Academic Program Review MA Mathematics

Table of Contents

APRC Recommendation to Faculty Senate
MA Mathematics

The Academic Program Review Committee (APRC) affirms that the Department of Mathematics and Statistics has completed program review as per policy, including self-study, external review, internal review, and action plan submission for the MA Mathematics. APRC recommends that the next program review be scheduled for six years from Faculty Senate approval; or, should the College of Natural Sciences and Mathematics decide to schedule a college-wide program review, the next program review will occur at that time.

APRC Chair: Jeffrey Brodd, Professor of Humanities and Religious Studies

Self-Study: Mathematics and Statistics (Fall 2021)

1 Mission and Context

1.1 Mission Statements

The Department of Mathematics and Statistics strives to offer an excellent instructional program that provides out students with the requisite knowledge and skills to allow them to fulfill their potential in their chosen professional fields. The department offers both a bachelor's and master's degree, however our mission reaches beyond just those two degrees. The department has an outsized role as a service department as well as a substantial impact on general education, consequently it has a unique role within the university.

The department's mission is in line with Sacramento State's mission that we transform lives by preparing students for leadership, service, and success. Our students have opportunities in both leadership and service. In addition, our faculty are very student focused and work hard to support and develop student success both within the classroom and beyond.

1.2 The Bachelor of Arts in Mathematics

The coursework required to complete a BA in Mathematics is broken down into three main components, namely the lower division core, the upper division core, and the emphasis requirements. All students majoring in mathematics complete the same collection of lower division core courses and upper division core courses. In addition, each student is required to select one of four emphases: Applied Mathematics, Pure Mathematics, Statistics, or Teacher Preparation. The remainder of the coursework is determined by the choice of emphasis.

The lower division core courses taken by all mathematics majors includes 18 units of lower division mathematics and 3 units of an introductory course in programming. The mathematics coursework includes a three-semester sequence of Calculus, a semester of Differential Equations, and a semester of Linear Algebra. The lower division core courses give the students the opportunity to develop computational fluency and conceptual understanding of the mathematics with two main goals in mind. First, it provides the fundamental tools that will allow students to apply mathematics in settings beyond the mathematics classroom, be it in their science and engineering courses or within their chosen career field. Secondly, the courses provide the background necessary to develop the analytic rigor that underscores the upper division mathematics and statistics courses.

There are 15 units of upper division mathematics coursework that must be taken by all mathematics majors. This includes an introductory course in formal mathematics, in which students develop their ability to analyze the mathematics and write rigorous proofs. This course is followed by year-long sequences in Modern Algebra and Real Analysis (MATH 110A/B, MATH 130A/B). The upper division core coursework provides students with the traditional background in advanced mathematics that prepares them for study of a broad range of more advanced mathematical topics. Flexibility is introduced within the mathematics major in the form of emphases. For the final 12-15 units of the major, students may choose an area of interest, allowing them to specialize depending on their career goals. With the core coursework a student in any emphasis has the necessary background to pursue a graduate degree in mathematics, however the Pure Mathematics Emphasis provides additional coursework that would be helpful to a student planning to obtain a graduate degree in mathematics. The Applied Mathematics Emphasis provides coursework that develops material in areas that have applications in industry. The Statistics Emphasis prepares students to pursue careers with a heavy use of statistics. Finally, the Teacher Preparation Emphasis provides students coursework beneficial to those interested in teaching mathematics in middle or high school.

The BA in Mathematics with an emphasis in Teacher Preparation has been approved by the California Commission on Teacher Credential (CTC) as a waiver program. To be certified as a waiver program, one must show that the coursework provided satisfies the criteria to meet subject matter competency in mathematics set by the CTC. As a result, students completing the program would be waived from taking the state's content examinations, California Subject Examinations for Teachers (CSET) in mathematics. It should be noted that due to California Assembly Bill 130 which was passed in July 2021, the mechanisms for which a credential candidate can meet subject matter competency has been expanded. In particular, the current guidelines specify a student completing any mathematics degree is now waived from taking the CSET. While this change in requirements does allow students interested in teaching to choose any of the emphases, we will still encourage them to complete the Teacher Preparation Emphasis because previously approved waiver programs are generally considered to be the most robust subject matter preparation for prospective teachers.

