

2) How many hours per week do you spend in front of a screen watching your shows or movies?

3) Do you use this time for leisure time or for watching projects for school?

4) How many hours per week do you work out?

5) Circle gender: F or M

6) What's your major?

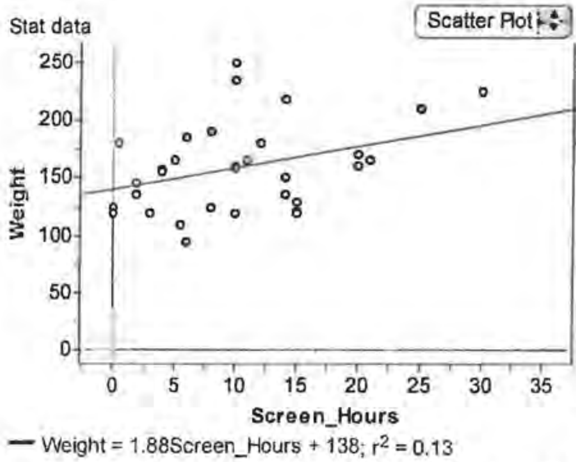
7) What is your current weight in pounds?

DATA COLLECTION:

Stat data2

	Media_...	Screen_...	Reason	Exercis...	Gender	Major	Weight	<new>
1	netflix	15	leisure	5	Female	Psych/S...	130	
2	netflix	10	leisure	3	Female	Accounti...	250	
3	netflix	10	leisure	0	Female	Business	160	
4	netflix	10	leisure	2	Female	Med. Lab...	120	
5	netflix	10	leisure	5	Female	pre-Nursi...	235	
6	netflix	3	projects	2	Female	fisheries ...	120	
7	netflix	0.5	leisure	5	Male	Geology	180	
8	netflix, D...	21	leisure	5	Female	history	165	
9	Youtube	20	leisure	0	male	Accounti...	171	
10	hulu	10	both	12	Female	history	160	
11	netflix	15	leisure	0	Female	chemistry	120.2	
12	other- list...	0	leisure	1	Female	biology	124	
13	netflix, h...	6	leisure	0.5	Male	criminal j...	185	
14	other-lap...	11	leisure	5	Female	conserv...		
15	netflix	11	leisure	9	Female	geology	165	
16	netflix	30	leisure	3	Female	Geology	225	
17	netflix, h...	6	leisure	5	Female	sports a...	95	
18	DVDs	14	leisure	5	Female	psycholo...	135	
19	TV	8	leisure	9	Male	criminal j...	190	
20	netflix	2	leisure	5	Female	fine arts	145	
21	TV	4	leisure	15	Female	undecided	157	
22	netflix, D...	8	leisure	7.5	Female	creative ...	125	
23	ndetflix, ...	15	leisure	10	Female	Psycholo...	120	
24	Hulu	5	leisure	25	Male	fire scien...	165	
25	youtube	12	leisure	6	Female	elementa...	180	
26	netflix	5.5	leisure	7.5	Female	business...	110	
27	hulu DVDs	10	leisure	6	Female	Biochemi...	159	
28	other	0	n/a	0	Male	biochemi...	120	
29	websites	2	leisure	2	Female	pre-Nursi...	135	
30	netflix, h...	15	leisure	3	Female	fire scien...	120	
31	netflix, c...	14	leisure	1.5	Female	fire scien...	218	
32	netflix	4	both	5	male	parmedic...	155	
33	netflix	14	leisure	10	female	fire scien...	150	
34	netflix	25	leisure	0	male	fire scien...	210	
35	netflix	20	leisure	4.5	Female	fire scien...	160	

College Student Weight vs. Hours of Media Watched per Week



Stat data

	Screen_Hours
Weight	0.35736501

S1 = correlation ( )

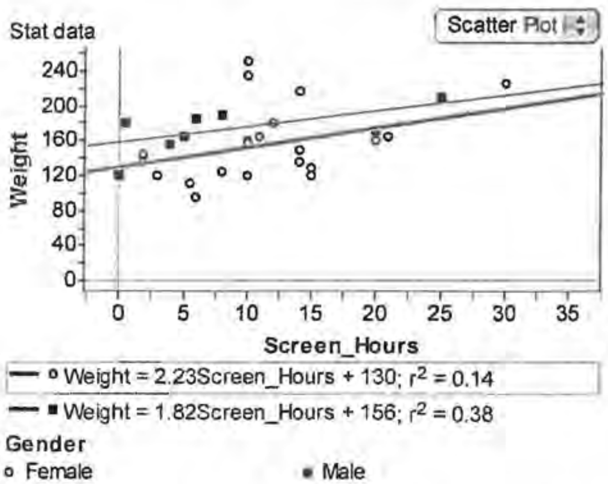
Stat data2

	Screen_Hours	Weight
	10.457143	157.62353

S1 = mean ( )

The above scatter plot shows the correlation between the weight of college students and hours spent watching some form of media. The r value is .357 indicating a very weak positive correlation between the two variables. The average number of screen hours is 10.46. The average weight is 157.62 pounds. Our r^2 value is 0.13 which tells us that 13% of our data values are represented by the least squares line y=1.88+138.

Gender Differentiation between Weight and Screen Hour Comparison



Stat data

		Screen_Hours
Gender	Female	27 11.018519
	Male	8 8.5625
Column Summary		35 10.457143

S1 = count ( )
S2 = mean ( )

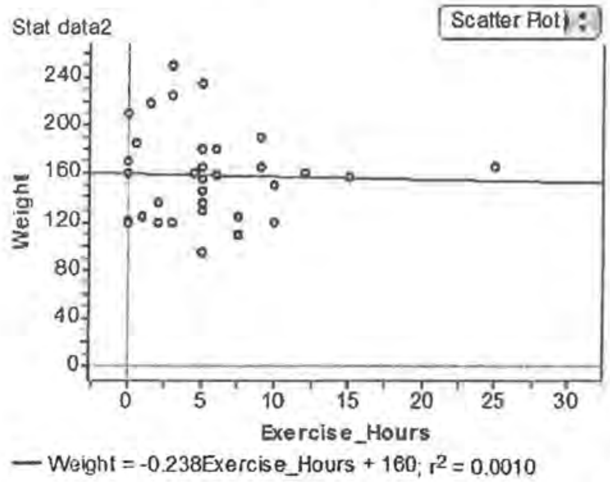
Stat data

		Weight
Gender	Female	26 153.2
	Male	8 172
Column Summary		34 157.62353

S1 = count ( )
S2 = mean ( )

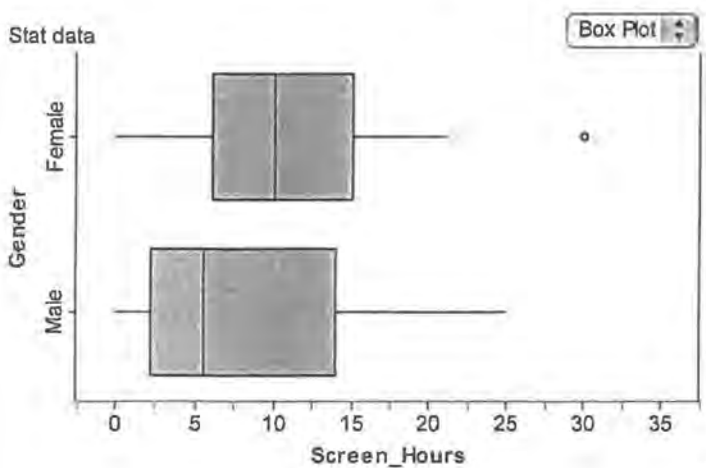
The above scatter plot shows the correlation between the screen hours and weight, but contrasts the data based on gender. Males had a positive correlation with r =0.62. Females had a slight positive to no correlation with r =0.40. The average female weight was 153.2 pounds and their average screen time was about 11 hours. The average male weight was172 pounds and their average screen time was about 9 hours. The male data had a stronger correlation compared to the female data. The male least squares line had a higher r squared value indicating that the line represented a greater proportion of the data collected.

College Student Weight vs. Hours Exercised per Week



The scatter plot above shows the relationship between college student's weight and the number of hours that they exercise per week. The data was completely scattered and our r squared value was very close to zero, indicating that no data is represented by the least squares line, expressing an end result of no correlation between the two variables. We had thought that more hours exercised would cause a lower weight, but the no correlation could be due to several factors. One factor not taken into consideration could have been that as some work out they are actually packing on muscle rather than losing weight, so their weights could be higher than someone who works out less. A BMI would have to be taken into consideration to further examine the correlation.

Gender vs. Hours of Watched Media per Week



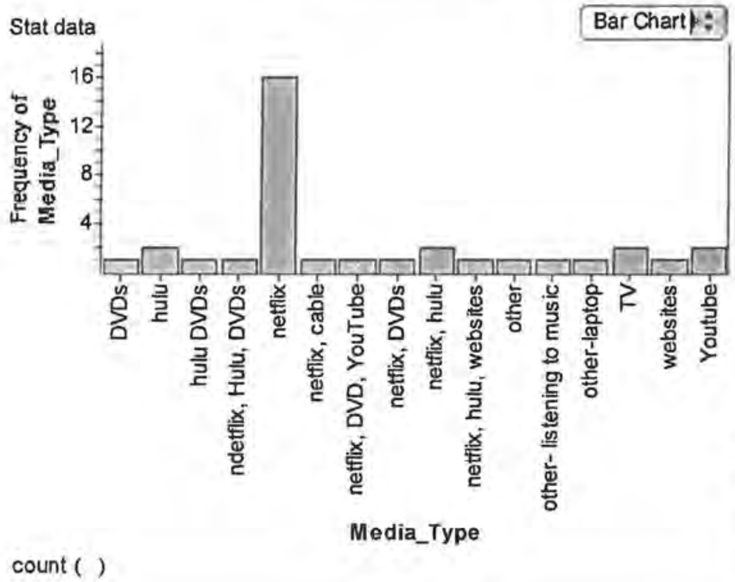
Stat data

	Gender: Female	Gender: Male	Row Summary
Screen_Hours	11.018519	8.5625	10.457143
	27	8	35
	0	0	0
	6	2.25	5
	10	5.5	10
	15	14	15
	30	25	30

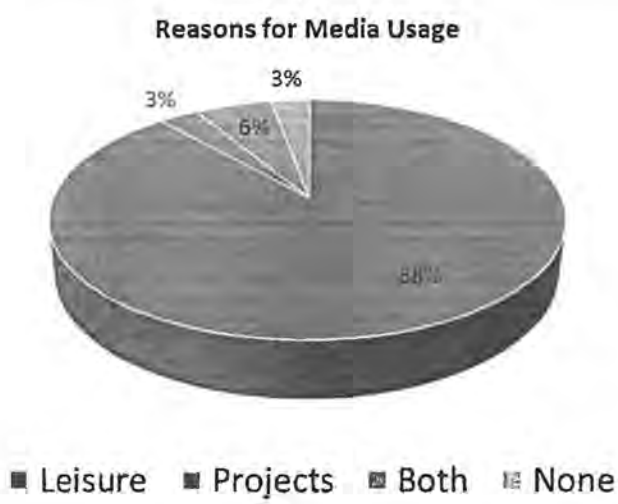
S1 = mean ( )
S2 = count ( )
S3 = min ( )
S4 = Q1 ( )
S5 = median ( )
S6 = Q3 ( )
S7 = max ( )

The box plot shows the comparison between genders and the hours of media/screen time college students watch per week. The female median was 10 hours watched per week and there was one outlier with a value of 30 hours. The female range was from 0 to 30 hours. Female data had an IQR of 9 hours. The male median was 5.5 hours and ranged from 0 to 25 hours. Male data had an IQR of 11.75 hours. (IQR=Q3-Q1)

Frequency of Media Type amongst College Students

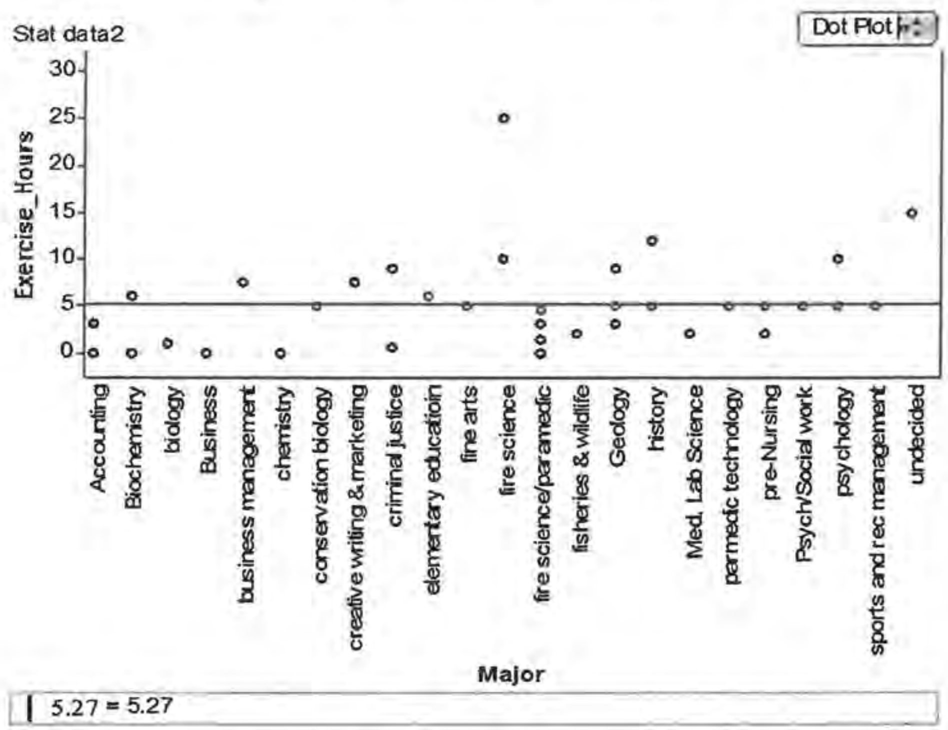


The bar graph shows the number of college students who use different types of media. Netflix was the most popular type, with having 23 out of 35 students reported that they watch it. Hulu was in second with 7 out of 35 students reportedly watching it. The third highest was DVDs with 5 out of 35 students. And television, YouTube, and other were tied at 3 out of 35 each. The least used form of media was website T.V. with 1 out of 35. In conclusion most of the student population reports having watched Netflix on a weekly basis.



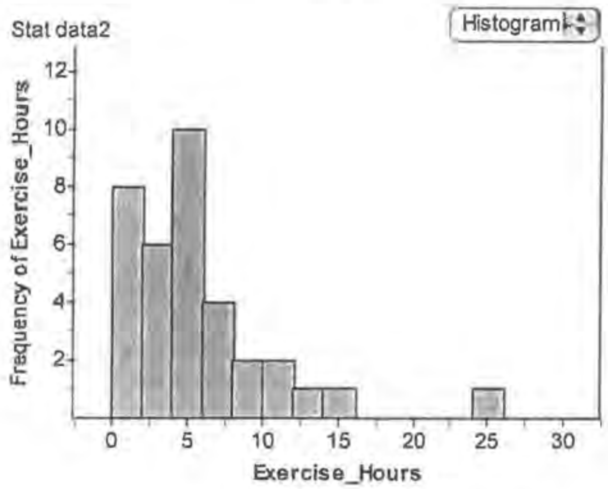
The pie chart indicates the percentage of students that watch media for various reasons. 88% of students reported watching media solely for the purpose of leisure. 3% reported they watched media for projects. Another 3% reported that they did not watch any form of media at all. Lastly 6% of student said that they watch media for projects and leisure.

College Major and Hours Exercised per Week



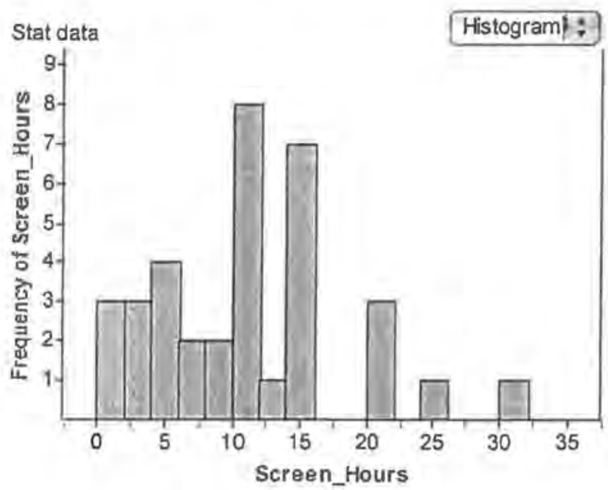
This plot shows the relationship between college majors and hours a student exercises per week. It indicates that the fire science major exercised the greatest amount with their max number of hours being 25. The lowest number of hours exercised per week was zero. Zero was recorded by an accounting, business, chemistry, biochemistry, and fire science/paramedic major. The average number of hours students exercised per week was 5.27 hours indicated by the blue line.

Histogram of Frequency of Hours Exercised per Week



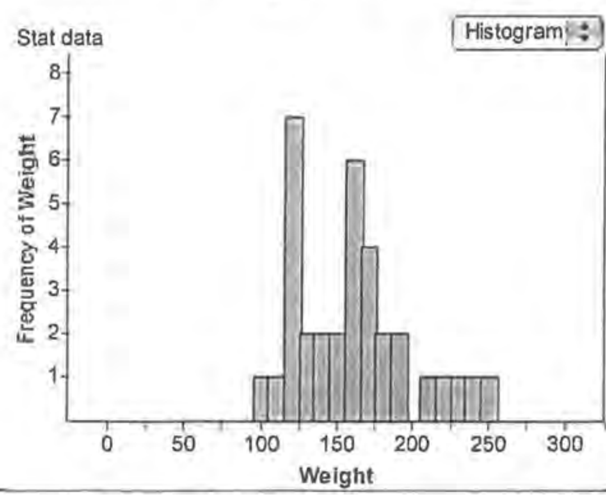
The histogram describes the frequency that college students exercised a certain amount of time per week. The graph is skewed right. The average number of hours a college student exercised per week was 5.27. The majority of the sampled students exercised between 0 and 7.25 hours. There was one outlier who exercised 25 hours per week.

Histogram of Frequency of Screen Hours of Media Use per Week



The histogram describes the frequency of screen hours spent on media by college students. The graph is sort of mound shaped with a slight skew to the right. The most occurring number of screen hours was between 10 and 15 hours.

Histogram of the Frequency of Weight amongst College Students



The histogram describes the frequency/ number of college students who reported being within each interval of a certain weight. The graph has a bimodal shape. One peak was around the 120 pound interval with the most frequency of occurrence. The second peak was around the 160 pound interval, which was the second most occurring weight interval.

CONFIDENCE INTERVALS:

95% Confidence Interval for Weight: 144.87 lbs. – 170.37 lbs.

We are 95% confident that the true population mean of the weight of LSSU student lies between 144.87 lbs. and 170.37 lbs.

SD=37.93, n=34, x bar= 157.62, E= 12.75

$144.87 \leq \mu \leq 170.37$

95% Confidence Interval for Screen Hours: 8.1 hours – 12.82 hours

We are 95% confident that the true population mean of the number of screen hours of media watched by LSSU students per week lies between 8.1 hours and 12.82 hours.

SD= 7.11, n=35, x bar= 10.46, E=2.36

$8.10 \leq \mu \leq 12.82$

95% Confidence Interval for the Population Proportion of Netflix Use: 50%-81%

We are 95% confident that the true population proportion of LSSU student that watch Netflix on a weekly bases lies between 50% and 81%.

P-hat=r/n=23/35= .6571, n=35

$.4999 < P < .8144$

HYPOTHESIS TESTS: 2 Populations Comparison Hypothesis Test at 5% Level of Significance

($\mu1$=male population mean, $\mu2$=female population mean)

Screen Hours:

- Null Hypothesis: $\mu1=\mu2$
  - The sample mean of male LSSU student screen hours per week is the same as the sample mean of female LSSU student screen hours per week.
- Alternate Hypothesis: $\mu1\neq\mu2$
  - The sample mean of male LSSU student screen hours per week is the same as the sample mean of female LSSU student screen hours per week.
- Test Statistic: Student T Test
  - t=-0.7096, d.f.=9.2268, P-Value=0.4955

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}}$$

- Decision: We fail to reject our null hypothesis
  - $P=.4955>0.05=\alpha$
- Conclusion: We do not have sufficient evidence at a 5% level of significance to conclude that the number male LSSU student media screen hours per week is different than that of females.

Hours Exercised per Week:

- Null Hypothesis: $\mu 1=\mu 2$
  - The sample mean of hours exercised by male LSSU student per week is the same as the sample mean of hours exercised by female LSSU students per week.
- Alternate Hypothesis: $\mu 1\neq\mu 2$
  - The sample mean of hours exercised by male LSSU student per week is the same as the sample mean of hours exercised by female LSSU students per week.
- Test Statistic: Student T Test
  - t=0.1195, d.f.=7.7740, P-Value=0.9079

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{S_1^{\,2}}{N_1} + \frac{S_2^{\,2}}{N_2}}}$$

- Decision: We fail to reject our null hypothesis
  - $P=.9079>0.05=\alpha$
- Conclusion: We do not have sufficient evidence at a 5% level of significance to conclude that the number hours exercised by male LSSU students per week is different than that of female students.

Weight:

- Null Hypothesis: $\mu 1=\mu 2$
  - The sample mean of male LSSU student weight is the same as the sample mean of female LSSU student weight.
- Alternate Hypothesis: $\mu 1\neq\mu 2$
  - The sample mean of male LSSU student weight is the same as the sample mean of female LSSU student weight.
- Test Statistic: Student T Test
  - t=1.5248, d.f.=17.6141, P-Value=0.1415

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{S_1^{\,2}}{N_1} + \frac{S_2^{\,2}}{N_2}}}$$

- Decision: We fail to reject our null hypothesis
  - $P=.1415>0.05=\alpha$
- Conclusion: We do not have sufficient evidence at a 5% level of significance to conclude that the weight of male LSSU students is different than that of female students.

DATA COLLECTION METHOD: Our data was collected by sampling from random LSSU general education courses.

RESULTS/CONCLUSIONS:

- Our data has no correlation between number of hours of exercise an individual LSSU college student has per week and their weight. This could be due to the lack of consideration and measurement BMI (Body Mass Index). A person could be going to the gym a lot and packing on muscle. Muscle weighs more than fat. As a result we do not know if the higher weights are due to little exercise (accumulation of fat) or excess exercise (buildup of muscle). As a result our data is inconclusive when looking at this correlation.
- There is a positive correlation between the weight of LSSU male college students and the number of media screen hours watched per week. There was no correlation among women when regarding the same relationship with their weight and screen hours. As a whole when looking at the data of both men and women combined, the data has a very weak positive correlation.
- The most widely used form of media watched per week by LSSU college students is Netflix.
- Most (88%) of LSSU college students use media for leisure.
- The average screen hours per week was 10.46 hours.
- The average weight was 157.62 pounds.
- The average number of hours of exercise per week was 5.27 hours.
- More data would need to be collected to adequately identify relationships amongst weight, screen hours, and hours exercised in comparison to college major.
- There was not enough sufficient evidence at the 5% level of significance to conclude that male and female LSSU college students differed in their weight, media screen hours per week, and exercise hours per week.

[redacted]

Math 207 - Statistical Analysis Project

[redacted]

Statistical Analysis Report

Questions:
1. What are the ages of most of the people who go to the gym?
2. What days of the week is it most common for people to go to the gym?
3. How long do males workout for compared to females?
4. How much time do people spend working out a week with respect to their age?
5. What is the proportion of males and females that go to the gym?
6. What is the proportion of males that participate in group exercises and what is the proportion of females?

This project was conducted through a survey placed at the front desk of the gym we chose to obtain our sample from. Any individual walking through the gym door has the ability to voluntarily fill out a survey.

Survey: Below is the survey we used for our sample.

Please be honest when filling out this survey. This survey is anonymous and any information used in this survey will be to the benefit the math 207 statistical project at Lake Superior State University.

Please circle your gender:
Male Female

How old are you?

Generally, what time do you arrive at the gym to begin your workout?

Generally, what time do you leave the gym?

Do you workout more then once a day at the gym?
Yes No

How long on average do you stay at the gym for your workout?

How much time outside of the gym do you spend working out (on average) per week?