We currently have approximately 300 mathematics majors. Many students do not declare an emphasis immediately, so it is often hard to track how many majors of each emphasis there are. However, of those that have declared an emphasis, about half are in the Teacher Preparation Emphasis. The other half is fairly evenly distributed across the other three emphases.

1.3 The Master of Arts in Mathematics

The department offers an [MA in Mathematics], which can be completed in four semesters. The program requires a total of 30 units in coursework and a culminating requirement. Similar to the BA program, all students are required to take a year-long sequence in Modern Algebra and Real Analysis (MATH 210A/B, MATH 230A/B). This core coursework constitutes 12 units, and 12 more units must be chosen from a specified list of courses. Finally, each student is allowed to choose 6 units of electives approved by the graduate coordinator. The program culminates with two comprehensive exams, one in Modern Algebra and one in Real Analysis. Students must pass both exams in order to complete the degree.

On average, between 30 and 40 students apply to the MA program each year. A solid background in undergraduate level Modern Algebra and Real Analysis is the main requirement for admission.

Students can be fully admitted if requirements are met or conditionally admitted if some background work in mathematics is still required. Each fall approximately 15-20 new graduate students are enrolled. Each year we graduate between 5 and 10 master's students. For a large majority of students in the program, this is a terminal degree that will be used to apply for post-secondary teaching jobs. A much smaller population pursue a career outside of teaching or pursue an advanced degree. Several graduates of this program teach here at Sac State as well as the many community colleges in the area.

1.4 Minors Offered by the Department

The department offers a Minor in Mathematics as well as a Minor in Statistics. We currently have about 100 math minors and about 10 statistics minors. A large proportion of the math minors are students in the College of Engineering. Both Mathematics and Statistics minors must take Calculus I and II. For the rest of the coursework, mathematics minors must choose from one of two options. Option I requires one more lower division course chosen from a specified list and 9 units of upper division mathematics or statistics coursework approved by an advisor. The second option for the mathematics minor has a more applied emphasis, where students must take, in addition to Calculus I and II, Calculus III, Differential Equations, and the year-long sequence Advanced Mathematics for Science and Engineering. The statistics minor requires one more lower division course beyond Calculus I and II as well as 9 units of upper division statistics.

The majority of students choosing a minor in mathematics or statistics often have a major that already has a large amount of mathematics coursework. However, we also see students pursuing one of these minors to increase their marketability in the work force or to strengthen their applications for graduate school. A third population of minors are those not majoring in mathematics but still considering teaching mathematics at the middle or high school. Therefore, the minors offered by the department can complement a wide variety of majors.

1.5 General Education

All graduates of Sacramento State are required to complete a course in quantitative reasoning to satisfy General Education (GE) Area B4. To meet this requirement students must choose one course from a list of 16 courses. Of that list, only three are not housed in the Department of Mathematics and Statistics. Consequently, the department plays a major role in the GE program. The majority of our lower division courses are GE courses and as such must go through periodic review. In addition, any changes to the courses must also be approved by the GE committee.

The department's GE courses are MATH 1, 17, 24, 26A, 26B, 29, 30, 31, 35 and STAT 1, 10AB, 50. These courses serve an extremely large number and broad range of students. In particular, these courses range from serving students whose major does not require specific mathematical content to STEM majors that have a very heavy load of mathematical requirements. Because the department serves such a large number of students at the university, it requires constant communication with various offices and departments on campus. In addition, faculty in the department must be pedagogically prepared to serve students with very different mathematical backgrounds and with very diverse mathematical goals. Service to this diverse population is exactly why our mission statement highlights that we want students to "fulfill their potential *in their chosen field*".