On average what days of the week do you always go to the gym? Please Circle.
Mon Tues Wed Thurs Fri Sat Sun

Do you workout with a partner at the gym?
Yes No

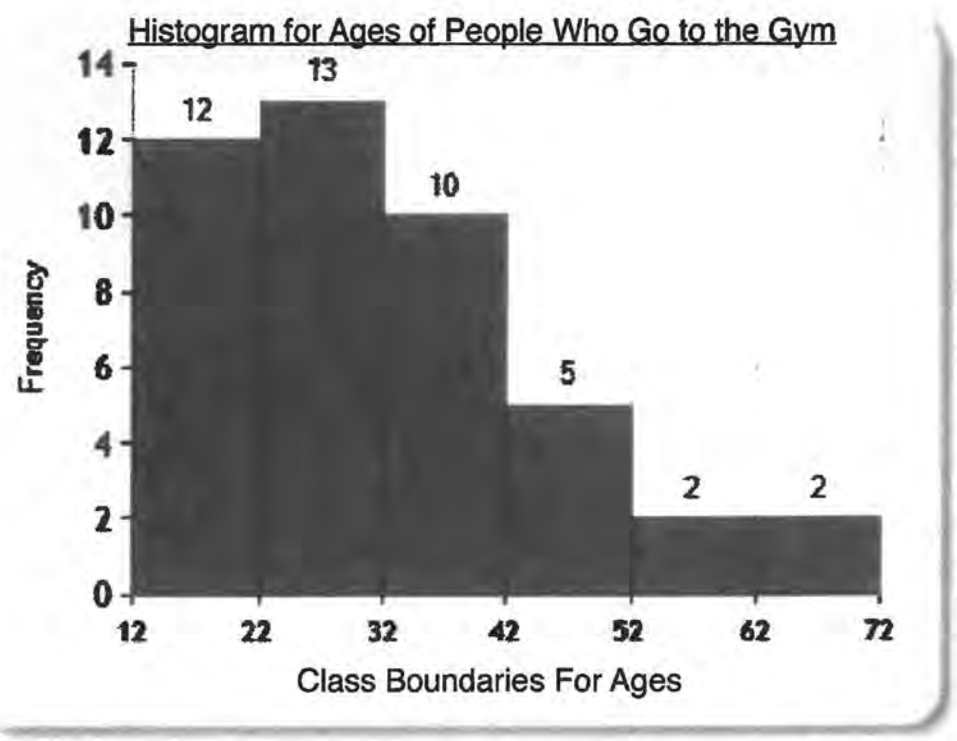
Do you get your workout through group exercises, personal training or through your own workouts? Please circle all that apply.
Group exercises Personal Training Independent workouts

Results:
A sample of 44 gym goers was collected and the results were summarized into a frequency table with a histogram, different pie charts, and various bar graphs.

1. What are the ages of most of the people who go to the gym?

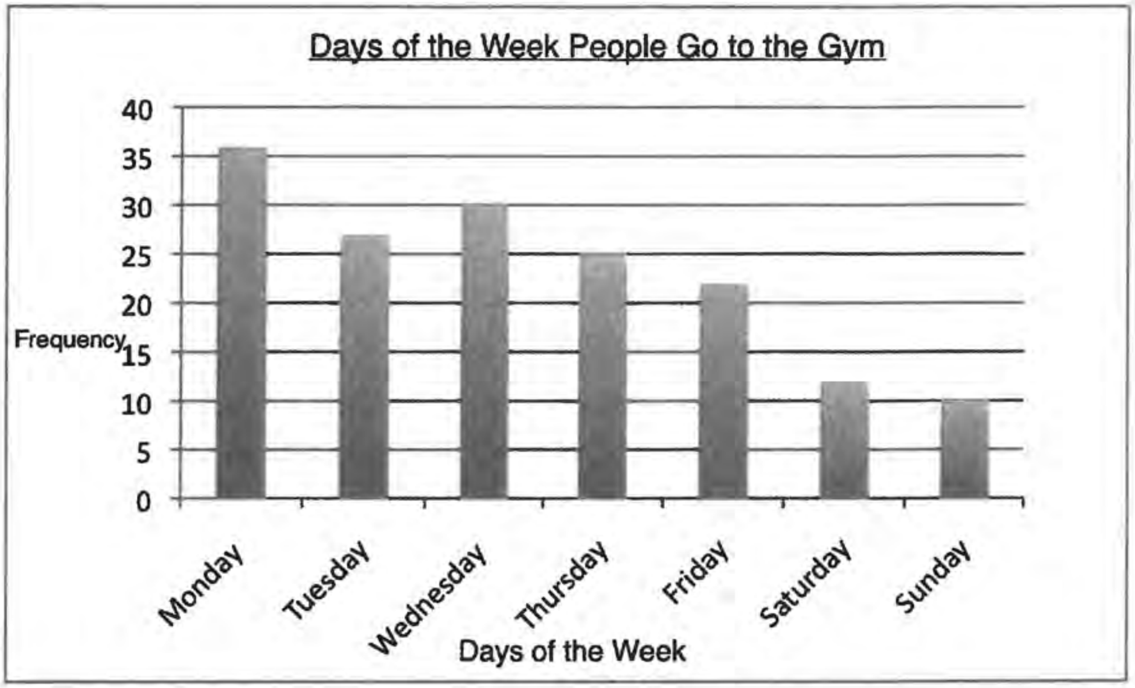
Frequency Table for Ages of People Who Go to the Gym

Class Limits	Class Boundaries	Class Midpoint	Frequency	Relative Frequency
12.5-21.5	12-22	17	12	0.272
22.5-31.5	22-32	27	13	0.295
32.5-41.5	32-42	37	10	0.227
42.5-51.5	42-52	47	5	0.114
52.5-61.5	52-62	57	2	0.045
62.5-71.5	62-72	67	2	0.045



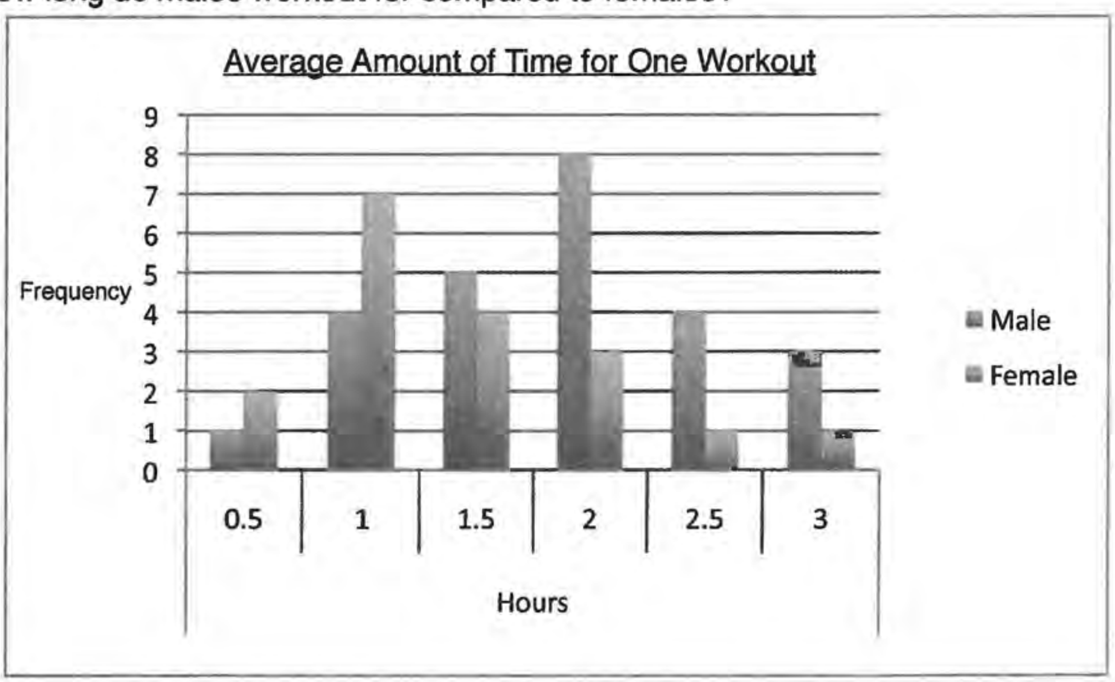
This histogram displays the ages of people who go to the gym that we collected our sample from. As you can see, most people who attend are between the ages of 22-32. Because of this the histogram is skewed right. The median of the data set is 28.5, the mean is 31.8, and the mode is 26. The range is 53.

2. What days of the week is it most common for people to go to the gym?



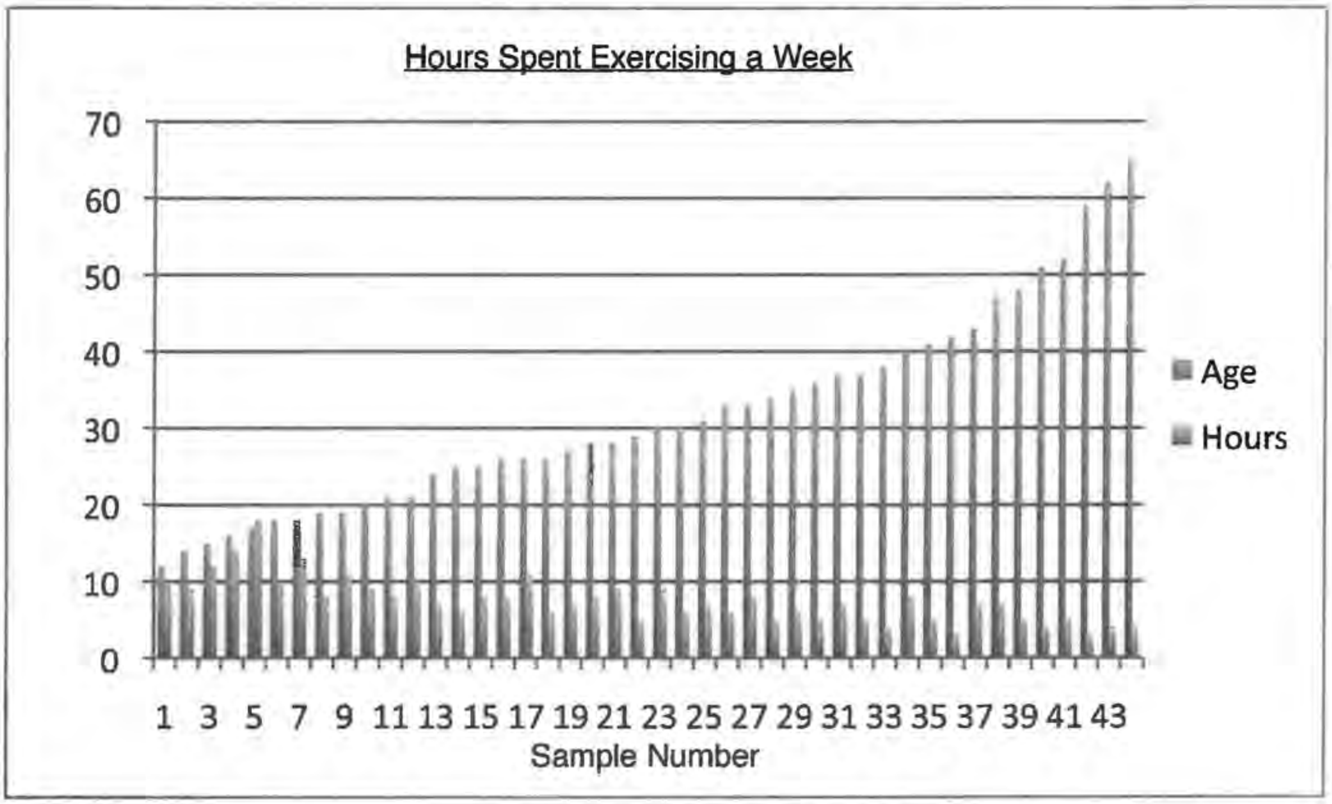
This bar graph displays what days are most common for people to go to the gym. It shows that monday is the most popular day, with saturday and sunday being this least popular. This could be due to the fact that many people like to take days off on the weekends.

3. How long do males workout for compared to females?



This cluster bar graph displays the average amount of time spent in the gym during one workout for the males and females in the sample. As shown in the graph, the male distribution has a bell shape with most of the workouts being two hours long. However, the females mostly workout for one hour as the distribution is skewed right. It can be concluded that the males in this sample tend to have longer workouts than the females.

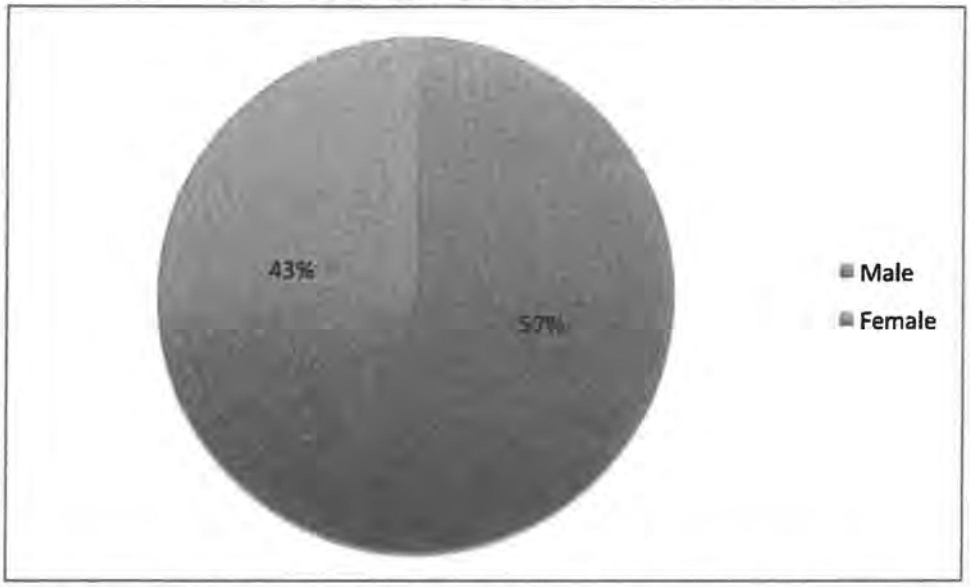
4. How much time do people spend working out a week with respect to their age? Note, the hours spent exercising per person in this sample were not just based on time spent in the gym, each person in the survey was asked to include the total time exercising outside the gym as well. The y-axis is a scale for both age and hours.



This graph displays the time each person in the sample spends exercising a week with respect to their age. As shown in the graph, as the age of each person increases, the amount of hours spent exercising tends to decrease. This could be due to a number of factors. A possible factor could be that many teenagers and young adults are involved in sports which could add on to the total time spent exercising a week. Also, most people over the age of 30 have a a full time job and may have less time to spend exercising during the week. In addition, younger people tend to be capable of more physical activity than older people without getting tired out and sore as easily.

5. What is the proportion of males and females that go to the gym?

Pie Chart for Males and Females That Go to the Gym

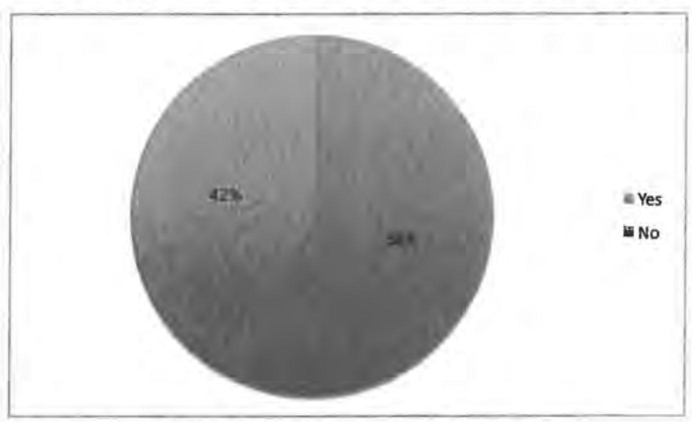


This pie chart displays the ratio of male gym goers to female. As shown, in the graph just over half of the people that go to the gym are males in this sample. The number of males was 25 and the number of females was 19.

6. What is the proportion of males that participate in group exercises and what is the proportion of females?

Pie Chart for Males that Workout in Classes

Pie Chart for Females that Workout in Classes



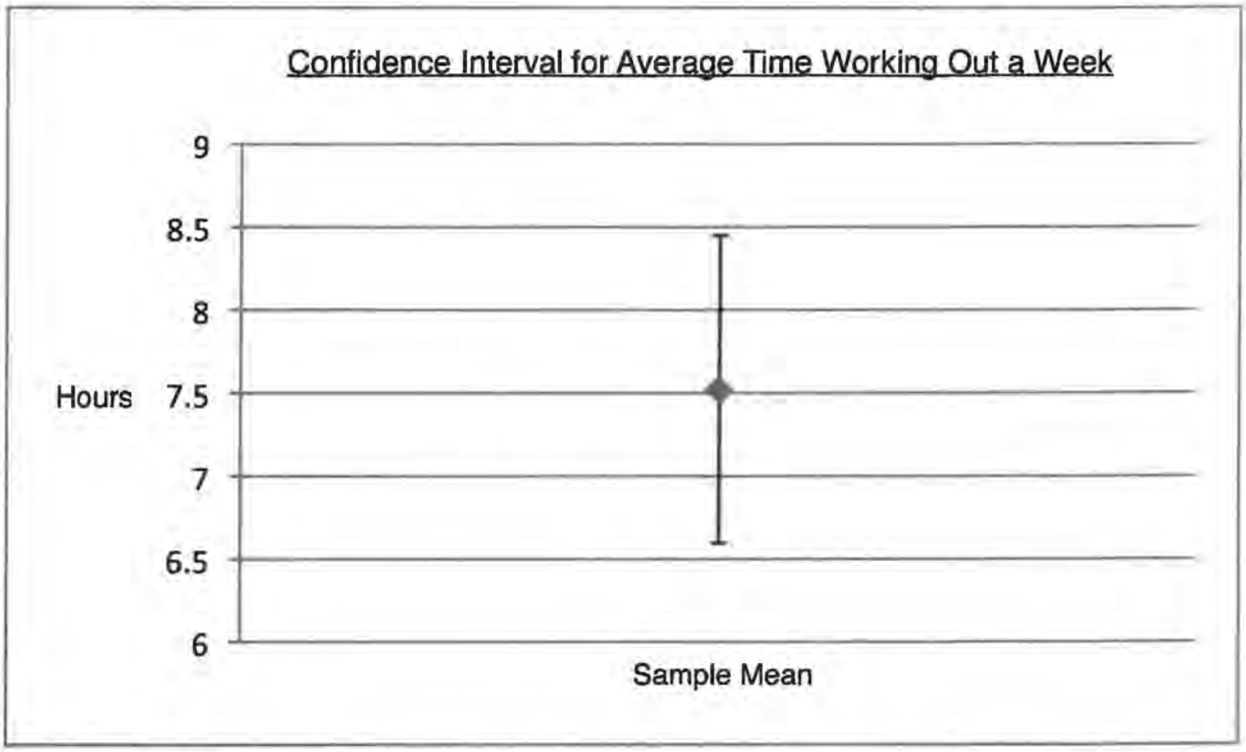
As shown in the left pie chart, most males (21/25) in this study do not participate in any kind of group exercise. On the other hand more than half of females do (11/19).

Confidence Intervals:

We chose three of our questions regarding quantitative data and created confidence intervals using the data obtained for each question. Because we had a sample without the population standard deviation, we used the t-distribution. Using the equation below we calculated the margin of error and then added it and subtracted it to the sample mean to find the confidence interval. We chose to make confidence intervals for the average workout time per week, the average age of the individuals in the gym, and the average length of one workout.

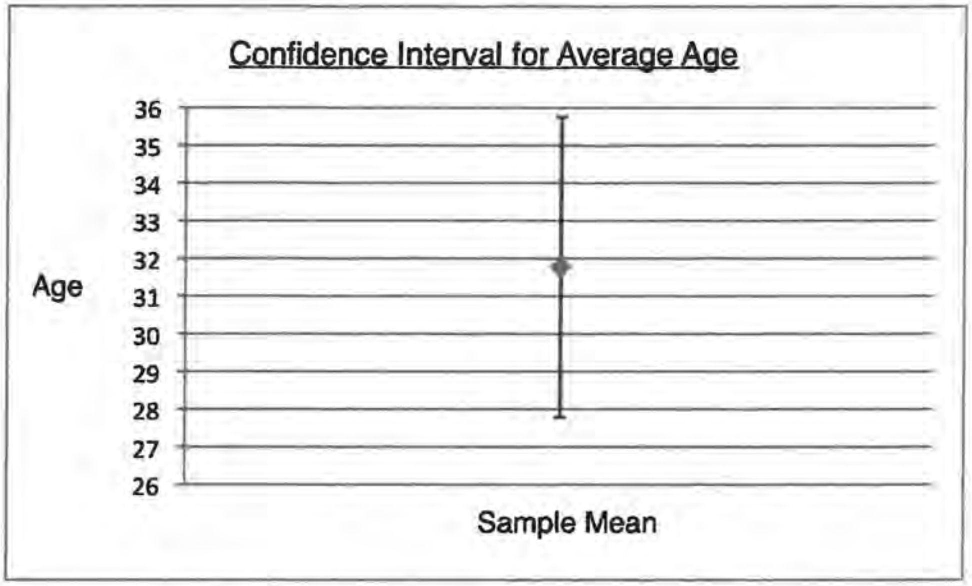
$$E = \frac{t_{\alpha/2} \cdot s}{\sqrt{n}}$$

1. Average workout time per week.



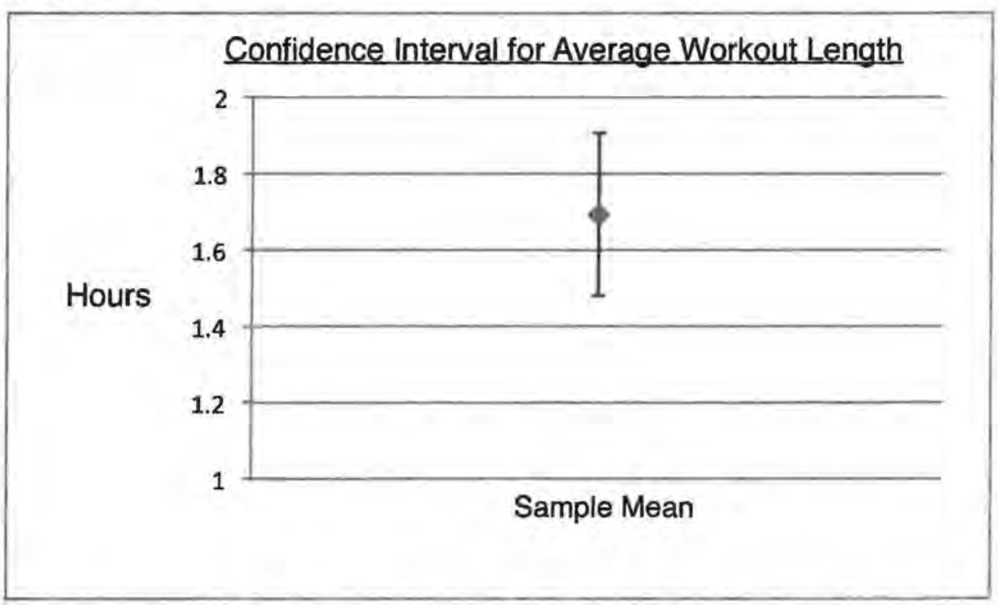
The graph above displays a 95% confidence interval for the average amount of time an individual spends exercising a week. A sample of 44 people that go to the gym was collected, the mean was 7.52 hours, the sample standard deviation was 3.05, and the t-value for a 95% confidence interval was 2.017 found from the chart. The margin of error was calculated to be +/- 0.926 which gives you an interval of 6.59 to 8.45 hours. We are 95% confident that the population mean lies within this interval.

2. Average age of the sample of the individuals in the gym.



The graph above displays a 95% confidence interval for the average age of the population of people that go to the gym. Out of the sample of 44, the mean was 31.8 years old, with a standard deviation of 13.15, the t-value was 2.017 and the margin of error was calculated to be +/- 3.99. Therefore, we are 95% confident that the population mean age for the people that go to the gym we surveyed is within the interval of 27.84 to 35.79 years old.

3. Average workout length.



The graph above displays a 95% confidence interval for the average length of one workout for the population of individuals that go to the gym we surveyed. The sample mean was 1.69 hours, with a standard deviation of 0.7, the t-value was 2.017, and the margin of error was +/- 0.213. Therefore, we are 95% confident that the population mean for the length of one workout is within the interval of 1.477 to 1.903 hours.

Hypothesis Testing: We used the data from our confidence intervals to perform hypothesis tests on.

Time Spent Working Out in a Week

Suppose we want to determine if the typical amount of time spent working out for each individual per week is greater than 7 hours. Our sample included 44 individuals from the gym we surveyed and the average amount of time is 7.52 hours. The sample standard deviation is 3.05. We will use a 0.01 level of significance to conclude if the typical amount of time spent working out is greater than 7 hours.

$$t = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{N}}}$$

Null Hypothesis: population mean = 7.0 hours

Alternate Hypothesis: population mean > 7.0 hours

Test statistic: Using the equation above, we calculated the test statistic to be 1.13.

Critical value: Approximately 2.42 (determined from using the chart in textbook)

Decision: Because the test statistic is less than the critical value (1.13 < 2.4) we fail to reject the null hypothesis since we are using right-tailed area.

Conclusion: Since we fail to reject the null hypothesis, we have insufficient evidence to say that the average amount of time spent working out for each individual per week is greater than 7 hours at the 0.01 level of significance.

Average Age of an Individual at the Gym

Suppose we want to determine if the typical age of a person at the gym we surveyed is less than 35 years old. The average age of our sample of 44 was 31.8 years old. The sample standard deviation is 13.15. We will use a 0.05 level of significance to conclude if the average age of a person at the gym is less than 35 years old.

Null Hypothesis: population mean = 35 years old

Alternate Hypothesis: population mean < 35 years old

Test Statistic: Using the equation, we calculated the test statistic to be -1.61.

Critical value: Approximately -1.68 (determined from using the chart in the textbook)

Decision: Because the test statistic is greater than the critical value (-1.61 > -1.68) we fail to reject the null hypothesis since we are using left-tailed area.

Conclusion: Because we fail to reject the null hypothesis, we have insufficient evidence to say that the average age of a person at the gym is less than 35 years old at the 0.05 level of significance.

Average Workout Length

Suppose we want to determine if the typical length of a workout for a person at the gym we surveyed is different from 2 hours. The average workout length computed from our sample of 44 was 1.69 hours. The sample standard deviation was 0.7. We will use the 0.05 level of significance to conclude if the average length of a workout is different from 2 hours.

Null Hypothesis: population mean = 2 hours

Alternate Hypothesis: population mean =/= 2 hours

Test Statistic: Using the equation, we calculated the test statistic to be -2.94.

Critical value: Approximately -2.0 (determined from using the chart in the textbook)

Decision: Because the test statistic is less than the critical value (-2.94 < -2.0) we reject the null hypothesis since we are using two-tailed area.

Conclusion: Because we reject the null hypothesis, we have sufficient evidence to say that the average length of a workout for a person at the gym is different from 2 hours at the 0.05 level of significance.

Raw Data

Sample Number	Age	Gender	Hours Exercising a week	Days Usually at the Gym	Participate in Group Exercise or Classes	Length of a regular workout
1	12	M	10	MTWRF	No	2.5
2	14	M	9	MTWF	No	2
3	15	F	12	MWS	No	3
4	16	M	14	MTWRF	No	2
5	17	M	18	MWRFSu	No	3
6	18	F	10	TRF	Yes	2.5
7	18	M	13	MWRFS	No	3
8	19	M	8	TRS	No	2
9	19	M	11	MTWRF	No	2
10	20	F	9	MFSu	Yes	2
11	21	F	8	MTWR	No	2
12	21	M	10	MWRF	No	2.5
13	24	F	7	MTRF	Yes	1.5
14	25	F	6	WFS	Yes	2
15	25	M	8	MTWR	No	2
16	26	F	8	MTS	Yes	1
17	26	M	11	MWR	Yes	3
18	26	M	6	MWF	No	2
19	27	F	7	MWSSu	No	1.5
20	28	M	8	MTWR	No	1.5
21	28	M	9	MTWF	No	2
22	29	F	5	MRF	Yes	1.5

Sample Number	Age	Gender	Hours Exercising a week	Days Usually at the Gym	Participate in Group Exercise or Classes	Length of a regular workout
23	30	M	9	MRS	No	2.5
24	30	M	6	MTFSu	No	1.5
25	31	F	7	MTWRF	Yes	0.5
26	33	M	6	MTF	No	1.5
27	33	M	8	MTW	No	1.5
28	34	M	5	TR	Yes	1
29	35	F	6	MTWFSu	Yes	1
30	36	F	5	MWFSu	No	1
31	37	M	7	TWF	No	2.5
32	37	F	6	MTRS	Yes	1
33	38	F	4	MWSu	No	1
34	40	M	8	MWRSu	Yes	2
35	41	M	5	MTWRS	No	1
36	42	F	3	MTW	No	1
37	43	F	7	MTWR	No	1
38	47	M	7	MTWSu	Yes	1
39	48	M	5	TRF	No	1.5
40	51	F	4	MWRF	Yes	0.5
41	52	M	5	MR	Yes	2
42	59	M	3	RFSSu	No	0.5
43	62	F	4	TW	No	1.5
44	65	M	4	MTW	No	1

PART 2: Degree-Level Review

Degree Program: **B.S. Mathematics**

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

13. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

The 4-Column Program Assessment Report is attached as a related document.

14. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

The University as a whole assessed Freshmen retention and found that students who took a university success seminar were more likely to be successful in their freshman year. While we had suggested students in this program take CSCI 103, it had not been required. As a result of that assessment, we now require students in this program to take CSCI 103 Survey of Computer Science, with the hope of one day having enough enrollment in the major to support our own seminar course. This course contains university seminar objectives such as identifying university resources, drafting a plan of study and effective research techniques.

In CSCI 105 Introduction to Computer Programming in 2017-2018, the ability to Acquire Data and the ability to Present and Display Data failed to meet expectations. This outcome is also reflected in the Student Learning Outcomes for the overall CSCI 105 course. As a result, both the outcomes related to the School of Education and the outcomes related directly to this course indicate a potential disconnect in the course. The students performed well on Transform Data using a Mathematical Calculation. This does not reflect the core competency in the topic of the course: programming. For the Fall 2018 semester, a new textbook was selected to strengthen the emphasis upon programming and data processing. This change was not driven just from this particular assessment, but also the SLO assessment from past offerings of the course.

In the 2015, program review (attached), based on the alignment of the program to the MAA standards as well as the assessment results related to the outcome involving technology, the School decided to strengthen the programming requirement for programming from one course to two. These changes went into effect in 2017. This requires students to learn two programming languages, better preparing those who are going to go to graduate school. In that same effort, more opportunities for use of technology were added in upper division coursework.

Quality, Resources and Support (CC 3.A)

15. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

There are many things that contribute to ensuring that the program-level and course-level learning outcomes are at an appropriate level.

A) Prerequisite Structure

Mathematics by its nature has a natural prerequisite structure. Each course must be rigorous enough to prepare students for courses which use it as a prerequisite. The success of students in MATH 411 Topics in Advanced Calculus, for example, is dependent on a solid foundation in Calculus 1, 2, 3 and Differential Equations. The success of students in Graph Theory is dependent on their success in Foundations of Mathematics and Discrete Mathematics.

B) Historical

Much of the early content in mathematics is inherited from a historical structure and must be easily transferred from one school to another. Many high school students take our MATH 151 and MATH 152 courses and transfer them to other schools including University of Michigan, so the content must be somewhat standardized. Many of the courses in the program are designed to prepare students to be successful in graduate school. The success of the students who go on to graduate school is monitored.

C) Standards and Guidelines

We review our degree content against several standards. For our mathematics degrees, we review the Curriculum Guide to Majors in Mathematical Sciences, published by the Mathematical Association of America's Committee on Undergraduate Programs in Mathematics (CUPM). It can be found at:

https://docs.google.com/viewer?url=https%3A%2F%2Fwww.maa.org%2Fsites%2Fdefault%2Ffiles%2Fpdf%2FCUPM%2Fpdf%2FCUPMguide_print.pdf.

The Lumina Foundation's Degree Qualification Profile (DQP) is suggested as a resource for answering the questions about what students should know and be able to do at each degree level:
http://degreeprofile.org/wp-content/uploads/2017/03/DQP-grid-download-reference-points-FINAL.pdf

Intellectual Inquiry (CC 3.B).

16. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

Students in this program complete many projects throughout their studies culminating in a capstone student-teaching experience. Here are two examples.

CAPSTONE

Students in this program are required to complete a semester-long project. The students independently study a topic or solve a mathematical problem from industry. They meet weekly with their mentor to present their results. At the end of the semester, they present their results to their peers and the faculty in the School of Mathematics and Computer Science. The faculty uses their presentation to complete the rubric for the Institutional Learning Outcomes. The student also makes a poster for the annual Senior Research Symposium that features all LSSU research. Examples of some Power Point presentations and posters are attached as evidence.

MATH 401 Project, Paper and Presentation

Students are asked to do a mathematical modeling project, working in groups. They present their work to the class and write a paper. Examples of papers from two groups are included as attachments.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**BS Mathematics Four-Column Report**
This documentation is relevant to Question number:	**13**
Briefly summarize the content of the file and its value as evidence supporting program review:	**It shows the four-column report was completed.**

Assessment: Program Four Column

Program (CoIS) - Mathematics BS

Assessment Contact: Dr. Robert Kipka
Mission Statement: We equip our graduates for success through emphasis on rigorous programs, hands-on experiences, and interaction with highly-qualified faculty members who are centered on student success.

Student Learning Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Communication - Students will be able to develop and clearly express mathematical concepts in written and oral communication. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 01/01/2018 **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex ideas in written and oral presentations.	**Direct - Presentation, Performance -** Students in MATH 401 Mathematical Modeling give an oral presentation about the results of a modeling project to their peers. The percentage of students earning 70% or more of the points is recorded. **Criteria Target:** 70% of students earn 70% or more. **Schedule/Notes:** Alternate year course. This course was chosen because it is a senior level course, taken predominantly by majors. This is an example of course embedded oral communication. **High Impact Program Practices 1:** Collaborative Assignments, Projects	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes At the end of spring semester, 2018, 100% of students earned 70% or more of points available on their final oral presentation. The assessment rubric and project guidelines are attached. (05/30/2018) **Related Documents:** MATH 401 Project Description and Rubrics.pdf	**Use of Result:** We will reassess in the Spring of 2020. We will increase the goal to 70% of the students earning 75% or more. (05/10/2018)
	Direct - Homework, Writing Assignment - Students in MATH 401 Mathematical Modeling submit a written report on the outcomes of a modeling project. The percentage of students earning 70% or more of points is recorded. **Criteria Target:** 70% of students earn	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes At the end of spring semester, 2018, 73% of students earned 70% or more of points available for their final written report. (05/30/2018) **Related Documents:** MATH 401 Project Description and Rubrics.pdf	**Use of Result:** We will reassess in the Spring of 2020. (05/10/2018)

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	70% or more. **Schedule/Notes:** Alternate year course. This course was chosen because it is a senior level course, taken predominantly by majors. This is an example of course embedded written communication.		
	Direct - Capstone Project - including undergraduate research - Students present the results of their MATH 490 [Individualized Research Topics in Mathematics] experience in the form of an oral presentation. The ILO rubric is used to assess this outcome. **Criteria Target:** The students scores on Communication using the rubric are recorded and averaged. The goal is an average of 3 out of 4. **Schedule/Notes:** All faculty in the School of Mathematics and Computer Science who attend the senior project presentation complete the ILO rubric. Each student's scores are based on an average of faculty respondents. **High Impact Program Practices 1:** Capstone Course(s), Projects **Related Documents:** ILO Rubric.docx	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Average of 3.07/4 (06/25/2018)	**Use of Result:** Reassess again in 2018-2019 using the ILO rubric. We will encourage faculty to participate through advance planning and communication. (05/10/2018)
Problem Solving - Students will be able to use computing, gather evidence, discover patterns, create models, experiment with data, and solve theoretical or applied problems. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 01/01/2018 **Goal Level (Bloom/Webb):** Mid-	**Direct - Exam/Quiz - within the course** - On the final exam in MATH 310 Differential Equations, two to three problems related to modeling and one problem related to the use of Laplace transform as a solution technique are chosen. The percentage of students earning 70% or more of points available on these	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Spring semester 2018, 100% of mathematics majors earned 70% or more of points on problems 4, 8, and 10 of the final exam, compared to 63% of all students. These three problems were chosen because they dealt with modeling and Laplace transforms. (05/30/2018)	**Use of Result:** Reassess during the 2018-2019 school year. In the fall of 2018, create a rubric or scoring guide for one or more modeling and Laplace transform problems that can be used by multiple instructors to standardize the assessment. (05/30/2018)

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO2 - Use of Evidence - Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem.	problems is recorded. **Criteria Target:** 70% of mathematics majors earn 70% or more of the available points on these problems. **Schedule/Notes:** Differentials Equations is one of two courses that are terminal to the calculus sequence. These problems were chosen to measure modeling and problem solving at a high level.		
	Direct - Exam/Quiz - within the course - The percentage of students earning 70% or above on the final exam in MATH 309 Applied Statistics is recorded. **Criteria Target:** 70% or more of students will score 70% or above. **Schedule/Notes:** Alternate Year Course This course was chosen because it is the terminal course in the statistics sequence. All problems on the final exam are targeted at computing, experimenting with data, and solving applied problems in statistics.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 86% of students earned 70% or more of points available on the final exam (05/30/2018)	**Use of Result:** Reassess during the 2019-2020 academic year. In Spring 2020, create a rubric or scoring guide for one or more applied statistics problems that can be used by multiple instructors to standardize the assessment. (08/07/2018)
	Direct - Exam/Quiz - within the course - In MATH 401 Mathematical Modeling, the percentage of students earning 70% or more of points available on one or two mid-semester exams is recorded. **Criteria Target:** 70% of students earned 70% or more. **Schedule/Notes:** Alternate Year Course These exams represent a variety of mathematical modeling and problem solving techniques at a senior level.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes During the spring semester of 2018, 93% of students earned 70% or more of points available on their two midterm exams. (05/30/2018)	**Use of Result:** Reassess during the 2019-2020 school year. In the Spring of 2020, create a rubric or scoring guide for one or more modeling problems that can be used by multiple instructors to standardize the assessment. (05/30/2018)
	Direct - Exam/Quiz - within the	**Finding Reporting Year:** 2016-2017	**Use of Result:** This objective is

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	course - Three or four problems on the final exam in MATH 411 Topics in Advanced Calculus, related to applications, are chosen. The percentage of students earning 70% or more of points available on these problems is recorded. **Criteria Target:** 70% of students earn 70% or more. **Schedule/Notes:** Alternate Year Course This course is one of two courses at the end of the calculus sequence. It was chosen as a course that assesses the entire calculus sequence and which contains advanced applied problems.	**Goal met:** Yes 97% success at 70% or better (08/27/2018)	met. We will monitor again in the next offering in Spring 2019. (08/27/2017)
	Direct - Capstone Project - including undergraduate research - Students present the results of their MATH 490 experience in the form of an oral presentation. The ILO rubric is used to assess this outcome. **Criteria Target:** The students scores on Use of Evidence using the rubric are recorded and averaged. The goal is an average of 3 out of 4. **Schedule/Notes:** All faculty in the School of Mathematics and Computer Science who attend the senior project presentation complete the ILO rubric. Each student's scores are based on an average of faculty respondents. **High Impact Program Practices 1:** Capstone Course(s), Projects **Related Documents:** ILO Rubric.docx	**Finding Reporting Year:** 2017-2018 **Goal met:** No 2.93/4 average on ILO rubric (05/30/2018)	**Use of Result:** This average is based on only 3 projects. Our goal is to continue to assess the presentations using the ILO rubric. One action item is to provide the rubric to students in advance. (05/30/2018)
Analysis - Students will be able to use	**Direct - Exam/Quiz - within the**	**Finding Reporting Year:** 2017-2018	**Use of Result:** Reassess during the

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
symbolic, analytical and quantitative skills and formal mathematical tools and techniques to analyze problems, synthesize solutions, and write proofs . **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) [Bloom] **Institutional Learning:** ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art.	**course** - Three or four problems on the final exam in MATH 310 Differential Equations, using a variety of mathematical tools developed through the calculus sequence, are chosen. The percentage of students earning 70% or more of points available on these problems is recorded. **Criteria Target:** 70% of students earn 70% or more. **Schedule/Notes:** This is one of two courses at the end of the calculus sequence and is used to assess the students' ability to use the tools of calculus at a high level.	**Goal met:** Yes During spring semester of 2018, 63% of all students and 100% of mathematics majors earned 70% or more of points available on problems 2, 3, 5, and 6 of the final exam. These problems were chosen because they utilize a variety of mathematical tools from the calculus sequence. (05/30/2018)	2018-2019 school year. In the fall of 2018, create a rubric or scoring guide for one or more problems that can be used by multiple instructors to standardize the assessment. (05/30/2018)
	Direct - Exam/Quiz - within the course - Three or four problems on the final exam in MATH 411 Topics in Advanced Calculus, using a variety of mathematical tools developed through the calculus sequence, are chosen. The percentage of students earning 70% or more of points available on these problems is recorded. **Criteria Target:** 70% of students earning 70% or more. **Schedule/Notes:** Alternate Year Course. This is one of two courses at the end of the calculus sequence and is used to assess the students' ability to use the tools of calculus at a high level.	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes 97% achieved 70% or better (08/27/2018)	**Use of Result:** No concerns at this time. We will monitor this objective again in the next offering during the Spring of 2019. (08/27/2018)
	Direct - Homework, Writing Assignment - Success on proof-writing homework assignments for MATH 351 Graph Theory which are related to the theory objective are	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes In the Fall of 2016, 100% of students earned 70% or more of points available on the final exam in MATH 351. (01/01/2017)	**Use of Result:** Reassess during the 2018-2019 school year. In the fall of 2018, create a rubric or scoring guide for one or more proofs that can be used by multiple

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	assessed. The percentage of students earning 70% or more of possible points is recorded. **Criteria Target:** 70% of students earning 70% or more. **Schedule/Notes:** Alternate Year Course This course was chosen because it is a terminal course in the discrete mathematics sequence. The theory objective states, "Students will be able to state, give illustrative examples of, and prove the most important graph theorems. These include correctness of each graph algorithm, min-max theorems (Hall's Theorem, Max-Flow-Min-Cut Theorem, Menger's Theorem, Euler-path theorem. State and prove computational complexity of graph algorithms." This assessment method is being used to assess advanced proof-writing. Because proofs at this level require time to write and revise, homework assignments were used.		instructors to standardize the assessment. (05/30/2018)
	Direct - Capstone Project - including undergraduate research - Students present the results of their MATH 490 experience in the form of an oral presentation. The ILO rubric is used to assess this outcome. **Criteria Target:** The students scores on Analysis and Synthesis using the rubric are recorded and averaged. The goal is an average of 3 out of 4. **Schedule/Notes:** All faculty in the School of Mathematics and Computer Science who attend the	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Average of 3.02 out of 4. (06/25/2018)	**Use of Result:** This average is based on only 3 projects. Our goal is to continue to assess the presentations using the ILO rubric. One action item is to provide the rubric to students in advance. (05/30/2018)

Student Learning Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	senior project presentation complete the ILO rubric. Each student's scores are based on an average of faculty respondents. **High Impact Program Practices 1:** Capstone Course(s), Projects **Related Documents:** ILO Rubric.docx		
Professional Responsibility - Students will be able to apply mathematical methodologies and adhere to ethical and professional standards in their senior capstone project. **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) [Bloom] **Institutional Learning:** ILO4 - Professional Responsibility - Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a problem, or achieving a goal.	**Direct - Capstone Project - including undergraduate research** - Students present the results of their MATH 490 experience in the form of an oral presentation. The ILO rubric is used to assess this outcome. **Criteria Target:** The students scores on Professional Responsibility using the rubric are recorded and averaged. The goal is an average of 3 out of 4. **Schedule/Notes:** All faculty in the School of Mathematics and Computer Science who attend the senior project presentation complete the ILO rubric. Each student's scores are based on an average of faculty respondents. **Related Documents:** ILO Rubric.docx	**Finding Reporting Year:** 2017-2018 **Goal met:** No 2.67 out of 4 (06/25/2018)	**Use of Result:** This average is based on only 3 projects. Our goal is to continue to assess the presentations using the ILO rubric. One action item is to provide the rubric to students in advance. For professional responsibility in particular, in the Fall of 2019, faculty in the School will devise a plan to communicate the cultural norms and practices of mathematicians to students and clarify how professional responsibility should be assessed during the capstone experience. (05/30/2018)
	Direct - Homework, Writing Assignment - Performance Indicator (B2)- Students have the ability to produce control charts and use them to monitor an on-going manufacturing process in EGNR 346 Probability and Statistics Laboratory for Engineers. This is assessed using a control charts report. **Criteria Target:** On a 4 point scale,		

Student Learning Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
	an average of 3.		

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**BS Mathematics 2015 Program Review**
This documentation is relevant to Question number:	**14 and 15**
Briefly summarize the content of the file and its value as evidence supporting program review:	**It shows assessment and narrative related to program assessment and it shows alignment to the standards.**

Bachelor of Science in Mathematics Program Review

1. **Mission/Vision**

The Bachelor of Science in Mathematics is a program of the School of Mathematics and Computer Science. The program has been in place since we broke off from Michigan Tech in 1970. Under this degree program students have the additional option of a Bachelor of Science in Mathematics with an emphasis in Actuarial and Business Applications. This option requires that the student earn a minor in accounting-finance.

> *LSSU Mission Statement*
>
> ***Our mission at Lake Superior State University is to help students develop their full potential. We launch students on paths to rewarding careers and productive, satisfying lives. We serve the regional, state, national and global communities by contributing to the growth, dissemination, and application of knowledge.***

Our mathematics program introduces students to a broad range of both pure and applied mathematics, both continuous and discrete, throughout their four years of study. Because of the broad array of mathematical experiences that our program offers our students and their many opportunities to apply this knowledge in later coursework and careers, our graduates have gone on to many different rewarding fields after leaving LSSU. These areas of graduate work or employment include, but are not limited to, pure or applied mathematics, higher education, banking, operations research, engineering, statistics, actuarial studies, mathematical modeling of weather patterns, and programming. (For more information see sections 3 and 4 on "Demand" and "Quality".) Because of our emphasis very early in MATH 215 and MATH 216 on inquiry-based student-centered learning and our requirement of a senior research experience, our graduates exit LSSU with the ability to both think independently and communicate their ideas effectively.

> *LSSU Vision Statement*
>
> ***Our programs grow and evolve in ways that keep our graduates at the cutting edge of technological and societal advances. As such, we will be viewed by our constituents as:***
>
> - ***The preferred regional choice for students who seek a quality education which provides a competitive edge in an evolving job market.***
> - ***An institution where relevant concepts are taught by quality faculty, and are paired with practical real-world experience to provide a well-rounded education.***
> - ***An institution which capitalizes on its location to instill graduates with an understanding of environmental issues and an overarching desire to be responsible stewards of the environment.***
> - ***A University that is highly student centered and empowers all students to realize their highest individual potential.***

Our program also supports the University Vision in several different ways. One of our program outcomes is that graduates should be able to "use software and other technology to solve problems". Several of our classes support this outcome including Linear Algebra, Graph Theory, Mathematical Modeling, Applied Statistics, and Principles of Programming. As for quality faculty, except in rare cases, all of our program courses are taught by faculty who hold a doctorate in a field of pure or applied mathematics, statistics or mathematics education. The rare exceptions include courses where there is a co-teacher with a terminal degree in a related field, such as computer science or engineering. All of these faculty members have publications in their respective fields, one had a previous successful career at a tier one university, one has had more than 50 publications since coming to LSSU, two have received teaching awards, and one has co-authored a textbook in his field. Another program outcome is for successful graduates to "create mathematical models and use their mathematical and analytical skills to solve real-world problems." Many of our courses have course objectives tied to this program outcome, including MATH 151, 152, 251, 310, 351, 401, and 411. Also our capstone course provides the real-world experience of doing independent research or study. One of our greatest areas of strength is the individual attention that our graduates receive. All of our classes are small with 30 or fewer students. When one compares this with larger state universities, which have large lecture classes for first year students, we provide a uniquely student-centered atmosphere in the classroom. Our introductory proof sequence has 15 or fewer students and is typically taught using inquiry based learning. This is a very student-centered approach where students present the material to each other.

There are several areas of the Strategic Plan supported by our program. Some of these are emerging and others are more established.

- **2.1 LSSU will increase enrollment.** This year we offered a Field Day experience for area high school students where we introduced students to topics in mathematics and computer science using hand-on activities. We also contacted admitted students after they were accepted, made new brochures and power point slides for our programs, increased the visibility of our Pi Day activities and saw a 20.0% increase in admitted students for this program (and 58.1% increase in admitted students for the School).

- 2.5 LSSU will graduate students who have had an exceptionally good university experience. The one-on-one attention that our graduates receive gives them a chance to exceed beyond expectations. Of four of our alumni who are known to have recently finished their master's or Ph.D. programs, their median entering ACT math score was 27.5. Note that 28 is the prerequisite score for our calculus sequence. Our program helped them to meet their full potential.
- 4.1 LSSU will increase high-impact educational experiences in BS/BA degree programs. In addition to requiring a senior project we try to periodically offer special topics courses such as logic, cryptography, computational geometry and game theory. These courses are often favorites of our students and supplement their degree program.
- 4.3 LSSU will improve the tracking process of graduate success. We have been tracking our graduates' placements three months after graduation since 2012 and have increased efforts to track them later.
- **4.6 LSSU will increase the number of students participating in professional conferences and workshops.** This is not an area we have highly encouraged in the past, but we have had two students attend conferences this year, one of whom will be presenting at a conference in August 2015 and received a grant to support his travel.
- **6.1 LSSU will define assessment and engage in meaningful, institutionalized assessment activities.** Our school has been doing course assessment with well-established objectives for many years. Our program assessment efforts are emerging.
- 6.2 LSSU will utilize appropriate and developing technology to facilitate effective and enriched learning experiences across the campus community. This is an area in which we excel. In fact we purchased and used many technologies such as i-Pads, tablets and document cameras before they were more widely available across campus. We also use many educational software packages in our courses to enhance student understanding of difficult mathematical concepts.