1.6 Function as a Service Department

As mentioned above, the department serves a broad range of students. In this section we provide greater detail into the courses offered by this department that are requirements in majors other than mathematics.

Physical Science and Engineering majors require a heavy mathematics load. In particular, majors in these areas include a combination of MATH 30 (*Calculus I*), 31 (*Calculus II*), 32 (*Calculus III*), 45 (*Differential Equations*), and STAT 50 (*Introduction to Probability and Statistics*). Depending on the major, a subset of these courses serves as the preliminary coursework necessary for students to continue in their major, and as such are considered gateway courses in the major.

The pre-major requirements for Business Administration includes STAT 1 (*Introduction to Statistics*) and MATH 24 (*Modern Business Mathematics*). MATH 24 is a course that was specifically developed for the College of Business Administration at this campus, and includes the study of functions, the mathematics of finance, rates of change, and linear programming. Students must complete both of these math courses as part of the requirements to declare a business administration major. Similar to business, STAT 1 serves as a pre-major requirement for a BS in Biological Sciences. In addition, students completing that degree are required to take MATH 26A (*Calculus for the Social and Life Sciences*). This course is also required of Construction Management majors.

In addition to the majors indicated above, STAT 1 is a requirement in other majors on campus. These include majors ranging from Economics to Nutrition and Food to several majors within the College of Health and Human Services. This is not surprising, as a general understanding of introductory statistics is crucial in many fields.

The Liberal Studies major at Sacramento State is designed to prepare prospective elementary school teachers by providing coursework that covers the breadth of subjects they will be teaching. As part of this program, students are required to take three mathematics courses, namely MATH 17 (*An Introduction to Exploration, Conjecture, and Proof in Mathematics*) and MATH 107A/B (*Fundamental Mathematical Concepts*). These courses are designed to engage the students deeply in the underlying concepts behind elementary school mathematics. In addition to the mathematical content, students are exposed to a variety of learning experiences to aid in the development of their pedagogical skills. The department acknowledges the responsibility and impact of these courses because these students become the teachers who provide the first exposure of mathematics to young students.

1.7 External Educational Partnerships

To better serve our students, the department works collaboratively with several entities on campus. In particular, there are two main student support services with which we partner, namely the Peer Assisted Learning (PAL) Program and Peer and Academic Resources (PARC) Supplemental Instruction (SI). In addition, due to the unique nature of the Liberal Studies program, we also work closely with them.

The Department of Mathematics and Statistics maintains a close relationship with the Liberal Studies program. This program, as mentioned above, primarily serves prospective elementary school teachers. Because the program must require courses that cover the breadth of topics taught by elementary school teachers, it does not have its own set of faculty and must work closely with many of the departments on campus. In particular, there is a Liberal Studies Faculty Council which serves as an advisory board for the program. The Department of Mathematics has had a representative on this council since its inception. In addition, the Liberal Studies program provides a robust advising experience for their students. The Liberal Studies program solicits advisors from the various content departments. Every semester, a faculty member from the Department of Mathematics and Statistics has served as a Liberal Studies advisor. The department cares deeply about mathematics education and consequently feels the responsibility and the desire to maintain a strong connection with the Liberal Studies program.

The PAL program has been a successful support structure for students taking courses in the College of Natural Sciences and Mathematics (NSM) since its inception in 2012. The PAL program offers support courses for several of the lower division courses offered in NSM. These support courses offer students the opportunity to collaboratively work on problems related to the content course. The activity in the support course is facilitated by a student, called a PAL facilitator, who has completed the designated content course successfully and has been trained in group facilitation and pedagogy. Over the past several years the PAL program has increased the number of courses for which it offers support. On average the program offers between 45 and 55 support sections, with 15 to 20 of those support sections in our department.