There are several areas that distinguish these programs from our main competitors in the state. One is the small class size, especially at the calculus level. Another is a strong mixture of both pure and applied coursework. Several programs focus on the theoretical aspects of math and several on applied mathematics, but ours has a strong mixture of both. Our actuarial program seems to be unique in that it requires the minor in accounting/finance which is a larger requirement than the other schools with this concentration.

2. Productivity

The faculty and adjuncts in mathematics teach a large percentage of classes that are not required by our majors. This includes developmental courses (MATH 087, MATH 088, MATH 102) and general education courses (MATH 110, MATH 111, MATH 131, MATH 207). There are also courses that are taught as service to other programs (MATH 103, MATH 104, MATH 112), courses only required by the Secondary Teaching Program (MATH 321, MATH 325) and courses that are filled by a variety of majors including Mathematics, Mathematics—Elementary Education, Mathematics—Secondary Education, Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering and Physical Science (MATH 151, MATH 152, MATH 251, MATH 308, MATH 310). Using data from two consecutive academic years (2013-2014 and 2014-2015) this can be summarized with the following percentage of our instructional load.

- Developmental—23.8%
- General Education—37.0%
- Requirements of other Programs—9.9%
- B.S. in Mathematics Secondary Teaching Only—2.8%
- Mathematics Requirement with Heavy Service—18.1%
- Mathematics and Mathematics Secondary Education Requirements—5.3%
- B.S. in Mathematics Only—3.2%

Note that only 3.2% of the instructional load is used only for this program, making this program a rather inexpensive program compared to most programs on campus. Only 11.3% of the load is used exclusively by the two mathematics programs. (This includes the 3.2%.)

The next comparison, to the right, with other academic areas was made using the faculty load report summary for 2014-2015. Because of our heavy service load our ratio of student credit hours per faculty instructional load hours is the 4th highest division on campus and our ratio of student credit hour per faculty contract hour is the 3rd highest division on campus. (Instructional load does not include release time and Faculty Contract Hours do. Some areas receive a larger percentage of release time than others.) This data deals with instructional load. The next table further shows the total enrollment in our courses over the previous 5 academic years (this year was not yet available in Argos).

	Faculty			Student Credit Hours per Instructional Load Hour	Rank of SCH per ILH	Student Credit Hour per Contract Hour	Rank of SCH per CH
	Instructional Load	Total Contract Hours	Student Credit Hours				
Business Fall	124.532	139.532	2344.000	18.034	5	16.910	5
Business Spring	146.409	149.409	2542.084				
CJ FS EMS Fall	109.494	107.494	2371.000	20.955	2	20.763	2
CJ FS EMS Spring	106.609	110.609	2157.500				
Education Fall	36.130	39.130	600.990	11.622	9	9.841	9
Education Spring	46.730	58.730	362.000				
Engineering Fall	112.663	123.532	1136.510	9.708	11	9.063	10
Engineering Spring	114.680	119.984	1070.500				
English Fall	150.589	164.353	2391.500	16.202	6	14.841	6
English Spring	130.441	142.441	2161.730				
Hum, Arts, SS Fall	176.619	188.619	4955.500	28.365	1	26.563	1
Hum, Arts, SS Spring	191.836	204.836	5495.740				
Lib Studies Fall	6.333	12.003	82.000	10.636	10	4.875	11
Lib Studies Spring	4.667	11.997	35.000				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]				
Nursing Fall	150.667	170.667	1821.500	11.861	8	10.517	8
Nursing Spring	154.500	173.500	1798.001				
RS-ES Fall	81.998	90.998	1116.000	13.482	7	12.086	7
RS-ES Spring	73.834	82.834	985.000				
Sciences Fall	298.792	334.562	5754.800	18.942	3	17.000	4
Sciences Spring	250.555	277.555	4650.992				

Course Enrollment						
COURSE	TITLE	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
MATH081	Pre-Algebra I	110	139	98	91	56
MATH082	Pre-Algebra II	108	136	99	92	56
MATH083	Pre-Algebra III	111	136	98	93	57
MATH084	Introductory Algebra I	224	231	205	168	124
MATH085	Introductory Algebra II	236	239	216	167	126
MATH086	Introductory Algebra III	237	242	224	173	127
MATH102	Intermediate Algebra	247	242	250	210	179
MATH103	Number Sys/Prob Solv Elem Teac	32	20	12	12	24
MATH104	Geometry/Measurement Elem Teac	32	29	18	18	12
MATH110	Explorations in Mathematics	32	62	59	35	79
MATH111	College Algebra	288	307	332	315	315
MATH112	Calculus Business/Life Science	97	120	112	96	91
MATH131	College Trigonometry	54	86	73	85	103
MATH151	Calculus I	83	92	97	103	89
MATH152	Calculus II	48	54	57	57	67
MATH207	Prin of Statistical Methods	220	253	295	268	243
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MATH251	Calculus III	39	31	42	24	24
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MATH308	Probability and Math Stats	33	27	29	26	9
MATH309	Applied Statistics	0	5	0	7	4
MATH310	Differential Equations	37	35	38	23	30
MATH321	History of Mathematics	13	20	13	5	9
MATH325	College Geometry	9	0	7	0	5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MATH351	Graph Theory	7	[illegible]	7	0	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MATH411	Advanced Topics in Calculus	0	15		7	0
MATH490	Ind Res Topics in Mathematics	1	2	2	4	3

Developmental*	1273	1365	1190	994	725
General Education (Primarily)	320	369	391	350	394
Service (Primarily)	161	169	142	126	127
Service and General Education	54	86	73	85	103
Service and Math Ed	220	253	295	268	243
Math Ed	22	20	20	5	14
Math and/or Math Ed Major with Large Service Requirement	238	235	263	233	219
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Math Major Requirement	8	26	9	18	7

*Note that these are one hour courses and often a student enrolls in three of these at a time.

Note the key to the table summarizes the constituents of each course. All LSSU graduates must take at least some mathematics at or above the level of MATH 110. The high enrollment in developmental coursework is partially due to double counting, but it is largely due to the large percentage of under-prepared students at LSSU.

The other enrollment numbers come from the following program requirements. The following courses are specifically required by other majors (than mathematics, mathematics secondary teaching or mathematics elementary teaching).

- MATH 103 & MATH 104—Elementary Education
- MATH 111—Accounting, Biology, Business Administration, Computer Networking, Conservation Biology, Finance & Economics, Electrical Engineering Technology, Fish Health, Fisheries and Wildlife Science, Forensic Chemistry, Geology, Industrial Technology, Manufacturing Engineering Technology, Medical Laboratory Science, Parks and Recreation

- MATH 112—Biology, Computer Science, Conservation Biology, Criminal Justice Criminalistics, Electrical Engineering Technology, Environmental Health, Environmental Science, Finance & Economics, Forensic Chemistry, Fire Science Engineering Technology, Fish Health, Fisheries and Wildlife Science, Geology, Manufacturing Engineering Technology, Medical Laboratory Science
- MATH 131—Computer Science, Electrical Engineering Technology, Industrial Engineering Technology, Manufacturing Engineering Technology
- MATH 207—Athletic Training, Biochemistry, Computer Networking, Computer Science, Criminal Justice (Corrections, Criminalistics, Generalist, Homeland Security, Law Enforcement, Loss Control, Public Safety), Electrical Engineering Technology, Environmental Science, Exercise Science, Fire Science, Forensic Chemistry, Geology, Industrial Technology, Manufacturing Engineering Technology, Medical Laboratory Science, Nursing, Parks and Recreation, Physical Science
- MATH 151 & MATH 152—Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering, Physical Science
- MATH 251, MATH 308, MATH 310—Computer Engineering, Electrical Engineering, Mechanical Engineering

Other than the 3.2% of the instructional load (or 11.3% if you include the mathematics education program), our mathematics degree program has very few expenses that are program specific. The needed software licenses, computers, instructional technologies and paper usage are more than covered by our course fees. The average salary of those 6 faculty who primarily teach mathematics program courses was $53,555 in 2014-2015. The average instructional load needed exclusively for the mathematics program is 7.25 instructional hours per year. If you include both the B.S. in Mathematics program and the B.S. in Mathematics—Secondary Education, the total hours needed exclusively for those two programs, and no other high enrolled service programs, is 25.6 instructional hours per year. This is approximately one faculty member's load. (All of our faculty typically teach overload, largely due to a lack of qualified adjuncts in the area.) Using a five year average of enrollment (in those courses only required by the two mathematics majors) those courses yield 244.8 student credit hours times $433 per credit hour, totaling $105,998.40. This would more than cover one faculty member's salary and benefits. Again there are factors not considered in this simple estimation such as our increasing attempt to offer courses less often, which will reduce future costs, and the University's tuition plateau, but it would seem the costs to the university are minimal, especially considering our large service role.

While our mathematics program enrollment overall is small, we have not seen the dramatic decrease in enrollment that LSSU has seen as a whole. The following data was pulled from Argos.

	Bachelor of Science in Mathematics	Bachelor of Science in Mathematics Secondary Teaching	Minors in Mathematics
Fall 2006	10		13
Fall 2007	8		11
Fall 2008	8		6
Fall 2009	9		7
Fall 2010	13	16	5
Fall 2011	11	19	4
Fall 2012	14	12	8
Fall 2013	12	9	14
Fall 2014	11	9	8

The number of students for the Bachelor of Science in Mathematics Secondary Teaching is included in the above table because 10 of the required courses for that program are also in the Bachelor of Science in Mathematics program. Seven courses are required for the minor in mathematics. Five of the courses in the program are also in the degree requirements for the engineering programs. (Many of our minors are engineering majors.) Two of the courses are required for a chemistry degree. The next table contains the fall enrollment numbers for the 15 public universities in Michigan for even numbered years (these years were all that were available for the data by major) from the Ipeds database from the National Center for Educational Statistics. (There are slight differences in the numbers that Argos is reporting and the numbers reported by Ipeds. This could be due to the time of reporting.)

Institution Name	2012 Mathematics Majors	2012 Undergraduates	2012 Percentage of Mathematics Majors	2010 Mathematics Majors	2010 Undergraduates	2010 Percentage of Mathematics Majors	2008 Mathematics Majors	2008 Undergraduates	2008 Percentage of Mathematics Majors	2006 Mathematics Majors	2006 Undergraduates	2006 Percentage of Mathematics Majors
Central Michigan University	36	21332	0.17	26	21633	0.12	27	20540	0.13	135	20129	0.67
Eastern Michigan University	78	18927	0.41	84	18554	0.45	74	17283	0.43	53	18245	0.29
Ferris State University	52	13271	0.39	48	13168	0.36	31	12250	0.25	29	11413	0.25
Grand Valley State University	572	21317	2.68	560	20986	2.67	517	20416	2.53	469	19578	2.40
Lake Superior State University	14	2582	0.54	12	2588	0.46	8	2557	0.31	9	2886	0.31
Michigan State University	427	37354	1.14	462	35921	1.29	389	36205	1.07	390	35821	1.09
Michigan Technological University	81	5611	1.44	92	5715	1.61	72	6025	1.20	81	5630	1.44
Northern Michigan University	25	8474	0.30	20	8719	0.23	32	8598	0.37	28	8880	0.32
Oakland University	201	16190	1.24	131	15530	0.84	124	14397	0.86	129	13701	0.94
Saginaw Valley State University	104	9310	1.12	72	9116	0.79	59	8190	0.72	55	7933	0.69
University of Michigan-Ann Arbor	450	27979	1.61	341	27027	1.26	290	25994	1.12	246	25555	0.96
University of Michigan-Dearborn	116	7328	1.58	108	7006	1.54	105	6588	1.59	103	6448	1.60
University of Michigan-Flint	17	6984	0.24	21	6874	0.31	28	6155	0.45	26	5600	0.46
Wayne State University	79	19342	0.41	30	20837	0.14	32	20122	0.16	56	20892	0.27
Western Michigan University	59	19478	0.30	71	19966	0.36	52	19854	0.26	62	20081	0.31

The percentage of students that are mathematics majors at LSSU is around ½ of one percent. This represents an increase over time. In 2012, that placed us at the median of the public Michigan institutions with those institutions with lower numbers in red. (The data comparing mathematics secondary education on Ipeds was unavailable because it grouped all education majors together. This data would be useful because in degree conferral rates, below, our numbers are combined.)

The table to the right has to do with degree conferral. The table contains both the Bachelor of Science in Mathematics and the Bachelor of Science in Mathematics Secondary Teaching because before 2009, the institutional data was combined. It is also combined for all years when reporting data to Ipeds.

Academic Year	Bachelor of Science in Mathematics	Bachelor of Science in Mathematics Secondary Teaching	Total
2014-2015	3	2	5
2013-2014	2		2
2012-2013	3	3	6
2011-2012	2	5	7
2010-2011	4	1	5
2009-2010	1	1	2
2008-2009	6		6
2007-2008	6		6
2006-2007	4		4

On a national level, data is collected every decade. According to the Conference Board of Mathematical Sciences 2010 survey at http://www.ams.org/profession/data/cbms-survey/cbms2010, there were a total of 16,938 degrees in mathematics, actuarial science or mathematics education awarded in 2009-2010. There were 2774 four-year institutions in that year, giving an **average of 6.1 related mathematics degrees per four year institution**. Our total degrees awarded for those programs is typically around 5, making us only slightly smaller than average. The next table compares our percentage of the conferred degrees to those of the other public institutions in Michigan from Ipeds. Red again denotes percentages that are below ours. (The change from only even years to the years 2012 and 2013 was only based on the availability of data from Ipeds. We are again unsure why the totals in Argos and Ipeds are slightly different.)

Institution Name	2013 Bachelor of Science in Mathematics Degrees Awarded	2013 Total Bachelor's Degrees Awarded	2013 Percentage of Degrees Awarded	2012 Bachelor of Science in Mathematics Degrees Awarded	2012 Total Bachelor's Degrees Awarded	2012 Percentage of Degrees Awarded
Central Michigan University	15	5991	0.250376	11	6163	0.178485
Eastern Michigan University	19	4553	0.417307	12	4131	0.290487
Ferris State University	14	3358	0.416915	13	3396	0.382803
Grand Valley State University	119	5479	2.171929	116	5313	2.183324
Lake Superior State University	6	512	1.171875	9	499	1.803607
Michigan State University	68	10821	0.628408	90	11026	0.816252
Michigan Technological University	20	1453	1.376462	28	1522	1.839685
Northern Michigan University	4	1785	0.22409	6	1743	0.344234
Oakland University	21	3820	0.549738	20	3641	0.5493
Saginaw Valley State University	22	1776	1.238739	15	1672	0.897129
University of Michigan-Ann Arbor	212	12390	1.711057	159	11814	1.345861
University of Michigan-Dearborn	17	1682	1.010702	21	1689	1.243339
University of Michigan-Flint	2	1510	0.13245	7	1474	0.474898
Wayne State University	16	5490	0.291439	15	5682	0.263992
Western Michigan University	13	5381	0.241591	13	5371	0.242041

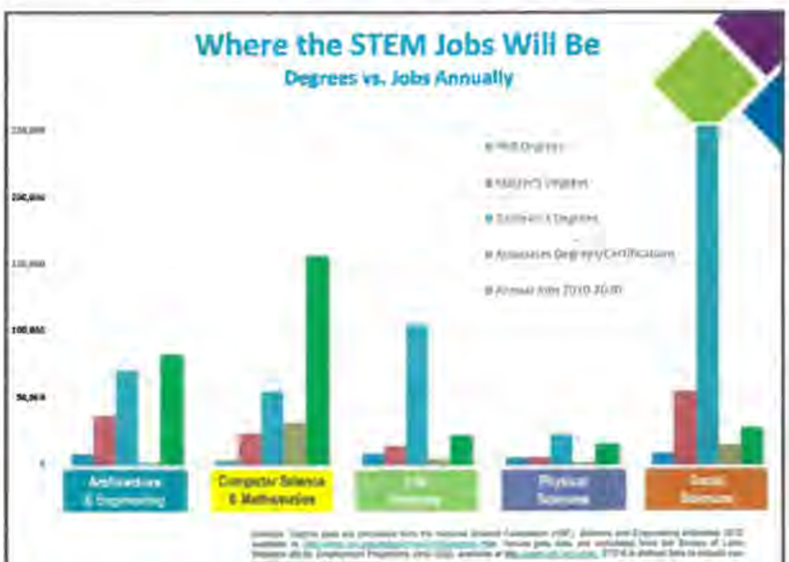
Note when comparing the percentage of the total awarded degrees that are Bachelor of Science in Mathematics Degrees, our University ranks 5th among the 15 state Universities.

Using Argos to estimate the terms to graduation for this program, the average was 7.70 terms for majors in this program over the last 4 years and 8.19 for LSSU graduates as a whole. These data appear to include transfer students, whose minimum number of terms was 4. It is therefore possible that there are confounding factors in making a comparison with the University as a whole without the actual data.

3. Internal and External Program Demand

External Demand:

Demand for mathematicians and actuaries is strong. The federal government's Labor of Statistics Occupational Outlook Handbook indicates that between 2012 and 2020, employment of mathematicians is projected to grow 23 percent. This growth is much faster than the average of all occupations. At the same time employment of statisticians is projected to grow 27 percent. Mathematicians will be needed to analyze the increasing volume of digital and electronic data while the growth in demand for statisticians is expected to result from more widespread use of statistical analysis to make informed business, healthcare and policy decisions. Another reason for the increase is the increase in available data from the Internet which will open up new areas for analysis. The figure shows that mathematics and computer science fields are two of the only STEM fields where there is more demand than there are students in the pipeline.



One exciting aspect of a mathematics degree is the many fields available to individuals with strong mathematics backgrounds. Our graduates go on to a variety of fields where mathematics is a core need. Here are some examples of those fields to demonstrate a wide range of demand. Other graduates are highlighted in the "Quality" section.

- [redacted] ('09); after finishing his PhD in Industrial Engineering from Iowa State University, began work for the Air Force Research Laboratory Information Directorate working with data mining methods.
- [redacted] ('07); after finishing her PhD from University of Wisconsin-Madison in Atmospheric and Oceanic Science, mathematically modeling weather patterns, took a job for the Department of Interior in Colorado in meteorology.

- [redacted] ('10); is the pupil and finance accountant at Sault Area Public Schools.
- [redacted] ('11); after finishing his master's degree in applied mathematics, teaches at Delta Community College.
- [redacted] ('12); Human Resources Analyst at Alpena Regional Medical Center.
- [redacted] ('14); Geographic Information System Specialist at Apple.

Internal Demand:
Refer back to page 3 for programs that require the Bachelor of Science in Mathematics program courses. The largest constituents outside of mathematics are:

- MATH 151 & MATH 152—Biochemistry, Chemistry, Computer Engineering, Electrical Engineering, Mechanical Engineering, Physical Science
- MATH 251, MATH 308, MATH 310—Computer Engineering, Electrical Engineering, Mechanical Engineering

However, that list did not include the courses required for the Mathematics—Secondary Teaching and Mathematics—Elementary Teaching Majors. The secondary teaching major in mathematics requires 10 of the same courses as the mathematics program (including CSCI 105) and the elementary teaching major in mathematics requires 5 of the same courses (including CSCI 105).

4. Program Quality

Mathematics introduces students to formal reasoning and, as a result, contributes to development of qualitative and quantitative analytic skills. The math department in its service role, as well as a major department, is proud to have promoted and to continue to promote and to improve those indispensable skills for the entire LSSU community and all LSSU graduates. Over the years the department has recruited and retained strong mathematicians and mathematics educators as witnessed by their recent scientific and pedagogical output:

- Dr. Grace Ngunkeng has published 3 refereed articles in the past 2 years, has presented her work at the 2013 Joint Mathematics Meetings, and has attended 5 conferences in the past 2 years.
- Dr. Kimberly Muller has published 4 refereed articles and has presented her scholarly work at 11 meetings in the past 10 years .
- Dr. Lorraine Gregory has made 6 conference presentations in the past 10 years.
- Dr. Brian Snyder has coauthored a textbook, published 1 refereed article, and attended 9 converences in the past 10 years.
- Dr. Collette Coullard has published 5 refereed articles and made 2 conference presentations in the past 10 years.
- Dr. George Voutsadakis has published 44 research articles and participated in 6 conferences in the past 10 years.

It has developed a regional reputation and has strongly contributed to outreach activities promoting mathematics and mathematics education and, thus, increased the University's visibility and service in the community. Some examples of our state and regional involvement are:

- Dr. Brian Snyder is the current chair of the Michigan Section of the Mathematical Association of America,
- Dr. Collette Coullard, Dr. Lorraine Gregory and Dr. Kimberly Muller, serve on the Eastern Upper Peninsula Math and Science Center Advisory Board,
- Dr. Collette Coullard and Dr. Kimberly Muller serve on the planning committee for the Eastern Upper Peninsula Math Teachers' Circle,
- The School of Mathematics and Computer Science hosted the Michigan Section of the Mathematical Association of America's annual meeting in 2013,
- Dr. Lorraine Gregory, Dr. Kimberly Muller and Dr. Brian Snyder have taught professional development workshops in 4 different regions across the state,
- The School of Mathematics and Computer Science held a Field Day for area high school students, an event we hope to repeat as an annual recruiting effort,
- The School of Mathematics and Computer Science holds an annual Pi Day and math bowl for area middle school and high school students.

Moreover, some of our majors have been among the highest GPA graduates and have been awarded University-wide distinctions, many with regular placement on the Dean's list and graduating cum laude, magna com laude or summa cum laude. Of the program's graduates over the last seven years, 35.3% graduated cum laude, 17.6% graduated magna cum laude, and 5.8% graduated summa cum laude. The average GPA was 3.37. Only 29.4% of these most recent graduates entered LSSU with this major. The remaining students had majors such as accounting, chemistry, computer or mechanical engineering, computer science, liberal arts, literature, or mathematics secondary education. Our program helps LSSU to retain these gifted students.

Several graduates have established themselves in positions of leadership and continue to distinguish themselves in their respective professions and to further showcase our major's and the University's value to the community and to the work force. Some of these have already been mentioned:

Year Graduated	Name	LSSU GPA	Honors and Awards	Immediately After Graduation: Graduate School	Immediately After Graduation: Job	Current Position (if known and different from first)
2015	[redacted]	[redacted]	Magna Cum Laude	Master of Science in Statistics Program at Oregon State University, Corvallis, OR, supported by a Graduate Teaching Assistantship		
	[redacted]	[redacted]			IFS Operations Specialist at State Street Bank and Trust Company, Kansas City, MO	
	[redacted]	[redacted]	Magna Cum Laude		Customer Service Specialist at Best Buy	
2014	[redacted]	[redacted]	Cum Laude		Geographic Information System Specialist at Apple Inc., Cupertino, CA	
2013	[redacted]	[redacted]	Cum Laude	MS/PhD Program in Industrial and Systems Engineering at Rensselaer Polytechnic Institute, Troy, NY, supported by a Graduate Research Assistantship		Application Developer, Eliza Corp. Danvers, MA
	[redacted]	[redacted]	Summa Cum Laude	Master of Science in Statistics Program at Michigan Technological University, Houghton, MI, supported by a Graduate Teaching Assistantship		
2012	[redacted]	[redacted]		Master of Arts in Statistics Program at Wayne State University, Detroit, MI		Remodeling Crew Member, Medilodge, Allen Park, MI
	[redacted]	[redacted]				Human Resources Analyst, Alpena Regional Medical Center, Alpena, MI
	[redacted]	[redacted]				United States Air Force
2011	[redacted]	[redacted]			Office Manager for The Asphalt Doctor, Green Bay, WI	
	[redacted]	[redacted]	Cum Laude	Master of Science in Statistics Program at Western Michigan University, Kalamazoo, MI, supported by a Graduate Teaching Assistantship		
	[redacted]	[redacted]			Analyst for the Royal Bank of Canada, Thunder Bay, Ontario	Project Manager (IT-Related Projects Portfolio), North West Health Alliance, Thunder Bay, Ontario'
	[redacted]	[redacted]	Magna Cum Laude	Master of Science in Mathematics Program at Oakland University, Rochester, MI, supported by a Graduate Teaching Assistantship		Adjunct Instructor at Delta Community College
2010	[redacted]	[redacted]				Pupil and Finance Accountant at Sault Area Public Schools
2009	[redacted]	[redacted]	Cum Laude	Master of Science in Statistics Program at Portland State University, Portland, OR, supported by a Graduate Teaching Assistantship		
	[redacted]	[redacted]	Cum Laude		Computer Programmer for an Insurance Company, Lansing, MI	
	[redacted]	[redacted]	Cum Laude	PhD Program in Industrial Engineering at Iowa State University, Ames, IO, supported by a Graduate Research Assistantship		Air Force Research Laboratory Information Directorate

This program compares favorably in its depth and quality to other peer mathematics programs. In 2015 the Mathematical Association of America's Committee on Undergraduate Programs in Mathematics (CUPM) released its new **Curriculum Guide to Majors in the Mathematical Sciences**. It has four cognitive recommendations and nine content recommendations for programs in mathematics. Since these recommendations are brand new, we were impressed with how well our program already fit. We will list those goals and briefly explain how we meet them. In some cases, for the sake of brevity, the recommendations are linked to our program outcomes.

Cognitive Recommendation 1: Students should develop effective thinking and communication skills. Program Outcome 7.

Cognitive Recommendation 2: Students should learn to link applications and theory. Program Outcome 5.

Cognitive Recommendation 3: Students should learn to use technological tools. Program Outcome 3.

Cognitive Recommendation 4: Students should develop mathematical independence and experience open-ended inquiry. Program Outcome 6. Specifically our use of inquiry-based learning in multiple mathematics courses and our senior project requirement.

Content Recommendation 1: Mathematical sciences major programs should include concepts and methods from calculus and linear algebra. MATH 151, MATH 152, MATH 251, MATH 305, MATH 310, MATH 401, MATH 411

Content Recommendation 2: Students majoring in the mathematical sciences should learn to read, understand, analyze, and produce proofs at increasing depth as they progress through a major. MATH 215, MATH 216, MATH 341, MATH 351

Content Recommendation 3: Mathematical sciences major programs should include concepts and methods from data analysis, computing, and mathematical modeling. MATH 308, MATH 309, MATH 401, CSCI 105, CSCI 121

Content Recommendation 4: Mathematical sciences major programs should present key ideas and concepts from a variety of perspectives to demonstrate the breadth of mathematics. Our program has a mixture of theoretical and applied topics.

Content Recommendation 5: Students majoring in the mathematical sciences should experience mathematics from the perspective of another discipline. CSCI 105, PHYS 231, and when possible MATH 310 is co-taught with a faculty member from engineering.

Content Recommendation 6: Mathematical sciences major programs should present key ideas from complementary points of view: continuous and discrete; algebraic and geometric; deterministic and stochastic; exact and approximate.

Continuous: The majority of the calculus sequence, MATH 411
Discrete: MATH 216, parts of MATH 152, MATH 351
Algebraic: MATH 305, MATH 341
Geometric: Some topics in the calculus sequence, some topics in MATH 305, MATH 351 and MATH 401
Deterministic: MATH 310, MATH 351, some topics in MATH 401, MATH 411
Stochastic: MATH 308, MATH 309, some topics in MATH 401

Exact: Most of the calculus sequence, some topics in MATH 351

Approximate: Some topics in the calculus sequence, some topics in MATH 351, MATH 401, MATH 411

Content Recommendation 7: Mathematical sciences major programs should require the study of at least one mathematical area in depth, with a sequence of upper-level courses. MATH 308, MATH 309

Content Recommendation 8: Students majoring in the mathematical sciences should work, independently or in a small group, on a substantial mathematical project that involves techniques and concepts beyond the typical content of a single course. MATH 490

Content Recommendation 9: Mathematical sciences major programs should offer their students an orientation to careers in mathematics. This is an area that needs improvement. We advise students individually, but do not have a formal process for this.

In addition, we attempt to consistently update our offerings, aligning them with new demands in the field of knowledge and the marketplace, as witnessed by our special topics offerings in logic, cryptology, game theory and computational geometry. We also plan curriculum updates as needed. In the upcoming year we plan to make several changes which would strengthen Content Recommendations 5 and 6. These will be discussed under "Assessment". Moreover, the School has been among the pioneers in installing a consistent and regular assessment process for its courses. This will also be discussed in "Assessment".

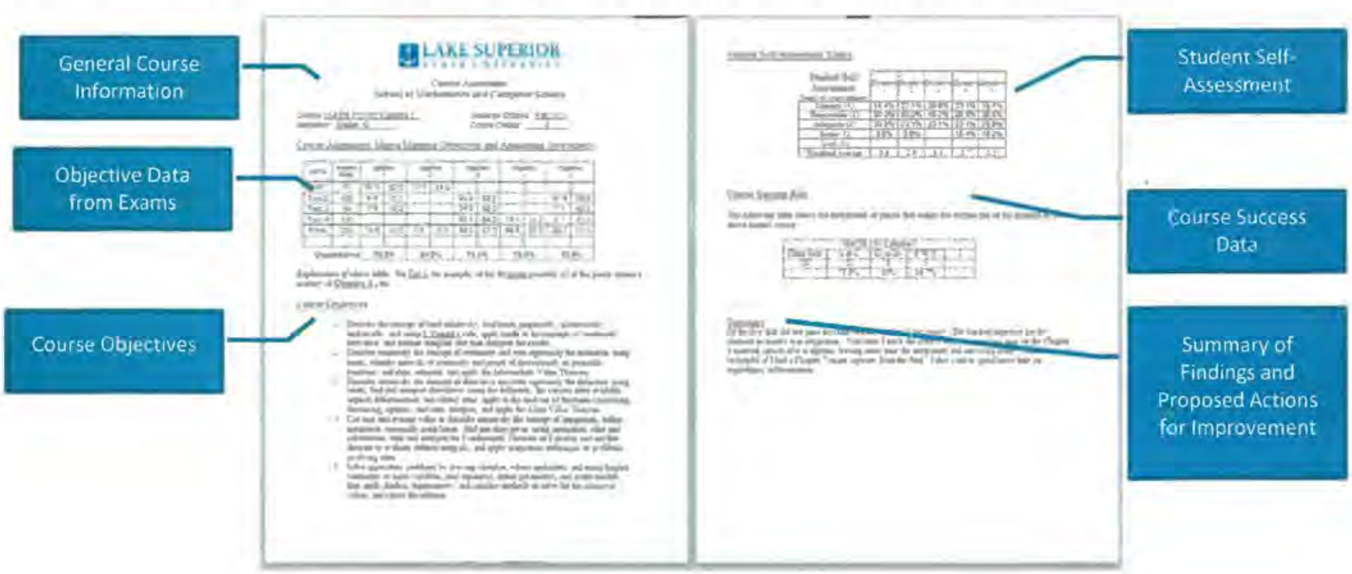
Finally, many of our classes are using technology in state-of-the-art classrooms and labs. Our School purchased many of these technologies for CAS 119, CAS 205, CAS 207, CAS 209A, CAS 210 and CAS 303 before they were more widely available on campus. All of our majors are required to complete a capstone course involving some undergraduate research component or a special study course of an advanced undergraduate character. Recent students have studied topics in fractal theory, actuarial science, Fourier transforms, numerical analysis, optimization models, modular arithmetic algorithms for mobile applications, and economic analysis of the Soo locks. It is also relevant to the Strategic Plan that some of these projects have included interdisciplinary work straddling the boundaries of various majors throughout campus or the community.

5. Assessment

Our School has a well-established assessment strategy for all of its programs which began in 2008 with the establishment of a School Assessment Committee under the leadership of now Professor Emeritus Sherry Duesing. The Assessment Committee formed subcommittees by discipline and measurable outcomes were created for all courses and programs by 2009 and a mapping was created by 2010. All of these objectives are located on the N: drive, though some have been edited in Tracdat since that time. Those objectives were then reviewed by Professor Duesing and Dr. Gregory to ensure that the outcomes were properly worded using established terminology in the field of Education.

Course Assessment

In 2009, we also created a two-page template for course objective assessment which recorded our data and a summary of how we planned to use this data to strengthen our courses, which would of course strengthen our programs as well. You can locate these old reports, beginning with assessment from 2009, on the N: drive under Assessment.



Before Tracdat, we had a well-established routine of completing our course assessment documents and steadily improving our courses. We feel our progress in this regard was well-ahead of the University as a whole. Course proposals were sent to the Curriculum Committee making changes to MATH 310, MATH 325, and MATH 411. We are also in the process of discussing another set of curriculum proposals regarding MATH 261 and MATH 421. (This is further outlined in Section 6 on "Opportunity Analysis".)

Now we find ourselves in 2015 with a dilemma largely created by Tracdat and the lack of clear communication by the School to new faculty members, as well as an assessment leadership hole left by Professor Sherry Duesing's retirement. (We will work to remedy this immediately.) Many of the faculty have continued under the old process while also entering data into Tracdat. These faculty upload the School document into Tracdat as evidence using "related document". Some faculty only complete the School document, but do not enter their data into Tracdat. Some faculty enter assessment data into Tracdat, but no longer complete the School document. It is our plan to have a meeting of School faculty early in the Fall of 2015 to discuss how we wish to report the data, while recognizing that it is being done.

In the summer of 2015, Dr. Kimberly Muller, Chair of the School of Mathematics and Computer Science reviewed the assessment reports for this program, both on the N: drive (pre-Tracdat) and on Tracdat. For those courses where the standard template is available, Dr. Muller found clear evidence of assessment data being used to change the amount of time spent on topics, the problems assigned, the methods of coverage of some material, the sequence of topics covered, etc. In cases where the form had been uploaded to Tracdat, she found that action items were not always made to demonstrate via Tracdat these changes, nor follow-ups on these items recorded in Tracdat to match the attached assessment document. There were a few courses where assessment data was minimal, leaving room for improvement, but overall assessment is being done. (The one exception is MATH 261 which is discussed in Section 6.) For data that is being uploaded without the School template and summary, it was found that it was less clear what actions are being done to improve the course when necessary, though some actions had been submitted. This again highlights the need for a School meeting on assessment to put us back on track.

Program Assessment

The School has mapped the course objectives to the program objectives. In most cases these course objectives are used to measure the program objectives. In one case the objective is measured by student placement after graduation. (These data were also in section 4 of this document.) For only one objective was the targeted threshold not met for the 2014-2015 academic year.

	Program Objectives	Courses	Targeted Threshold	Success Rate
1	Demonstrate a fundamental and foundational knowledge of mathematics by developing quantitative and abstract reasoning skills in order to build a conceptual understanding of logical structures and axiomatic systems.	MATH 215, MATH 216, MATH 305, MATH 341, MATH 351, MATH 401	90% of related objectives to hit targeted threshold	90.5%
2	Demonstrate technical mathematical skills in the areas of algebra, geometry, calculus, and statistics for solving problems.	MATH 151, MATH 152, MATH 251, MATH 305, MATH 308, MATH 309, MATH 310, MATH 351, MATH 411	90% of related objectives to hit targeted threshold	98.8%
3	Use software and other technology to solve problems.	MATH 305, MATH 309, MATH 351, MATH 401	90% of related objectives to hit targeted threshold	100.0%
4	Use their acquired skills in the pursuit of a job and/or graduate school.		At least 80% of the respondents should be employed or in graduate school within a year of graduation.	100.0%
5	Create mathematical models and use their mathematical and analytical skills to solve real-world problems.	MATH 151, MATH 152, MATH 251, MATH 310, MATH 351, MATH 401, MATH 411	90% of related objectives to hit targeted threshold	94.4%
6	Continue to acquire new knowledge for life-long learning in pursuit of their professional and personal goals.	MATH 215, MATH 216, MATH 341, MATH 401, MATH 490	90% of related objectives to hit targeted threshold	87.5%
7	Communicate mathematically in their profession and the broader community.	MATH 215, MATH 341, MATH 490	90% of related objectives to hit targeted threshold	100.0%

It was also noted that that this objective was low due to only one low-enrolled course in a single semester and the desired threshold is typically met. We will reassess the program in two years after another full rotation of courses to determine if further action needs to be made.

6. Opportunity Analysis

Recruitment

Our School developed several new initiatives to increase enrollment in the past year including a **Mathematics and Computer Science Field Day** for area high school students, calling and writing potential students, developing new pamphlets and power point presentations on our programs and increasing our presence on social media. We expected it to take several years to see any increase based on our efforts, but our school shows a remarkable 58.1% increase in admits already this year (the largest increase shown in the data compiled by Joe Barrs). We invite the administration to take advantage of this initial recruitment success by placing ours into the chosen set of programs, including biology, criminal justice, engineering, fire science and nursing , that regularly receive major emphasis in the LSSU promotional materials and presentations. A major STEM recruitment push makes perfect sense right now, and we believe our school is poised to attract those attentive to the job predictions. Note that our programs are much less expensive to run than those other programs, and we have the capacity to substantially increase enrollment with little or no marginal cost. Note that Mathematics and Computer Science produced 11 BS graduates in 2014-2015, compared to 14 BS graduates from the School of Engineering. Imagine what we could do if we had access to the level of support and resources of the SOE! We will continue to increase our efforts in recruitment, and we will continue to point out this opportunity for non-academic departments to support our efforts.

Facilities

Our facilities requirements are minimal. We share a lab with computer science and the computers are updated on a five year rotation using course fees.

Potential

Only 9 of the 17 BS Mathematics graduates in the past 7 years began their LSSU careers as mathematics majors. The majority started off as engineering majors, and 2 started as accounting majors. Thus, our program continues to provide an attractive option for retaining our strong analytical students.

We have streamlined our course offerings so that courses exclusively for the BS Mathematics program are offered only every 2 years. Still, these courses typically run with an enrollment of 7-10 students, which leaves room to recruit up to 20 additional BS Mathematics students, at no marginal cost to LSSU.

Section 4 provides strong evidence of the high quality of our BS Mathematics program is of high quality, but we do expect to make one change. We have not offered the required course MATH 261 Numerical Methods in several years, having instead offered a series of special topics courses in cryptography, game theory, logic, and computational geometry. These courses are often students' favorites and draw students from other majors. We would like to formalize this special-topics practice within our BS Mathematics program. Alternately, we may opt to require MATH 421 Real Analysis, since it would benefit the majority of our students who continue on to graduate school. Obviously, this course would then join the 2-year rotation. A third option is to replace the MATH 261 requirement with MATH 325 College Geometry. The first 2 options are cost neutral, whereas the third option would provide a net savings, since MATH 325 is a required course in the BS Mathematics—Secondary Education program.

Our BS Mathematics program is strong. Our graduates get into graduate school and get jobs. Recent experience indicates recruitment efforts yield results. We hope for support to build upon these arenas of potential.

7. Optional

While our program is not zero-cost it does pay for itself as evidenced in other sections. We would also like to again draw your attention to the tables in Section 2 that demonstrate that we are at the median of mathematics programs in the state relative to overall enrollment. Most mathematics programs across the U.S. are small when compared with overall offerings because it takes a comparatively rare gift for a student to succeed in such a program. However, a vast majority of universities still have mathematics programs to lend legitimacy to liberal arts and STEM offerings, draw talented faculty with terminal degrees and attract these gifted students to their ranks.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Degree audit**
This documentation is relevant to Question number:	**15**
Briefly summarize the content of the file and its value as evidence supporting program review:	**It shows the current curriculum for this degree.**

School of Science and Medicine Fall 2018

Degree Audit: Bachelor of Science in Mathematics

Name: ______________________ ID # ______________________

Advisor's Signature: ______________________ Chair's Signature: ______________________

General Education

Communication (9 cr)

Course	Credits		Grade
ENGL 110	3	______	___
ENGL 111	3	______	___
COMM 101 **or** COMM 201 **or** COMM 225	3	______	___

Social Science (minimum 6 credits)

Two courses from two different disciplines

______ ___ ______ ___
______ ___ ______ ___

Cultural Diversity (minimum 3 credits)

______ ___ ______ ___

Humanities (minimum 6 credits)

Two courses from two different disciplines
(Humanities approved courses)

______ ___ ______ ___
______ ___ ______ ___

Mathematics (3-4 cr)

Satisfied by degree requirements

Natural Science (minimum 7 credits)

Two courses from two different disciplines-one with a lab

PHYS 231 * 4 ______ ___
______ ___ ______ ___

* Required in Major

Free Electives (or Minor) (33 to 34 cr)

______ ___ ______ ___
______ ___ ______ ___
______ ___ ______ ___
______ ___ ______ ___

Departmental Requirements (63 - 64 cr)

Mathematics (49-50 cr)

Course	Credits		Grade
MATH 151	4	______	___
MATH 152	4	______	___
MATH 215	3	______	___
MATH 216	3	______	___
MATH 251	4	______	___
MATH 305	3	______	___
MATH 308	3	______	___
MATH 309	4	______	___
MATH 310	3	______	___
MATH 341	3	______	___
MATH 351	3	______	___
MATH 401	3	______	___
MATH 411	3	______	___
MATH 490	3	______	___

One additional MATH course numbered above 216

______ 3-4 ______ ___

Other Requirements (14 cr)

Course	Credits		Grade
CSCI 103	3	______	___
CSCI 105	3	______	___
CSCI 121	4	______	___
*PHYS 231	4	______	___

*Satisfies Natural Science General Education requirement

______ At least 124 total credits
______ At least 50% of school 300/400 level credits earned at LSSU
______ At least 30 of last 60 credits earned at LSSU
______ 2.0 Overall GPA
______ 2.0 GPA in School Requirements

Appendix Cover Sheet

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**Examples of Senior Project Posters and Power Point Presentations**
This documentation is relevant to Question number:	**16**
Briefly summarize the content of the file and its value as evidence supporting program review:	**Examples of students' creative activities and projects.**

Complex Analysis: Stereographic Projection, Riemann Spheres, Möbius Transformations

LAKE SUPERIOR STATE UNIVERSITY

Senior Project for [redacted]
Advisor: Dr. Kimberly Muller

What is Complex Analysis?

- Complex analysis is the study of calculus with complex numbers; their derivatives, manipulations, and properties.
- Complex numbers are expressed as:

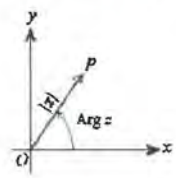
$$z \in \mathbb{C} \rightarrow z = x + iy, \text{ where } x, y \in \mathbb{R}.$$

- Moreover ι is defined as:

$$i^2 = -1 \rightarrow \iota = \sqrt{-1}$$

- We know what a complex number is, but what is $\mathbb{C}$?
- $\mathbb{C}$ is the plane that holds complex numbers, thus we call it the complex plane.

$\mathbb{C}$: The Complex Plane



Complex Numbers, Properties

- Complex numbers have two parts; one real, one imaginary:
$$Re(z) = x \qquad \text{Im}(z) = y$$
- When we want to plot a complex number on the complex plane we do the following:
$$z = x + iy \leftrightarrow (x, y)$$
- We define the modulus of a complex number as:
$$|z| = \sqrt{x^2 + y^2}$$
- Complex conjugate s refer to: $\bar{z} = x - iy$
- Arg(z) is the angle between our complex number and the positive real axis:
$$Arg(z) = \theta$$
- We can add complex numbers by adding their real and imaginary parts:
$$(x + iy) + (u + iv) = (x + u) + i(y + v)$$

Complex Arithmetic and Functions

- Multiply complex numbers using the FOIL method:
$$(u + iv)(x + iy) = ux - vy + i(uy + vx)$$
- Complex Inverses:
$$\frac{1}{z} = \frac{\bar{z}}{|z|^2} \ (z \neq 0)$$
- Exponential function:
$$f(z) = e^z = e^x \cos(y) + ie^x \sin(y)$$
- Logarithmic Function:
$$\log(z) = \log|z| + iArg(z) + i2\pi m$$
- Power Function:
$$z^\alpha = e^{\alpha \cdot \log|z|} \times e^{\alpha \cdot iArg(z)} \times e^{2\pi\alpha im}$$
- Trigonometric Functions:
$$Sin(z) = \frac{e^{iz} - e^{-iz}}{2i}$$
$$Cos(z) = \frac{e^{iz} + e^{-iz}}{2}$$

Stereographic Projection

- Stereographic projection is a method of visualizing the extended complex plane, $\mathbb{C} \cup \{\infty\} = \mathbb{C}^*$.
- To do so we establish a map from the Riemann Sphere, unit sphere in $\mathbb{R}^3$, to $\mathbb{C}^*$.
- If $P = (X, Y, Z)$ is any point of the unit sphere, but not $N = (0,0,1)$, we draw a straight line through N and P.
- Define the stereographic projection of P to be the point $z = x + iy \sim (x, y, 0)$ where our line hits $Z = 0$.
- Define the projection of N to be the point at ∞. Below we derive our mapping.

Start by representing the line through N and P parametrically, $N + t(P - N), -\infty < t < \infty$, meeting the point $(x, y, 0)$.

$$(x, y, 0) = (0,0,1) + t[(X, Y, Z) - (0,0,1)]$$

$$(x, y, 0) = (tX, tY, 1 + t(Z - 1))$$

$$0 = 1 + t(Z - 1) \rightarrow t = \frac{1}{1 - Z}$$

$$x = tX = \frac{X}{1 - Z}$$

$$y = tY = \frac{Y}{1 - Z}$$

- Take the equation of the unit sphere: $X^2 + Y^2 + Z^2 = 1$
- Multiply both sides by t^2, $t^2X^2 + t^2Y^2 + t^2Z^2 = t^2$
- By substitution we have, $x^2 + y^2 + t^2 - 2t + 1 = t^2$
- Solve for t, $t = \frac{1}{2}(|z|^2 + 1)$; this yields,

$$X = \frac{2x}{|z|^2 + 1}$$

$$Y = \frac{2y}{|z|^2 + 1}$$

$$Z = 1 - \frac{1}{t} = \frac{|z|^2 - 1}{|z|^2 + 1}$$

- Thus P is uniquely determined by the point $z = x + iy$
- There exists a bijection between all points on the sphere and the complex plane.

Möbius Transformations

Also known as a fractional linear transformations, Möbius transformations are functions of the form:

$$w = f(z) = \frac{az + b}{cz + d}$$

where $a, b, c, d \in \mathbb{C}$ and $ad - bc \neq 0$.

- We can regard a fractional linear transformation as a mapping from $\mathbb{C}^*$ to $\mathbb{C}^*$.
- As we describe our different types of transformations we will also discuss how they handle points at infinity.

Types of Transformations

All of the following functions are generalized types of translations.

Affine Transformation: $f(z) = az + b, a \neq 0$

- For affine transformations we define $f(\infty) = \infty$, as $a * \infty = \infty$ for when we multiply two complex numbers together and take the argument, we receive the sum of the individual arguments. Thus we are rotating our point at infinity by the angle of the constant, a, which keeps us at infinity.

Translations: $f(z) = z + b$

Dilations: $f(z) = az$

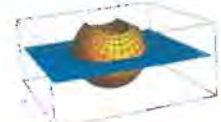
Inversion: $f(z) = \frac{1}{z}$

- What happens if $z = 0$?
$$\text{Take } z = -\frac{d}{c}, f\left(-\frac{d}{c}\right) = \frac{-\frac{ad}{c} + b}{-\frac{cd}{c} + d} = \frac{-\frac{ad}{c} + b}{0} = \infty$$
- Suppose $z = \infty$, then $f(\infty) = \frac{1}{\infty} \approx 0$.

Making Connections

- Möbius transformations are mappings from $\mathbb{C}^*$ to $\mathbb{C}^*$, which are manipulations of the riemann sphere.
- We use stereographic projecting to view such mappings.

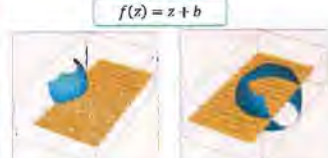
Stereographic Projection: $f(z) = z$



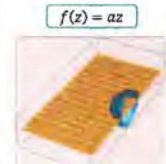
$f(z) = z^3$

$f(z) = Sin(z)$

$f(z) = z + b$



$f(z) = az$



$f(z) = \frac{1}{z}$

$f(z) = \frac{1}{cz + d}$

Nonlinear Oscillations and Dynamical Systems

[redacted]

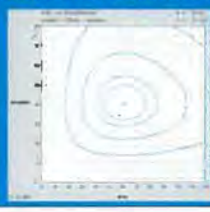
Advised by: Dr. Robert Kipka

LAKE SUPERIOR STATE UNIVERSITY

Phase Plane

The phase plane is a 2D visual representation of the solutions for a differential equation. This method of qualitative analysis is useful for several nonlinear differential equations, where a quantitative solution may be difficult to produce.

Predator-Prey Population Cycle



Stability:

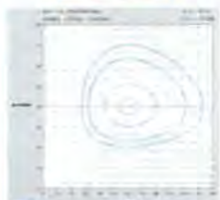
Stable Equilibrium: Nearby solutions stay close.

Asymptotically Stable Equilibrium: Nearby trajectories approach this point as time approaches infinity

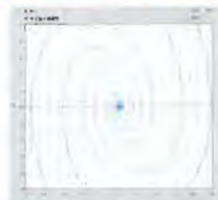
Unstable Equilibrium: Solutions are repelled from this point as time approaches infinity

Limit Cycle: Closed trajectory in phase plane

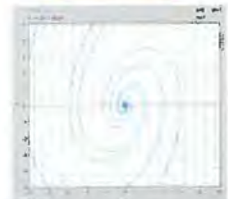
Stable



Asymptotically Stable



Unstable



Energy Analysis Method

If the equations for a conservative dynamic system are perturbed slightly, the equations become:

$\dot{x} = v + \varepsilon f(x,v),\ \dot{v} = -x + \varepsilon g(x,v), \quad \varepsilon \ll 1,$

The change in energy is dependent on initial amplitude A of the system and epsilon: $\Delta E = \varepsilon\varphi(A) + o(\varepsilon)$, where

$$\varphi(A) = \int_0^{2\pi} xf(x,v) + vg(x,v)dt$$

Where $x = A\cos(t)$ and $v = -A\sin(t)$.

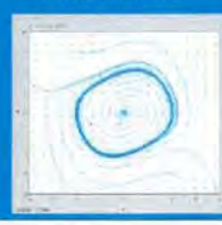
A simple zero of $\varphi(A)$ indicates the existence of a limit cycle. The sign of $\varphi'(A)$ determines its stability.

Energy Analysis applied to the Weakly Damped Van der Pol Oscillator:

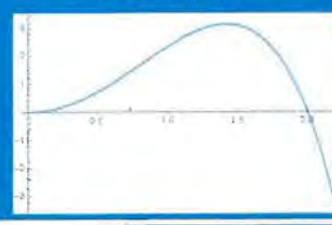
Weakly Damped Van der Pol Oscillator: $\ddot{x} + x - \varepsilon\dot{x}(1 - x^2) = 0$

A stable limit cycle was found close to: $x^2 + \dot{x}^2 = 2$

Phase Plane



ΔE based on A



Finding Limit Cycles Using the Poincaré-Bendixson Theorem

Suppose:

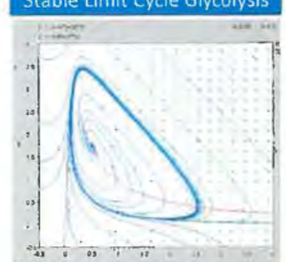
(i) R is a closed, bounded region in a 2-D space

(ii) No fixed points in region R

(iii) There exists a trapped trajectory T, meaning T(x(t), y(t)) is within R at time $t = t_0$ and remains there for all $t > t_0$.

Visual interpretation of the Poincaré-Bendixson Theorem

Stable Limit Cycle Glycolysis



Applications in Glycolysis

Using assumptions from the Poincaré-Bendixson Theorem, either a stable equilibrium or a stable limit cycle can be found in glycolysis, the transition between them being a "Hopf bifurcation."

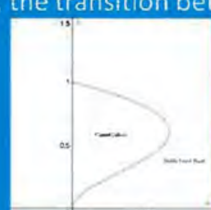
$\dot{x} = -x + ay + x^2y$

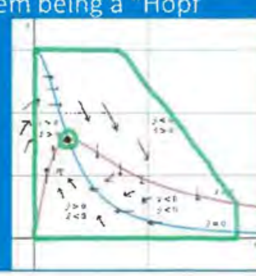
$\dot{y} = b - ay - x^2y$

$x = [ADP] > 0$

$y = [F6P] > 0$

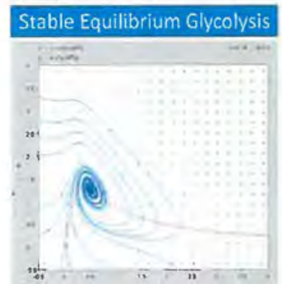
$a, b > 0$





Coefficients a and b determine a stable limit cycle or fixed point.

Stable Equilibrium Glycolysis



Fractal Geometry

LAKE SUPERIOR STATE UNIVERSITY

[redacted]

Advised by
Dr. Kimberly Muller

What is a Fractal?

The Middle Third Cantor Set

The Von Koch Curve

Sierpinski Triangle

Sierpinski Dragon

Heighway Dragon

BOX-COUNTING DIMENSION

δ-cover and $N_\delta(F)$

Box Dimension

Calculation

Calculation cont.

HAUSDORFF DIMENSION

Lebesgue Measure

Lebesgue Measure and Dimension

Hausdorff Measure

Hausdorff Dimension

ITERATED FUNCTION SYSTEMS

Iterated Function Systems

Similarity Dimension

SIMILARITY DIMENSION

Calculation

The Middle Third Cantor Set

The Von Koch Curve

Sierpinski Triangle

Sierpinski Dragon

References

Fractal Geometry

[redacted]

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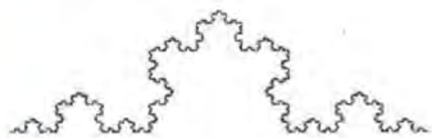
What is a Fractal?

- F has detail on arbitrarily small scales
- F is too irregular to be described in traditional geometrical language
- Often F is self-similar
- Often the fractal dimension of F is greater than its topological dimension



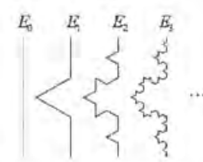
The Middle Third Cantor Set

- We construct the middle third Cantor set by the following operation: at each level of construction E_k, remove the middle third of each interval to obtain the next level E_{k+1}
- Each level of construction E_k is made up of two copies of E_{k-1} scaled down by a factor of $\frac{1}{3}$
- The middle third Cantor set can then be defined as

$$\bigcap_{k=0}^{\infty} E_k$$

- Properties: At each level k, E_k is the union of 2^k disjoint intervals, each having length 3^{-k}

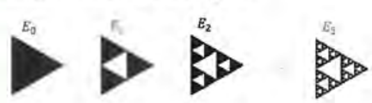
The Von Koch Curve



- At each level of construction E_k, remove the middle third of each interval and replace it with two sides of an outwardly oriented equilateral triangle to obtain the next level E_{k+1}
- Each level of construction E_k is made up of four copies of E_{k-1} scaled down by a factor of $\frac{1}{3}$
- The von Koch curve can then be defined as

$$\bigcap_{k=0}^{\infty} E_k$$

Sierpinski Triangle



- At each level of construction E_k, replace every triangle with three identically oriented triangles as shown to obtain the next level E_{k+1}
- Each level of construction E_k is made up of three copies of E_{k-1} scaled down by a factor of $\frac{1}{2}$
- The Sierpinski triangle can then be defined as

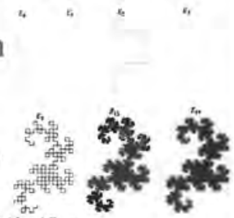
$$\bigcap_{k=0}^{\infty} E_k$$

Sierpinski Dragon

- At each level of construction E_k, replace every line segment with one half of a regular hexagon, alternating between inward and outward orientation, to obtain the next level E_{k+1}
- Each level of construction E_k is made up of three copies of E_{k-1} scaled down by a factor of $\frac{1}{2}$
- The Sierpinski dragon can then be defined as

$$\bigcap_{k=0}^{\infty} E_k$$

Heighway Dragon



- At each level of construction E_k, replace every line segment with two sides of a right isosceles triangle alternating between inward and outward orientation, to obtain the next level E_{k+1}
- Each level of construction E_k is made up of two copies of E_{k-1} scaled down by a factor of $\frac{\sqrt{2}}{2}$
- The Heighway dragon can then be defined as

$$\bigcap_{k=0}^{\infty} E_k$$

Quantifying Fractals

- Fractals can be difficult to describe using traditional geometry
- For example,

every subset of the von Koch curve has infinite length and an area of 0

Every subset of the middle third Cantor set contains infinite points, but has a length of 0

- One way we can describe fractal sets is by calculating their fractal dimension, which gives us an idea of how a fractal takes up space, or how densely packed it is

Definitions

- Borel sets are a class of subsets of R^n with the following properties:
  - Every open set and every closed set is a Borel set
  - The union of any finite or countable collection of Borel sets is a Borel set
  - The intersection of every finite or countable collection of Borel sets is a Borel set
- A congruence is a function $S: R^n \to R^n$ that is distance preserving, in other words, $|S(x) - S(y)| = |x - y| \; \forall x, y \in R^n$
- A Similarity is a function $S: R^n \to R^n$ for which

$$|S(x) - S(y)| = c|x - y| \; \forall x, y \in R^n$$

- A function $S: R^n \to R^n$ is Lipschitz if

$$|S(x) - S(y)| \le c|x - y| \; \forall x, y \in R^n, 0 < c < \infty$$

- A function $S: R^n \to R^n$ is bi-Lipschitz if

$$c_1|x - y| \le |S(x) - S(y)| \le c_2|x - y| \; \forall x, y \in R^n, 0 < c_1 \le c_2 < \infty$$

Definitions cont.

μ is a measure on R^n if $\forall A \subset R^n, \mu(A) \ge 0$ and

- (a) $\mu(\emptyset) = 0$
- (b) $\mu(A) \le \mu(B)$ if $A \subset B$
- (c) if $A_1, A_2, \ldots$ is a countable or finite sequence of sets, then

$$\mu\left(\bigcup_{i=1}^{\infty} A_i\right) \le \sum_{i=1}^{\infty} \mu(A_i)$$

- (d) if the A_i are disjoint Borel sets, then

$$\mu\left(\bigcup_{i=1}^{\infty} A_i\right) = \sum_{i=1}^{\infty} \mu(A_i)$$

BOX-COUNTING DIMENSION

Definitions

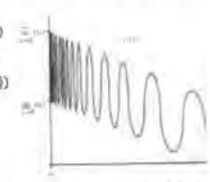
- For a set $A \subset R$ the infimum of A

$$\text{Inf}(A) = \text{Min}\{x : x \in \overline{A}\}$$

- For a set $A \subset R$ the supremum of A

$$\text{Sup}(A) = \text{Max}\{x : x \in \overline{A}\}$$

- In other words, Inf(A) and Sup(A) are the minimum and the maximum of the closure of the set A
- The limit inferior of a function $f(x)$:
  $\underline{\lim}_{x \to 0} f(x) = \lim_{r \to 0}(\inf\{f(x) : 0 < x < r\})$
- The limit superior of a function $f(x)$:
  $\overline{\lim}_{x \to 0} f(x) = \lim_{r \to 0}(\sup\{f(x) : 0 < x < r\})$



δ-cover and $N_\delta(F)$

- We call $\{U_i\}$ a δ-cover of F if

$$F \subset \bigcup_{i=1}^{\infty} U_i \text{ and } 0 < |U_i| \le \delta \quad , \forall i \in N$$

- Further, $N_\delta(F)$ is the minimum $|\{U_i\}|$ where U_i is a δ-cover of F.
- In other words, $N_\delta(F)$ is the smallest number of sets of diameter at most δ which covers F.

Box Dimension

- The box dimension measures the way $N_\delta(F)$ grows as $\delta \to 0$
- A set F has box dimension s if it obeys an approximate power law:

$$N_\delta(F) \cong c\delta^{-s}$$

- As a simple example, let F be a solid square of side length k
- Divide F into squares of radius δ and side length $\frac{\delta\sqrt{2}}{2}$. This provides a δ-cover of F.
- There are $\left(\frac{k}{\frac{\delta\sqrt{2}}{2}}\right)^2$ such smaller squares
- for all values of δ
- Thus, the smallest covering

$$N_\delta(F) = \left(\frac{k}{\frac{\delta\sqrt{2}}{2}}\right)^2$$

$$= \left(\frac{k}{\frac{\sqrt{2}}{2}}\right)^2 \delta^{-2}$$

- Since $\left(\frac{k}{\frac{\sqrt{2}}{2}}\right)^2$ is a constant, F has box dimension 2

Box Dimension Cont.

Solving this power law for s:

$$N_\delta(F) \cong c\delta^{-s}$$

$$\log N_\delta(F) \cong \log c - s\log\delta$$

$$s \cong \frac{\log N_\delta(F)}{-\log\delta} + \frac{\log c}{-\log\delta}$$

The exact value of s is obtained from taking the limit as $\delta \to 0$:

$$s = \lim_{\delta\to 0}\left[\frac{\log N_\delta(F)}{-\log\delta} + \frac{\log c}{-\log\delta}\right]$$

$$s = \lim_{\delta\to 0}\frac{\log N_\delta(F)}{-\log\delta}$$

Because s may oscillate, we define

- $\underline{\dim}_B F = \underline{\lim}_{\delta\to 0}\frac{\log N_\delta(F)}{-\log\delta}$
- $\overline{\dim}_B F = \overline{\lim}_{\delta\to 0}\frac{\log N_\delta(F)}{-\log\delta}$

If $\underline{\dim}_B F = \overline{\dim}_B F$, then

$$\dim_B F = \lim_{\delta\to 0}\frac{\log N_\delta(F)}{-\log\delta}$$

Calculating the Box Dimension

- When calculating the box dimension, it is often easier to use the following theorem, rather than the definition of $\dim_B F$
- Theorem:

Let $\{\delta_i\}$ be a decreasing sequence such that $\delta_k = c^k$ for some $0 < c < 1$

Then

$$\overline{\dim}_B F = \overline{\lim}_{\delta\to 0}\frac{\log N_\delta(F)}{-\log\delta} \le \overline{\lim}_{k\to\infty}\frac{\log N_{\delta_k}(F)}{-\log(\delta_k)}$$

And

$$\underline{\dim}_B F = \underline{\lim}_{\delta\to 0}\frac{\log N_\delta(F)}{-\log\delta} \ge \underline{\lim}_{k\to\infty}\frac{\log N_{\delta_k}(F)}{-\log\delta_k}$$

- Proof:

Let $\{\delta_i\}$ be a decreasing sequence such that $\delta_k = c^k$ for some $0 < c < 1$. Let $\delta_{k+1} \le \delta < \delta_k$. Then $N_\delta(F) \le N_{\delta_{k+1}}(F)$

$$\log\delta \le \log\delta_k$$

$$-\log\delta \ge -\log\delta_k$$

Multiplying by $\frac{1}{\log\delta\log\delta_k}$: $\quad \frac{1}{-\log\delta} \le \frac{1}{-\log\delta_k}$

$$\frac{\log N_\delta(F)}{-\log\delta} \le \frac{\log N_\delta(F)}{-\log\delta_k}$$

$$\frac{\log N_\delta(F)}{-\log\delta} \le \frac{\log N_{\delta_{k+1}}(F)}{-\log\delta_k}, \quad \text{Since } N_\delta(F) \le N_{\delta_{k+1}}(F)$$

$$= \frac{\log N_{\delta_{k+1}}(F)}{-\log(\delta_k) + (\log\delta_{k+1} - \log\delta_{k+1})}$$

$$= \frac{\log N_{\delta_{k+1}}(F)}{-\log(\delta_{k+1}) + \log\left(\frac{\delta_{k+1}}{\delta_k}\right)}$$

$$= \frac{\log N_{\delta_{k+1}}(F)}{-\log(\delta_{k+1}) + \log\left(\frac{c^{k+1}}{c^k}\right)}, \quad \text{Since } \delta_k = c^k$$

$$= \frac{\log N_{\delta_{k+1}}(F)}{-\log(\delta_{k+1}) + \log c}$$

Giving us

$$\frac{\log N_\delta(F)}{-\log\delta} \le \frac{\log N_{\delta_{k+1}}(F)}{-\log(\delta_{k+1}) + \log c}$$

Then, taking the limit:

$$\overline{\lim}_{\delta\to 0}\frac{\log N_\delta(F)}{-\log\delta} \le \overline{\lim}_{\delta\to 0}\frac{\log N_{\delta_{k+1}}(F)}{-\log(\delta_{k+1}) + \log c}$$

$$= \overline{\lim}_{k\to\infty}\frac{\log N_{\delta_{k+1}}(F)}{-\log(\delta_{k+1}) + \log c}, \text{ since } \{\delta_i\} \text{ is decreasing}$$

$$= \overline{\lim}_{k\to\infty}\frac{\frac{\log N_{\delta_{k+1}}(F)}{-\log(\delta_{k+1})}}{\frac{-\log(\delta_{k+1})}{-\log(\delta_{k+1})} + \frac{\log c}{-\log(\delta_{k+1})}}$$

$$= \overline{\lim}_{k\to\infty}\frac{\frac{\log N_{\delta_{k+1}}(F)}{-\log(\delta_{k+1})}}{1 + \frac{\log c}{-\log(\delta_{k+1})}}$$

Since $\overline{\lim}_{k\to\infty}\frac{\log c}{-\log(\delta_{k+1})} = 0$,

$$= \overline{\lim}_{k\to\infty}\frac{\log N_{\delta_{k+1}}(F)}{-\log(\delta_{k+1})}$$

$$= \overline{\lim}_{k\to\infty}\frac{\log N_{\delta_k}(F)}{-\log(\delta_k)}$$

Giving us the final equation

$$\overline{\lim}_{\delta\to 0}\frac{\log N_\delta(F)}{-\log\delta} \le \overline{\lim}_{k\to\infty}\frac{\log N_{\delta_k}(F)}{-\log(\delta_k)}$$

By a similar argument,

$$\underline{\lim}_{\delta\to 0}\frac{\log N_\delta(F)}{-\log\delta} \ge \underline{\lim}_{k\to\infty}\frac{\log N_{\delta_k}(F)}{-\log\delta_k}$$

Calculation

Let F be the middle third Cantor set. Calculate the box dimension of F

Upper Dimension

- Let $\{\delta_i\}$ be the decreasing sequence such that $\delta_k = \left(\frac{1}{3}\right)^k$. Let $3^{-k} < \delta \leq 3^{-(k-1)}$. Then the 2^k intervals of E_k, each having length 3^{-k}, form a δ-cover of F. Thus $N_{\delta_{k-1}}(F) \leq N_\delta(F)$, because $\delta \leq \delta_{k-1}$, and $N_\delta(F) \leq 2^k$, because we know of a size 2^k δ-cover of F.

Illustration at k=2

Calculation cont.

$$\overline{\dim}_B = \overline{\lim_{\delta \to 0}} \frac{\log N_\delta(F)}{-\log \delta} \leq \overline{\lim_{k \to \infty}} \frac{\log N_{\delta_{k-1}}(F)}{-\log \delta_{k-1}}$$

$$\leq \overline{\lim_{k \to \infty}} \frac{\log 2^k}{-\log 3^{-(k-1)}}, \text{since } N_{\delta_{k-1}}(F) \leq 2^k$$

$$= \overline{\lim_{k \to \infty}} \frac{k \log 2}{(k-1)\log 3} = \frac{\log 2}{\log 3} \overline{\lim_{k \to \infty}} \frac{k}{(k-1)} = \frac{\log 2}{\log 3}$$

Calculation cont.

Lower Dimension

- Let $3^{-(k+1)} \leq \delta < 3^{-k}$. Any interval of length δ such that $3^{-(k+1)} \leq \delta < 3^{-k}$ intersects at most one of the intervals of E_k, since the smallest distance between any two k-level intervals is 3^{-k}. There are 2^k intervals in E_k, and all of them contain points in F. Thus, at least 2^k intervals of length δ are required to cover F. So $N_\delta(F) \geq 2^k$.

Illustration at k=1

Calculation cont.

$$\underline{\dim}_B = \underline{\lim_{\delta \to 0}} \frac{\log N_\delta(F)}{-\log \delta} \geq \underline{\lim_{k \to \infty}} \frac{\log N_{\delta_k}(F)}{-\log \delta_k}$$

$$\geq \underline{\lim_{k \to \infty}} \frac{\log 2^k}{-\log 3^{-(k+1)}}, \text{since } \log 3^{-(k+1)} \leq \log \delta_k \text{, by what was given}$$

$$= \underline{\lim_{k \to \infty}} \frac{k \log 2}{(k+1)\log 3} = \frac{\log 2}{\log 3} \underline{\lim_{k \to \infty}} \frac{k}{k+1} = \frac{\log 2}{\log 3}$$

Since $\overline{\dim}_B = \underline{\dim}_B = \frac{\log 2}{\log 3}$, F has box dimension $\frac{\log 2}{\log 3} \cong 0.6309$

HAUSDORFF DIMENSION

Lebesgue Measure

- The Lebesgue Measure on R^n

$$\mathcal{L}^n(A) = \inf\left\{\sum_{i=1}^{\infty} \mathrm{vol}^n(A_i) : A \subset \bigcup_{i=1}^{\infty} A_i\right\}$$

Where $\mathrm{vol}^n(A) = (b_1 - a_1)(b_2 - a_2) \dots (b_n - a_n)$ for the nth dimensional box A

- In other words, we cover the set A with n-dimensional boxes in such a way that minimizes the n-dimensional volume of those boxes
- For the purposes of this talk, it is sufficient to understand that
  - $\mathcal{L}^0(A)$: The number of points in A
  - $\mathcal{L}^1(A)$: The total length of the line segments in A
  - $\mathcal{L}^2(A)$: The total area of the surfaces in A
  - $\mathcal{L}^3(A)$: The total volume of the solids in A

Lebesgue Measure and Dimension

- The graph of the Lebesgue measure jumps from ∞ to some finite, nonzero value (as long as A is a Borel set), then down to 0
- This critical value of n at which the graph jumps is the dimension of A
- Example:
  - Let A be a filled rectangular surface
  - $L^0(A)$: The number of points in $A = \infty$
  - $L^1(A)$: The total length of the line segments in $A = \infty$
  - $L^2(A)$: The total area of the surfaces in A = Area
  - (As long as A is bounded and nonempty, this value is neither ∞ nor 0)
  - $L^3(A)$: The total volume of the solids in $A = 0$
  - For $n > 3$, $L^n(A) = 0$
- Because $L^n(A)$ requires that n be an integer, we need a different measure that will give us analogous insight into the dimension of fractal sets

Hausdorff Measure

- Let $F \subset R^n$ and $s \geq 0$. For each $\delta > 0$,

$$H_\delta^s(F) = \inf\left\{\sum_{i=1}^{\infty} |U_i|^s : \{U_i\} \text{ is a } \delta - \text{cover of } F\right\}$$

- $H_\delta^s(F)$ is the minimum sum of the sth powers of the diameters of a δ-cover of F
- The s-dimensional Hausdorff measure of F is given by

$$H^s(F) = \lim_{\delta \to 0} H_\delta^s(F)$$

- The Scaling Property:

  Let $f: R^n \to R^n$ be a similarity transformation of scale factor $\lambda > 0$. If $F \subset R^n$, then

$$H^s(f(F)) = \lambda^s H^s(F)$$

Hausdorff Dimension

- The Hausdorff dimension, written $\dim_H F$, is the value of s at which the graph of $H^s(F)$ jumps from ∞ to 0

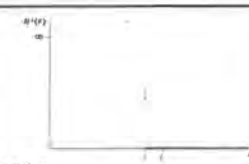
$$\dim_H F = \inf\{s \geq 0 : H^s(F) = 0\} = \sup\{s : H^s(F) = \infty\}$$

- The sets that I researched in this course satisfy the additional property that, at $s = \dim_H F$

$$0 < H^s(F) < \infty$$

- In other words, the s-dimensional Hausdorff measure of F at F's Hausdorff dimension is finite and nonzero.

Claim: If $t > s$ and $H^s(F) < \infty$, then $H^t(F) = 0$



Proof:

- Let $t > s$ and $\{U_i\}$ be a δ-cover of F, then

$$\sum_{i=1}^{\infty}|U_i|^t = \sum_{i=1}^{\infty}|U_i|^{t-s}|U_i|^s \leq \delta^{t-s}\sum_{i=1}^{\infty}|U_i|^s \text{, since } |U_i|^{t-s} \leq \delta^{t-s}\ \forall i$$

- This means that taking the infima over all $\{U_i\}$ gives

$$\inf\left\{\sum_{i=1}^{\infty}|U_i|^t : \{U_i\} \text{ is a } \delta - \text{cover of } F\right\} \leq \inf\left\{\delta^{t-s}\sum_{i=1}^{\infty}|U_i|^s : \{U_i\} \text{ is a } \delta - \text{cover of } F\right\}$$

$$\inf\left\{\sum_{i=1}^{\infty}|U_i|^t : \{U_i\} \text{ is a } \delta - \text{cover of } F\right\} \leq \delta^{t-s}\inf\left\{\sum_{i=1}^{\infty}|U_i|^s : \{U_i\} \text{ is a } \delta - \text{cover of } F\right\}$$

$$H_\delta^t(F) \leq \delta^{t-s}H_\delta^s(F)$$

- Thus, as $\delta \to 0$, if $H^s(F) < \infty$, then

$$\lim_{\delta \to 0} H_\delta^t(F) \leq \lim_{\delta \to 0} \delta^{t-s}H_\delta^s(F) = 0$$

Meaning $H^t(F) = 0$

Calculation

Find $\dim_H F$ when F is the middle third Cantor set

F can be split into a left half and a right half in the following way:

$$F \cap \left[0, \frac{1}{3}\right] = F_L \text{ and } F \cap \left[\frac{2}{3}, 1\right] = F_R$$

Since $F = F_L \cup F_R$ is a union of disjoint Borel sets, by property (d) of measures,

$$H^s(F) = H^s(F_L) + H^s(F_R)$$

Now, let $f_1 : [0,1] \to [0,1]$ be defined as $f_1(x) = \frac{1}{3}x$

Observe that $f_1(F) = F_L$, and

$$|f_1(x) - f_1(y)| = \left|\frac{1}{3}x - \frac{1}{3}y\right| = \frac{1}{3}|x - y|$$

Which, by definition, makes f_1 is a similarity transformation of scale factor $\lambda = \frac{1}{3}$

Let $f_2 : [0,1] \to [0,1]$ be defined as $f_2(x) = \frac{1}{3}x + \frac{2}{3}$

By a similar argument, $f_2(F) = F_R$, and is a similarity transformation of scale factor $\lambda = \frac{1}{3}$

Calculation cont.

By substitution,

$$H^s(F) = H^s(f_1(F)) + H^s(f_2(F))$$

By the scaling property of the Hausdorff measure,

$$H^s(F) = \left(\frac{1}{3}\right)^s H^s(F) + \left(\frac{1}{3}\right)^s H^s(F)$$

At the critical value $s = \dim_H F = s_0$, $0 < H^{s_0}(F) < \infty$, so we can divide by $H^{s_0}(F)$

$$H^{s_0}(F) = \left(\frac{1}{3}\right)^{s_0} H^{s_0}(F) + \left(\frac{1}{3}\right)^{s_0} H^{s_0}(F)$$

$$\downarrow$$

$$1 = \left(\frac{1}{3}\right)^{s_0} + \left(\frac{1}{3}\right)^{s_0}$$

$$1 = 2\left(\frac{1}{3}\right)^{s_0}$$

$$\frac{1}{2} = \frac{1}{3^{s_0}}$$

$$2 = 3^{s_0}$$

$$\log 2 = s_0 \log 3$$

$$s_0 = \frac{\log 2}{\log 3} \cong 0.6309$$

Iterated Function Systems and

SIMILARITY DIMENSION

Iterated Function Systems

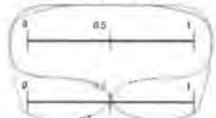
- Iterated Function Systems give us another way to define a fractal set without using construction
- An IFS is a finite family of contractions $\{S_1, S_2, \dots, S_m\}$ with $m \geq 2$
- Where a contraction is a function on a closed set $D \subset R^n$ such that $S: D \to D$ and
$$|S(x) - S(y)| \leq r|x - y| \quad \text{for some } 0 < r < 1$$

In other words, a Lipschitz function with a shrinking scale factor

- A special type of contraction is the contracting similarity:
$$|S(x) - S(y)| = r|x - y| \quad \text{for some } 0 < r < 1$$

Attractors

- Every Iterated Function System has a unique attractor F, which is defined as having the following property:
$$F = \bigcup_{\text{all } i} S_i(F)$$
- In other words, F is made up of its own images under the S_i
- For example, $[0, 1]$ is the unique attractor of the IFS $\{S_1, S_2\}$ where $S_1(x) = \frac{1}{2}x$ and $S_2(x) = \frac{1}{2}x + \frac{1}{2}$, since
$$S_1[0,1] \cup S_2[0,1] = \left[\frac{1}{2}(0), \frac{1}{2}(1)\right] \cup \left[\frac{1}{2}(0) + \frac{1}{2}, \frac{1}{2}(1) + \frac{1}{2}\right] = [0,1]$$



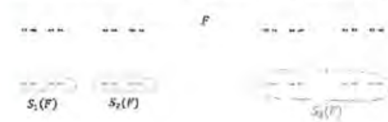
- While each IFS has a unique attractor, it is not true that each set can only be defined as the attractor for a unique IFS

For example, the middle third Cantor set is the attractor for the IFS

- $\{S_1, S_2\}$ where $S_1(x) = \frac{1}{3}x$ and $S_2(x) = \frac{1}{3}x + \frac{2}{3}$

It is also the attractor for the IFS

- $\{S_1, S_2, S_3\}$ where $S_1(x) = \frac{1}{9}x$, $S_2(x) = \frac{1}{9}x + \frac{2}{9}$, and $S_3(x) = \frac{1}{3}x + \frac{2}{3}$



Similarity Dimension

Let $S_1, \dots, S_m : R^n \to R^n$ be a collection of similarity contractions, that is,
$$|S_i(x) - S_i(y)| = r_i|x - y| \quad \forall x, y \in R^n \text{ for some } 0 < r_i < 1$$
Let F be the attractor of the IFS $\{S_1, \dots, S_m\}$. Then
$$F = \bigcup_{i=1}^{m} S_i(F)$$
In the case that this union is "nearly disjoint", by property (d) of measures,
$$H^s(F) = \sum_{i=1}^{m} H^s(S_i(F))$$
$$= \sum_{i=1}^{m} r_i^s H^s(F) \text{ , by the scaling property of } H^s$$

- At $s = \dim_H F = s_0$, $0 < H^{s_0}(F) < \infty$. So, dividing by $H^{s_0}(F)$:
$$1 = \sum_{i=1}^{m} r_i^{s_0}$$
- Solving this equation for s_0 gives the similarity dimension of F.

Open Set Condition

To find the similarity dimension, we require that the S_i be nearly disjoint. In other words, there must exist a non-empty bounded open set V such that
$$\bigcup_{i=1}^{m} S_i(V) \subset V$$
With this union disjoint.

- This condition is always satisfied if the S_i are disjoint, by taking V to be any set.

Calculation 1

The middle third Cantor set is the attractor of the IFS $\{S_1, S_2\}$ where $S_1(x) = \frac{1}{3}x, S_2(x) = \frac{1}{3}x + \frac{2}{3}$

Since S_1 and S_2 are disjoint, the open set condition is satisfied.

For these similarity contractions, $r_1 = \frac{1}{3}$ and $r_2 = \frac{1}{3}$

$$\sum_{i=1}^{2} r_i^s = 1$$

$$\left(\frac{1}{3}\right)^s + \left(\frac{1}{3}\right)^s = 1$$

$$3^s = 2$$

$$s = \frac{\log 2}{\log 3} \cong 0.6309$$

Calculation 2

Find an IFS for this fractal F and find its similarity dimension.

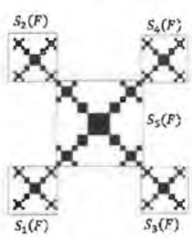
$$F = \bigcap_{k=0}^{\infty} E_k$$

- F is the attractor of the IFS $\{S_1, S_2, S_3, S_4, S_5\}$ where

$$S_1\binom{x}{y} = \frac{1}{4}\binom{x}{y}, S_2\binom{x}{y} = \frac{1}{4}\binom{x}{y} + \binom{0}{0.75},$$

$$S_3\binom{x}{y} = \frac{1}{4}\binom{x}{y} + \binom{0.75}{0}, S_4\binom{x}{y} = \frac{1}{4}\binom{x}{y} + \binom{0.75}{0.75}$$

$$S_5\binom{x}{y} = \frac{1}{2}\binom{x}{y} + \binom{0.25}{0.25}$$



Verify open set condition

- Let V be the interior of the square whose vertices are (0, 0), (0, 1), (1, 1), (1, 0)
- Then $\bigcup_i S_i(V)$ is a disjoint union and a strict subset of V as shown

Calculate s

$$\sum_{i=1}^{5} r_i^s = 1$$

$$4\left(\frac{1}{4}\right)^s + \left(\frac{1}{2}\right)^s = 1$$

Let $x = \left(\frac{1}{2}\right)^s$. Then $x^2 = \left(\frac{1}{4}\right)^s$, and we can rewrite

$$4x^2 + x - 1 = 0$$

$$x = \frac{-1 \pm \sqrt{17}}{8}$$

Since $\left(\frac{1}{2}\right)^s > 0$,

$$\left(\frac{1}{2}\right)^s = \frac{-1 + \sqrt{17}}{8}$$

$$2^s = \frac{8}{-1 + \sqrt{17}}$$

$$s = \frac{\log 8 - \log(\sqrt{17} - 1)}{\log 2} \cong 1.357$$

Estimating Dimension

- In the case that F is the attractor of an IFS which is not a collection of similarities, we can still estimate the Hausdorff dimension of F by calculating an upper and lower bound
- Let $S_1, \ldots, S_m : R^n \to R^n$ be a collection of contractions, that is, $|S_i(x) - S_i(y)| \leq r_i|x - y| \quad \forall x, y \in R^n$ for some $0 < r_i < 1$
- Let F be the attractor of the IFS $\{S_1, \ldots, S_m\}$. Then $\dim_H F \leq s$, where
$$1 = \sum_{i=1}^{m} r_i^s$$
- Let $S_1, \ldots, S_m : R^n \to R^n$ be a collection of contractions such that, $b_i|x - y| \leq |S_i(x) - S_i(y)| \quad \forall x, y \in R^n$ for some $0 < b_i < 1$
- Let F be the attractor of the IFS $\{S_1, \ldots, S_m\}$. Then $\dim_H F \geq t$, where
$$1 = \sum_{i=1}^{m} b_i^t$$

Calculation

Let $D=[0,1]$ Let $S_1, S_2 : D \to D$ be defined as $S_1(x) = \frac{x}{2+x}$ and $S_2(x) = \frac{2}{2+x}$

Estimate the Hausdorff dimension of F, the attractor of $\{S_1, S_2\}$

$$S_1(D) = [S_1(0), S_1(1)] = \left[0, \frac{1}{3}\right]$$
$$S_2(D) = [S_2(1), S_2(0)] = \left[\frac{2}{3}, 1\right]$$

Since $F \subset D$, $S_1(F) \subset \left[0, \frac{1}{3}\right]$ and $S_2(F) \subset \left[\frac{2}{3}, 1\right]$

Thus $F = S_1(F) \cup S_2(F)$ is a disjoint union, so the open set condition is satisfied

---

Let $D=[0,1]$ Let $S_1, S_2 : D \to D$ be defined as $S_1(x) = \frac{x}{2+x}$ and $S_2(x) = \frac{2}{2+x}$

Estimate the Hausdorff dimension of F, the attractor of $\{S_1, S_2\}$

$$S_1'(x) = \frac{x+2-x}{(x+2)^2} = \frac{2}{(x+2)^2}$$
$$S_2'(x) = \frac{-2}{(2+x)^2}$$

Observe that, $\forall i$, $|S_i'(x)| = \frac{2}{(2+x)^2} \leq \frac{2}{2^2}$, since $x \geq 0$

Additionally, $\frac{2}{(2+x)^2} \geq \frac{2}{3^2}$, since $x \leq 1$

$$\frac{2}{9} \leq |S_i'(x)| \leq \frac{2}{4}, \forall i$$

By the Mean Value Theorem,

$$\frac{2}{9} \leq \frac{|S_i(a) - S_i(b)|}{|a-b|} \leq \frac{1}{2}, \text{for all } a, b \in D$$
$$\frac{2}{9}|a-b| \leq |S_i(a) - S_i(b)| \leq \frac{1}{2}|a-b|$$

So $r_i = \frac{1}{2}, b_i = \frac{2}{9}\ \forall i$

- **Upper Estimate:**

$$\sum_{i=1}^{2} \left(\frac{1}{2}\right)^s = 1$$
$$2\left(\frac{1}{2}\right)^s = 1$$
$$2^s = 2^1$$
$$s = 1$$

- **Lower Estimate:**

$$\sum_{i=1}^{2} \left(\frac{2}{9}\right)^t = 1$$
$$\left(\frac{2}{9}\right)^t = \frac{1}{2}$$
$$t = \frac{\log\frac{1}{2}}{\log\frac{2}{9}} \cong 0.46$$

So $0.46 \leq \dim_H \leq 1$ However, we can modify our choice of IFS to obtain a more accurate estimate.

Observe that F is also the attractor for the IFS

$$S_1(S_1(x)) = \frac{\frac{x}{2+x}}{2+\frac{x}{2+x}} = \frac{x}{4+3x} \qquad S_1(S_2(x)) = \frac{\frac{2}{2+x}}{2+\frac{2}{2+x}} = \frac{1}{3+x}$$
$$S_2(S_1(x)) = \frac{2}{2+\frac{x}{2+x}} = \frac{4+2x}{4+3x} \qquad S_2(S_2(x)) = \frac{2}{2+\frac{2}{2+x}} = \frac{2+x}{3+x}$$

Since $S_1(F)$ and $S_2(F)$ are disjoint, the four compositions are also disjoint, meaning the open set condition is still satisfied

---

$$S_1(S_1(x))' = \frac{4+3x-3x}{(4+3x)^2} = \frac{4}{(4+3x)^2}$$
$$S_1(S_2(x))' = \frac{-1}{(3+x)^2}$$
$$S_2(S_1(x))' = \frac{2(4+3x)-3(4+2x)}{(4+3x)^2} = \frac{-4}{(4+3x)^2}$$
$$S_2(S_2(x))' = \frac{3+x-2-x}{(3+x)^2} = \frac{1}{(3+x)^2}$$

Since $0 \leq x \leq 1$,

$$\frac{4}{7^2} \leq |S_1(S_1(x))'| = |S_2(S_1(x))'| = \frac{4}{(4+3x)^2} \leq \frac{4}{4^2}$$
$$\frac{4}{49} \leq |S_i(S_1(x))'| \leq \frac{1}{4}$$
$$\frac{1}{4^2} \leq |S_1(S_2(x))'| = |S_2(S_2(x))'| = \frac{1}{(3+x)^2} \leq \frac{1}{3^2}$$
$$\frac{1}{16} \leq |S_i(S_2(x))'| \leq \frac{1}{9}$$

By the Mean Value Theorem

$$\frac{4}{49} \leq \frac{|S_i(S_1(a)) - S_i(S_1(b))|}{|a-b|} \leq \frac{1}{4}$$
$$\frac{4}{49}|a-b| \leq |S_i(S_1(a)) - S_i(S_1(b))| \leq \frac{1}{4}|a-b|$$
$$\frac{1}{16} \leq \frac{|S_i(S_2(a)) - S_i(S_2(b))|}{|a-b|} \leq \frac{1}{9}$$
$$\frac{1}{16}|a-b| \leq |S_i(S_2(a)) - S_i(S_2(b))| \leq \frac{1}{9}|a-b|$$

Giving $r_1 = \frac{1}{4}, r_2 = \frac{1}{9}, b_1 = \frac{4}{49}, b_2 = \frac{1}{16}$

$$2\left(\frac{1}{4}\right)^s + 2\left(\frac{1}{9}\right)^s = 1$$
$$2\left(\frac{4}{49}\right)^t + 2\left(\frac{1}{16}\right)^t = 1$$

Which gives $s = 0.80$ and $t = 0.53$

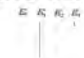
So our new estimate for the Hausdorff dimension of F is

$$0.53 \leq \dim_H(F) \leq 0.80$$

FRACTAL DIMENSION VERSUS TOPOLOGICAL DIMENSION

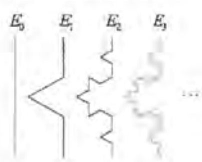
Recall: "Often the fractal dimension of F is greater than its topological dimension"

The Middle Third Cantor Set



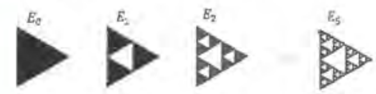
- The middle third Cantor set has fractal dimension $\frac{\log 2}{\log 3} \cong 0.6309$
- Since the MTCS is a collection of disjoint points, it has topological dimension 0
- The middle third Cantor set's fractal dimension exceeds its topological dimension

The Von Koch Curve



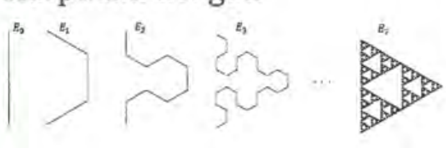
- The von Koch curve has fractal dimension $\frac{\log 4}{\log 3} \cong 1.2619$
- Since the von Koch curve is a collection of curves, it has topological dimension 1
- The von Koch curve's fractal dimension exceeds its topological dimension

Sierpinski Triangle



- The Sierpinski triangle has fractal dimension $\frac{\log 3}{\log 2} \cong 1.5850$
- The Sierpinski triangle has topological dimension 1
- The Sierpinski triangle's fractal dimension exceeds its topological dimension

Sierpinski Dragon



- The Sierpinski dragon has fractal dimension $\frac{\log 3}{\log 2} \cong 1.5850$
- Since the Sierpinski dragon is a collection of curves, it has topological dimension 1
- The Sierpinski dragon's fractal dimension exceeds its topological dimension

References

- Edgar, Gerald. *Measure, Topology, and Fractal Geometry.* 2nd ed. N.p.: Springer Science & Business Media, LLC, 2008. Print.
- Falconer, K. (2014). *Fractal Geometry: Mathematical Foundations and Applications* (3rd ed.). N.p.: John Wiley & Sons, Ltd.
- Falconer, K., & Stallard, G. (2014). Solutions Manual. In *Wiley Student Companion.* Retrieved from http://bcs.wiley.com/he-bcs/Books?action=resource&bcsId=8728&itemId=111994239X&resourceId=34235

Graph Theory & Computational Geometry

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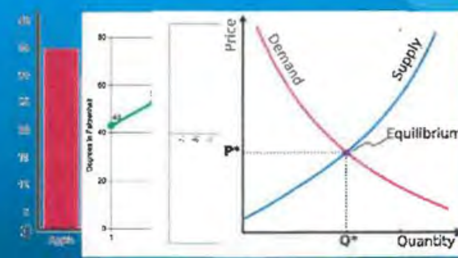
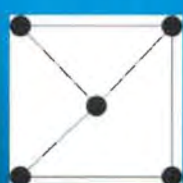
Fall 2013

What is a graph??



A ***graph*** consists of a non empty finite set V(G) of elements called vertices, and a finite set E(G) of distinct unordered pairs of distinct elements of V(G) called edges.



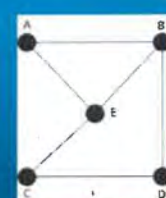
Adjacency

Two vertices are ***adjacent*** if there is an edge joining them. they are ***incident*** with the edge. Two edges are **adjacent** if they share a vertex.

i.e.
A and B are adjacent.

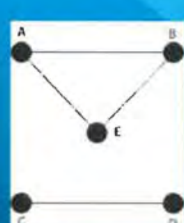
The edge AB is incident to A.

The edges AE and AB are adjacent.



More key terms

- Degree
- Subgraph
- Connected
- Bridge
- Disconnected



Special kinds of Graphs

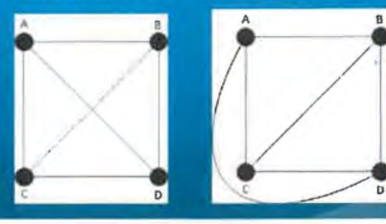
- Complete (K_n)
- Bipartite ($K_{m,n}$)
- Peterson Graph

Trees

- Connected graph with no cycles
- Spanning Tree - Connects every vertex in a graph G
- Minimum Spanning Tree (MST)

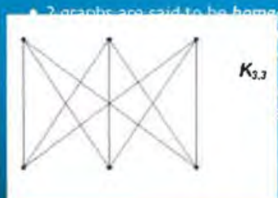
Planarity

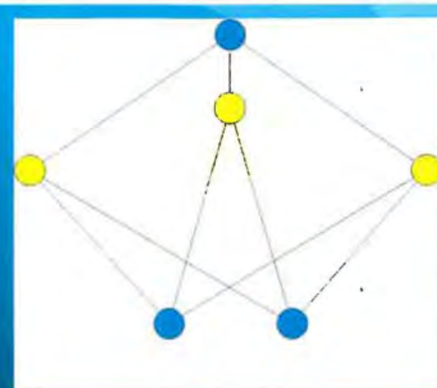
- ***Planar Graph*** - a graph that can be drawn in the plane without crossings.
- ***Plane graph*** - a planar graph drawn in one plane.



Is the Peterson Graph Planar?

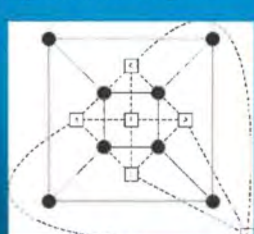
- **Kuratowski's Theorem (1930)**
  - A graph is planar if and only if it contains no subgraph homeomorphic to $K_{3,3}$ and K_5





Duals

- **Geometric dual** - graph, G*, with vertices inside G's faces. Two vertices of G* are adjacent if their corresponding faces in G are adjacent.



Coloring Graphs

- *k-colorable(v)* - we can assign one of k colors to each vertex so that adjacent vertices have different colors.
- *k-chromatic* - if G is k-colorable, but not (k-1)-colorable.
- Appel and Haken, 1976
  - Theorem - Every simple planar graph is 4-colorable.

Examples

4 - chromatic

2 chromatic

3 chromatic

4 - chromatic

3 - chromatic

Digraphs

- A ***Directed graph(digraph)*** D consists of a non-empty finite set V(D) of elements called vertices, and a finite family A(D) of ordered pairs of elements of V(D) called arcs.

Strongly connected Digraph

- A graph is said to be ***Strongly connected*** if for any two vertices v and w of D, there is a path from v to w.
- A ***Path*** is a finite sequence of edges of the form v_0v_1, v_1v_2, ... , $v_{m-1}v_m$ in which any two consecutive edges are adjacent or identical and all the edges are distinct.
  - Strongly connected

Orientable

- A graph G is said to be ***Orientable*** if each edge of G can be directed so that the resulting graph is strongly connected.

Activity Network

- Weighted Digraph

Max Flow

- **Max-flow min-cut theorem** - In any network, the value of any maximum flow is equal to the capacity of any minimum cut.
- Cut - a set A of arcs such that each path from v to w includes an arc in A.

Max flow/ Min cut = 8

Computational Geometry

- A branch of computer science devoted to the study of algorithms which can be stated in terms of geometry.
- Computational Geometrist are always working to come up with new and faster algorithms to compute different structures.
- For this brief introduction, I looked at a few of these structures and looked at some application in GIS.

Nearest Neighbor Graph (NNG)

- Connects each point in a set to its closest neighbor.
- For a point x, point y is its nearest neighbor if there is no other point in x's search space.
- X's search space: A circle centers at x with radius dist(x,y).

NNG on a set of 20 points

Minimum Spanning Tree (MST)

- Less than or equal to the weight of every other spanning tree.
- Obtained by connecting the clusters of the NNG by choose the minimum distance from one cluster to another.

MST on a set of 20 points

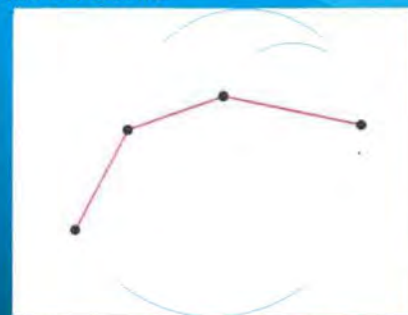
Relative Neighborhood Graph (RNG)

- Connects two points if they are *relative neighbors* of each other
- Search space: Lune

Gabriel Graph

- Connects two points, x and y, if they are *Gabriel neighbors* of each other
- Search space: Circle with diameter dist(x,y)

Gabriel Demo



GG on a set of 20 points

Delaunay Triangulation (DT)

- Geometric Dual of the ***Voronoi Diagram***
- ***Voronoi Diagram*** is a way of dividing space into a number of regions.
- Runtime goes from n^3 to (n log n)

DT on a set of 20 points

How are these related??

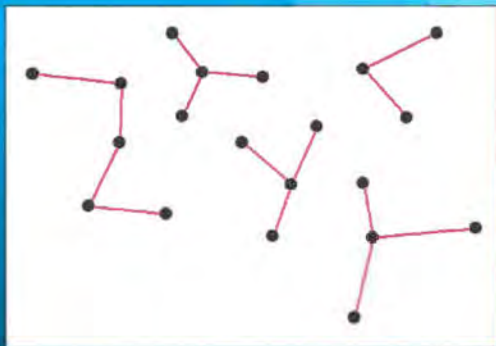
NNG is a subgraph of MST

MST is a subgraph of RNG

RNG is a subgraph of GG

GG is a subgraph of DT

$NNG \subseteq MST \subseteq RNG \subseteq GG \subseteq DT$



DT Application in GIS

α (alpha) - hulls

Fig. 1. Positive α-hull.

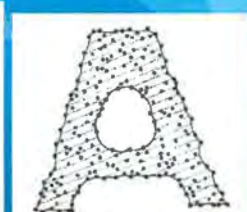


Fig. 2. Negative α-hull.

α - shapes

(a)

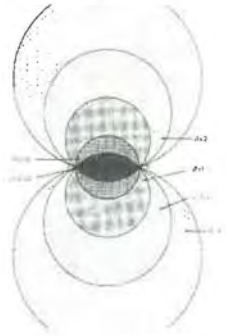
(b)

β (beta) – Skeletons

- Two methods for generation
- $0 < \beta < \infty$
- Circle based method
- Lune based method

Circle Based Method

- When $\beta < 1$, for points x and y, search space is the intersection of 2 circles of diameter (dist(x,y) * (1/β)). Both circles contain both x and y on their circumference.
- When $\beta = 1$, circles have diameter of dist(x,y). GG
- When $\beta > 1$, for points x and y, search space is the union of 2 circles of diameter (dist(x,y) * β). Both circles contain both x and y on their circumference.
- As β approaches infinity, search space becomes whole plane.



Lune Based Method

- When β < 1, search space is the same as circle based method
- When β = 1, Gabriel Graph
- When β > 1, for points x and y, search space is the intersection of 2 circles with diameter (dist(x,y) * β). Each circle contains either x or y. The centers of the circles move along the line xy in opposite directions as β approaches infinity.
- When β = 2, relative neighborhood graph
- As β approaches infinity, search space becomes a corridor between x and y, stretching to infinity in either direction.

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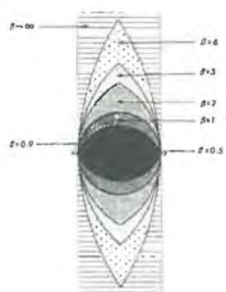


Figure 5
Lune-based neighbourhoods N(x,y,β) for various β>0.

Future...?

- Program a lune based method application for finding β-skeletons
- No one has looked into 3D beta skeletons

Thank you!!

Questions??

Cost Analysis of Newspaper Distribution

MATH 490 – Spring 2017

[redacted]

Collette Coullard, Ph. D - advisor

Methods of Distribution

- Newspapers are generally distributed in one of two ways: independent carrier or USPS.
- Each method has its advantages and disadvantages over each other involving a multitude of points:
  Cost, Labor, Delivery time, Reliability, Customer preference, etc.

Objective

- To minimize total cost over all areas to find the best method of distribution for The Sault News, while ensuring that all subscribers still receive their newspaper on the date of publication.

1st Case – All papers by USPS

- All home deliveries sent through the mail
- Dealer papers still done by carrier
- Mail bags dropped off at PO's by carrier
- 21-25 PO's in the Eastern Upper Peninsula
- Papers must be received at PO's by deadline

2nd Case – All papers by carrier

- Papers individually bagged and deposited at home of customers
- 15 carriers, each with varying loads, operate across EUP
- Circulation imposes 10a.m. deadline, but does not strictly enforce

3rd Case – Hybrid distribution

- USPS distribution in some areas and carrier distribution in others
- How does total cost vary from area to area?

- While an interesting concept, time did not allow for examination.

2nd Case – All papers by Carriers

- According to figures provided, carriers travel a total of 1,035 miles per day
- Total cost to deliver papers per week: $4,066.
- Company pays the following rates for services provided:
- Mileage: 35 ¢ per mile
- Home delivery: 10-15 ¢
- Dealer drop: 75 ¢

1st Case – All papers by USPS

- 91 total destinations to drop papers at (25 post offices and 66 dealers)
- With few exceptions, post offices must receive papers by 6:30 a.m. to guarantee delivery
- Dealers will ideally receive papers by 7a.m. or when the business opens – with a few exceptions

Map of Distribution Area

Map of Distribution Area

1st Case – All papers by USPS

- 1st objective – simulate possible routes to ensure distribution method can meet the time deadline.
- Time papers are typically ready: 2:30a.m. (after printing, inserting, tagging and bagging.)
- What will the cost be?
- How many routes will be necessary?
- Utilization of the Vehicle Routing Problem

Vehicle Routing Problem

Given a set of customers and distances or times between customers and k delivery vehicles, assign each customer to a vehicle and route each vehicle so that each customer is visited.

Minimize total distance or time

or

Minimize the max distance or time.

Finding costs

- USPS works on weight of papers
- Provided: invoice from USPS with price paid to currently mail papers (about 325) to find cost per ounce.
- Found mean by weighing each paper from 2016 to determine average weight and cost.
- Average cost (Mon-Fri): 19¢
- Average cost (Saturday): 29¢

Can it be done with only one vehicle?

- The short answer – no.
- The long answer – noooooooooooo.
- Why not? Not all locations can be reached in 4 hours.
- So how many vehicles will it take?

Routing

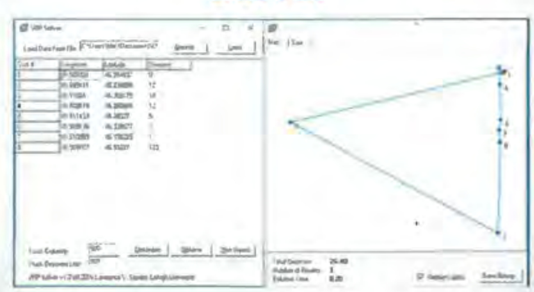
- To simplify finding distances, most PO's and dealers have been clustered into the community most identifiable in the area.
- 17 clusters exist, including communities such as Brimley, Kinross & Kincheloe, DeTour, and the Eckerman area.
- Distance between clusters is based on the PO's in the area.
- Within each cluster, distances are analyzed to find best route within clusters.

Sample Cluster – Newberry area

Constructing Routes

- Several data sets were constructed: half dealing with distances between points in miles, half dealing with times between points in minutes.
- Info for sets found using Google Maps
- Using geographical reasoning (i.e. staring at a map for a long time,) routes were developed & analyzed to see if the time constraint could be met.
- Programs dealing with vehicle routing were explored, but were not suitable for use in this project (round trips.)

Sample Cluster in VRP Solver



[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Evening News	[illegible]	1	16	24	25	26	27	30	43	50	65	107	47	67	75	49	85
USPS - Soo	1	0	18	23	24	24	26	31	44	51	66	108	48	66	75	49	85
USPS - Dafter	18	18	0	15	12	14	17	20	33	41	56	98	34	54	62	40	73
USPS - Barbeau	24	25	13	[illegible]	25	13	23	13	28	35	50	93	47	67	67	47	85
USPS - Brimley	25	24	12	20	0	19	16	31	43	51	66	108	28	48	56	44	67
USPS - Kincheloe	26	24	14	13	19	0	11	14	27	34	50	91	41	61	70	35	73
USPS - Rudyard	27	26	17	33	16	11	0	18	21	38	53	95	36	56	[illegible]	[illegible]	[illegible]
USPS - Pickford	30	31	20	15	31	14	18	0	14	21	36	78	55	63	82	41	79
USPS - Cedarville	[illegible]	44	33	28	43	27	31	[illegible]	0	23	27	67	64	84	[illegible]	[illegible]	[illegible]
USPS - Goetzville	50	51	41	35	31	34	38	21	23	0	15	55	73	93	109	56	94
USPS -																	

2 Routes

- Route 2:
  Soo
  Barbeau
  Kincheloe
  Rudyard
  Pickford
  Cedarville
  Goetzville
  DeTour Village
  Drummmond Island.
- Route 1:
  Dafter
  Brimley
  Eckerman
  Paradise
  Newberry
  Engadine area
  Trout Lake

2 Routes

Distance: 363 miles
Time: 6 hrs. 18 min.

Distance: 161.5 miles
Time: 5 hrs. 5 min.

2 Routes

Total distance: 459.3 mi. Longest time: 6 hrs, 18 min.

3 Routes

Route 1:
Paradise
Newberry
Engadine area
Trout Lake

Route 2:
Barbeau
Pickford
Cedarville
Goetzville
DeTour Village
Drummond Island.

Route 3:
Soo
Brimley
Dafter
Kincheloe
Rudyard
St. Ignace

3 Routes

Distance: 224.6 miles
Time: 4 hrs, 41 min.

Distance: 113.2 miles
Time: 3 hrs, 16 min.

Distance: 127.8 miles
Time: 3 hrs, 31 min

3 Routes

Total distance: 465.6 miles
Longest time: 4 hrs 41 min

4 Routes

- Route 3:
  Brimley
  Dafter
  Eckerman
  Trout Lake
  St. Ignace
- Route 4:
  Paradise
  Newberry
  Engadine area.
- Route 1:
  Soo
  Barbeau
  Pickford
  Rudyard
  Kincheloe
- Route 2:
  Cedarville
  Goetzville
  DeTour Village
  Drummond Island.

4 Routes

Distance: 104.2 miles
Time: 2 hrs, 56 min.

Distance: 91.3 miles
Time: 2 hrs, 52 min.

4 Routes

Distance: 142.3 miles
Time: 2 hrs, 47 min.

Distance: 193.5 miles
Time: 3 hrs, 21 min.

4 Routes

Total distance: 521.3 miles
Longest time: 3 hrs 21 min

Cost Analysis

Given Figures:

- Number of home delivery papers: 1,983
- Number of bundles dropped: 77
- Projected number of USPS bags: 35
- Current number of miles driven: 1,035

Current (and projected) costs for distribution:

- Cost for carrier delivery: 10-15¢
- Cost for USPS delivery: 17-30¢
- Cost for bundle drop: 75¢
- Cost for mail bag drop: $2
- Cost per mile driven: 35¢

Cost Analysis

Carrier Delivery

	Rate	Units	Days	Total
Weekday paper delivery	0.13	1983	5	$1,288.95
Weedend paper delivery	0.13	1983	1	$257.79
Mileage	0.35	1035	6	$2,173.50
Bundle drops	0.75	77	6	$346.50
Weekly Cost				$4,066.74

USPS Delivery

	Rate	Units	Days	Total
Weekday paper delivery	0.19	1983	5	$1,883.85
Weedend paper delivery	0.29	1983	1	$575.07
Mileage	0.35	531.3	6	$1,115.73
Bundle drops	0.75	67	6	$301.50
Mail bag drops	2	35	6	$420.00
Weekly Cost				$4,296.15

Looking at the bigger picture

Although cost appears to favour independent carriers, what do other factors say about delivery method?

Labour

USPS

- Newspapers must be inserted, labeled, sorted into postal routes, bagged & tagged.
- More time must be spent peeling mail labels off of sheets and sticking on papers.
- Estimated time: 60 minutes to 150 minutes

Carriers

- Newspapers must be inserted, counted into bundles, and strapped.
- Carriers hold delivery manifests, with addresses, so carriers can locate destinations.
- Estimated time: 30 minutes to 90 minutes

Reliability

- Company only knows that papers do not reach destination when customer contacts them.
- According to circulation department, current USPS carriers commit a similar amount of errors that independent carriers do (percentage-wise)

Further Work

- Many avenues in which this project can go
- Did not examine Buyer's Guide
- Examine hybrid distribution
- Intangibles

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Mathematics and Computer Science**
Document Title (if attached) or Filename (if emailed):	**MATH 401 Project Paper**
This documentation is relevant to Question number:	**16**
Briefly summarize the content of the file and its value as evidence supporting program review:	**This shows two examples of papers for group projects in MATH 401. The students must collect, analyze and communicate information.**

3D Lotka-Volterra Models

The reason that this group chose this project was our fascination with penguins. We knew we wanted to do some type of food chain project using the Lotka-Volterra model we used in class. Therefore, we looked up different food chains dealing with penguins and decided to look more carefully at the Antarctic food chain. Going into this project, we knew that we had to do something a little bit more difficult than the models in class. Since the models in class used two animals, or two species, we decided to look at different models with three different species. While doing this project, our group noticed that we could use some of the information that we learned during the SIR models and incorporate into these models as well. As we got a little farther into the semester we noticed that there were other types of food chain systems that interested us as well. For example, there are two types of other models: the diamond food chain and the circle food chain. However, these models got a little bit more complicated since they used 4 species instead of three.

To start, the easiest model is the two dimension that we learned in class. Just as an intro to the rest of the paper this model uses two different equations, one for the predator and one for the prey.

$$x' = Ax - Bxy$$

$$y' = -Cy + Dxy$$

In these two equations the x is used as the prey and the y is the predator. We know this based on the fact that when y is non existent the x is positive, which means that the prey can survive when there are no predators. That is why the growth rate for the y equation is negative, because as more predators are being born, the lower amounts of them there will be because more will be killing the prey. The term in the equation with the x and the y is when both species are in the food chain. You could consider this the interaction variable between the two species and since the predator will win that battle that is why it has a positive interaction term and the prey has a negative interaction term. This was the easy model. The next models only get more difficult and more involved.

The model that we first built off of the one learned in class was a 3D model using sort of a straight line chain. Where

$$X \longrightarrow Y \longrightarrow Z$$

In this model we used a similar approach to the 2D model and also the SIR models that we learned in class. The way we first thought of these equations was setting up terms in sort of two 2D models since the "B" becomes a prey after it is a predator. In this specific food chain, A represents the squid, B represents the penguins and C represents the leopard seal. The equations that we came up with for this 3D model are as followed

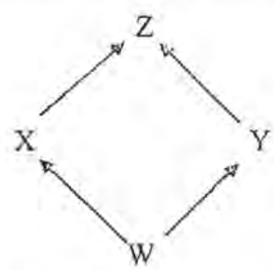
$$x' = Ax - Bxy$$

$$y' = -Cy + Dxy - Eyz$$

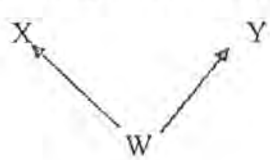
$$z' = -Fz + Gyz$$

In these equations A through G are all positive rates. These equations work the same way that the 2D models works, with x being the squid and being the prey to the penguins (y) and then the leopard seal (z) becomes the predator to the penguins. When coming up with these equations breaking them down was a little easier. We made two 2D models with the squid and the penguins. After that we made another model with the penguins and the leopard seal and just put them together since the squid and the seal don't truly have any type of interaction. When we were trying to graph these equations we couldn't really use sage since we could not get the 3D to really work, so we had to use Mathematica. In some of the comments made, you suggested to try and incorporate a x^2 function into the equations and we just weren't sure how to really do that. If we had more time to really look at these equations and more time to understand how the x^2 function changed the equations we could have incorporated it into the project, but this model was the easiest of the models that we looked into. The next one has multiple parts and can be broken down in a couple different ways.

We call this next model the diamond formation model. This model is slightly more complicated than the above model because the squid now has two different predators and the leopard seal now has two prey. This model looks like the following



In this model W is the squid, the X is the penguins and now Y is the crabeater seal and Z is the leopard seal. When we first came up with this model we had a couple questions on how the final equations were going to look. For example, is there any competition between the penguins and the crabeater seal. We decided that there wasn't and the reason that we decided this was that when we broke the food chain down in to two different models it made a little bit more sense. We started with the bottom half of this model with one prey and two different predators.



This model deals with the same three species as above. But deals with the competition question since there are two different predators. But we broke it all the way down to the 2D models and came up with the following equations,

$$x' = Ax - Bxy - Cxz$$

$$y' = -Dy + Exy$$

$$z' = -Fz + Gxz$$

In these equations the x is the squid with the other two equations being interchangeable as the two predator equations. We decided that there wasn't much predator competition here, but if the food chain got big enough then there would be more competition. For example, let's say that there was one more predator. If we were to look at more numbers from the last couple years of different food chains we may consider putting in some competition term, which would go into the y and z equations in this model where it would be a negative term in both of these equations, but a smaller rate than the other rates involved. On the flip side there is the top half of the diamond formation where there is two prey and one predator. This is the easier half of the model since there is no competition factor. These equations look like,

$$x' = Ax - Bxz$$

$$y' = Cy - Dyz$$

$$z' = -Ez + Fxz + Gyz$$

In these equations the x and y are the prey with z being the top predator. When coming up with the diamond model we started very simple and built up from there. After coming up with these two different models we put them together to come up with the equations for the diamond formation

$$w' = Aw - Bwx - \mathrm{Cwy}$$

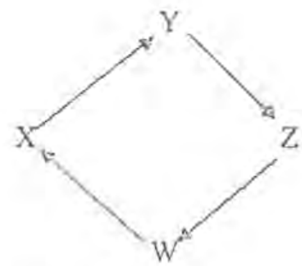
$$x' = -Dx + Ewx - \mathrm{Fxz}$$

$$y' = -Gy + Hwy - Jyz$$

$$z' = -Kz + Lxz + Myz$$

These equations represent that first diamond formation with w being the squid x and y are the penguins and the crabeater seals and z is the leopard seals. When going to graph these equations we broke it down into the two simpler equations first. We then were able to graph the 4D model on Mathematica. Working with these equations using different coefficients, we found that this model is very chaotic because it changes significantly.

The last model we looked at was a circle food chain. This model does not exist inside of the Antarctic food chain, but it does exist in other food chains. For an example when there are decomposers involved, or in some cases people consider this food chain when mosquitos are involved. This food chain looks like,



This model is more difficult from the last two because it really never stops. The other hard part is we know that W starts off this model but when it comes to Z eats W does the model continue or does it stop? The way we approached it is we tried to imagine that the model was the first 3D model constantly, so at each letter we started the model so each equation looks similar because of that. The equations look like,

$$w' = Aw(1 - \frac{w}{k_1}) - Bwx + Cwz$$

$$x' = Dx(1 - \frac{x}{k_2}) + Ewx - Fxy$$

$$y' = Gy(1 - \frac{y}{k_3}) + Hxy - Jyz$$

$$z' = Kz(1 - \frac{z}{k_4}) + Lyz - Mwz$$

In these equations the first part of each equation deals with the growth rate of the species if just that animal lived by itself in the habitat. Think about the negative rate for the predators and the positive for the prey put together, that's what this first term is in each of these equations. The other parts of these equations deal with the interaction parts of both when that animal is the predator and when that animal is the prey. When graphing this model we found that it really just stayed level because that it keeps going in a circle so most of the time it stays in the original spots.

One other thing that we looked was environmental factors, in this case it would be the temperature changing, which could go two different ways. The first way would be if the temperature rose so that the ice was melting. The way we think that these systems would be affected would be that the squid population would go down, because of the less space on the land for the penguins to stay, they would be in the water more, which then they would be hunting more squid, which would lead to a bigger decrease in squid, but same with the penguins, the penguin population would go down because they would be in the water more often with the leopard seals whose population would go up at the end of all of it. Now if the temperature went the other way and decreased so it got colder, we would see the opposite, where the squid population would most likely increase because now there is more land for the penguins and the seals to be on so they aren't in the water as much. Now these increases and decreases are very small, just because the temperature goes up or down is not going to determine the feeding rate of these animals. They are going to be feeding at the same rate, so the rates should not change much just because they are in the water more. It just gives them a higher chance to feed on the squid because they are in the water more often. We didn't add anything to these equations but if we did it would be a mixture of rates for the squid and the penguins where the seals increase would be higher depending on the temperature increase.

Overall in this project we learned a lot about these models and how they work. During the first couple of weeks we were all confused on how to even come up with some of the optimizations models. The fact that we came up with some of the models by ourselves was very rewarding. Also, learning about these penguins was nice for us because that was one of the reasons we chose this food chain in the first place. This project challenged our thinking, but it was a good way to end the semester because we all enjoyed this class.

APRIL 27, 2018

PORTFOLIO SELECTION

By:

Creating a stock portfolio is never an easy task; starting the stock portfolio is the hardest step to take especially as a beginning investor. No one just looks at a stock and has a realization that they should invest in that stock; all smart investors make calculations. It takes months, sometimes even years for people to learn how to manage a portfolio and select the correct investments. This is where our project came into play. Over our time here at LSSU, we have learned some concepts of the stock market. This includes how investing works, what risk comes with investing, and how to diversify a portfolio in order to reduce that risk. Knowing the concepts behind investing we were able to determine that by implementing a linear program we could simplify how one should choose their starting stocks for a portfolio. Originally, our intent was to created a model that reduced risk and maximized return, this is still the case, but it is for beginning investors that do not know where to start. This linear program takes into consideration diversification, cost of stocks, the risk within stocks, and the return we hope to achieve.

There are multiple constraints on our model, and they differ depending on the preferred outcome. There are two different options one can look into. First, a model that returns the different stocks that they should add to their portfolio. This model informs them to purchase only one of each suggested stock. This model leads to the investor having the capability to buy more of each stock. For that model it is necessary to use binary. The second model, one prefered by some beginning investors, is a model that tells you both the stock to purchase, and how much stock from that company should be purchased. This needed many extra constraints because with the linear program, it would instantly invest as much as it could into the stock that had the highest return. The next constraint that was needed for this is the one that limits how many stocks can be purchased from each company. For example, if you want to buy a maximum of five stocks from a certain company you would set that as your individual constraint. As a beginning investor, a model such as this would be ideal to show one where to start. There are many different informative sites out there on how to invest in stock, but it is still hard to decide the specific stocks to invest in. For that reason, we chose to look into this project.

To tackle this project we used a linear programming model. For our project, there were eighty-three different stocks that were implemented under variables and then chosen from. Each of these values have meaning, and the output in our situation is the number of stocks one should purchase from that specific company's stock. This only applies in the nonbinary version, otherwise, it is just the stocks to invest in, not the amount.

The objective function of our model was to maximize the return, but this model also had to have different constraints depending on the variable of each stock. If one simply sets a function to maximize, the program would say to invest in every stock holding a positive return. Below is a sample of how the information was inputted as a variable. For each ticker, the ticker symbol itself represented the return. The ticker symbol followed by "cost" represented the cost per stock. Finally, the ticker symbol followed by "beta" represented the beta of that specific stock.

```
BMY =0.000277662123144
BMYcost =63.9220967741935
BMYbeta =0.73
```

The following is a mathematical explanation of the constraints and then objective function used in our linear model:

Objective function:

$$\sum_{i=0}^{82} TickerSymbol * x[i]$$

Cost Constraint:

$$\sum_{i=0}^{82} TickerSymbolcost * x[i] \le TotalAllowance$$

Beta Constraint:

$$0.90 \le \sum_{i=0}^{82} TickerSymbolbeta * x[i] \le 1.1$$

The objective function and the total allowance constraint were fairly straight forward, set each sum as a multiple of the cost associated with individual tickers. As for the beta constraint, this one had to be implemented as two individual constraints: one keeping average beta above 0.9 and another keeping average beta below 1.1. Also, since this is a linear programing model in sage we could not implement an average on the left side of the inequality. Instead, the right side of the equation was (desired beta)*(the number of total stocks), this was a way of keeping the average contained in a linear model. The final constraint, which was only necessary to implement in non binary mode, was the constraint that limited the total number of stock that could be bought from a single stock. This one was actually implemented as 83 different constraints, each just a single stock less than the total allowed per stock. By keeping these constraints in the model, and then maximizing the return, we were able to achieve a desired beginning portfolio output.

The math that comes from these equations is mostly related to basic financing concepts. We needed a constraint for the total amount of money available because having unlimited funds is unrealistic. The beta constraint is for the risk that comes with investing in a portfolio. As a beginning investor, it is safer to keep beta around one because it is the measure of a stock's volatility (or riskiness) as it relates to the market. The market itself has a beta of 1.0 and stocks are ranked according to how much they deviate from the market. Keeping it close to 1.0 is a way of reducing this risk. The last constraint is that of the limiting per stock, or the binary setting. If the binary setting is in place, the program will only output a one if it finds that stock worth investing in. Therefore, you would buy one unit of that stock and the cost doesn't matter because it was already implemented into your total budget. If one were to want a total amount to invest in each stock instead of only buying one unit of each, then they would use the constraint where each individual integer, x[i], is less than the maximum number they wanted to buy of one singular company's stock. This constraint was set into place because of diversification. It is necessary to diversify your portfolio so that if a specific area of the market crashes, not all of your money is invested in that individual area, or company either.

To interpret the output of this program, you need to know which stock is related to which x[i]. For this reason, we made our program in mostly alphabetical order, and the order that the variables are inputted in is the order that they are inputted into the linear model. The following is a screenshot of one section of output:

```
45: 0.0,
46: 1.0,
47: 0.0,
48: 1.0,
49: 0.0,
50: 1.0,
51: 0.0,
```

This output states that you should buy one unit of stock x[46], x[48], and x[50]. These integers as actual stocks can be find by looking at an inputted constraint:

```
+LOW*x[42]+MET*x[43]+MMM*x[44]+MO*x[45]
+MON*x[46]+MRK*x[47]+MS*x[48]+MSFT*x[49]
+MA*x[50]
```

From this, we see that the code suggests we invest in MON, MS, and MA companies. These are ticker symbols of which stand for Monsanto Co., Morgan Stanley, and Mastercard Inc.. So the user of this program would then add one stock of each of those companies to their portfolio, or a higher amount if the investor desires to do so.

In order to test out our model, we made mock portfolios on investopedia. These two mock portfolios came from the $1,000 and $25,000 investments. Both had successful positive returns. They were created April 11, 2018. The ending values were evaluated on April 22, 2018. So these portfolios were only active for a little over a week, and yet the results are still satisfying. The more time the stocks remain invested, the more return an investor can expect to see. These mock portfolios were how we tested our model, and we are satisfied with the outcome. Overall, this project returned desired results, in fact there were more ways to approach this project than we initially thought. If we were to expand on this project in the future, we would try to take live data from the stock market and include virtually every stock in the market.