The department has a very close connection with the PAL program. Faculty within the department were involved in creating some of the original content for the support courses, and faculty have continued to be involved in the creation and editing of the curriculum as well as the training of the PAL facilitators. We currently have three faculty members that have taken on leadership roles within the program. This is an excellent support system that the department supports and works with closely. There is a concern about the decline in participation during the COVID era and the department has been discussing ways to recruit students to bring the numbers back up to a more robust participation.

The mathematics courses served by the PAL program are those required for a STEM major. However, the department believes it is important to offer support structures for as many students as possible, and we have found a promising collaboration with PARC SI. This is another program that offers support courses tied to a designated content course, and these support courses are led by students trained in the content, facilitation, and pedagogy. Over the past few years, the department has partnered with PARC to offer SI courses tied to MATH 10 (*Essentials of Algebra*), MATH 24 (*Modern Business Mathematics*), STAT 1 (*Introduction to Statistics*), and STAT 10AB (*Introductory Statistics with Developmental Mathematics*). Faculty in the department have worked with PARC to recruit both leaders and participants, as well as support the leaders during the semester. This is a newer collaboration than with PAL, but the department has seen benefit in this program and plans to work with PARC to recruit more participants.

1.8 Major Structural Changes

1.8.1 Executive Order 1110

In 2017 we had some major structural changes forced upon us due to Executive Order 1110. This order most directly affected the department by requiring the removal of all mathematics remediation at the university. Previously, students needing remediation completed coursework within the Learning Skills Center, housed in the College of Education, prior to taking any courses in our department. With the removal of this remediation, the challenge facing the department was to determine how to serve the students previously requiring remediation and do so in a way that offers them college credit for any course they must take.

The department response was two-fold. We began using a new placement system, namely ALEKS PPL, and we created two new courses to serve the students formerly beginning in remediation. ALEKS PPL, which is a placement exam coupled with practice modules, has been a success, and we continue to use it currently. The COVID era has altered our use of it somewhat as we currently allow unproctored ALEKS exams to accommodate restrictions due to the pandemic. The department plans to revisit our practice of proctored versus unproctored as we slowly transition away from pandemic related decisions.

The two new courses that were created were MATH 10 (*Essentials of Algebra*) and MATH 12 (*Algebra for College Students*). MATH 12 is designed for students in STEM majors whereas MATH 10 is designed for students majoring in subjects other than STEM that still have a specific mathematics requirement. Overall, these two courses have been implemented successfully serving the students as planned. As they are fairly new courses, the involved faculty continue to improve on the curriculum and pedagogy as they learn more from each iteration. Both courses are highly coordinated which allows faculty teaching these courses to easily collaborate and share ideas and concerns. We are monitoring the DFW rates in these courses but hesitate to make any major decisions based on those numbers as they are no doubt skewed by the disruption of the pandemic.

1.8.2 The Blended Program

The Integrated Math Major/Single Subject Credential Program, less formally known as the Blended Program, is a program that allows students to work on their bachelor's degree in math simultaneously with their single subject credential. This is a highly individualized program that provides a great deal of support to the students. Consequently, it is very labor intensive for the Blended Program Coordinator, and the program serves a very small number of students. The department sees the strength in the program but recognizes that its sustainability is in jeopardy. Therefore, this program has been on hiatus for the past few years, not accepting any new applicants. If this program is to continue in some form it will need to be restructured. The department hopes to work with the College of Education to create a program with as many of the benefits of the original Blended Program but with a more sustainable structure. Unfortunately, due to EO 1110 and the pandemic, we have not made much progress in this area.

1.8.3 Growth of the Statistics Program

The statistics program within our department is fairly small, and we have found there is a need to provide more opportunities for our students. With the goal of growing our statistics offerings and involvement, the department hired three new statistics faculty, which doubled the number of statistics faculty in the department. The new faculty, together with the veteran faculty, have been very active over the past few years. A more detailed description of these activities can be found in Section 4.1. We anticipate continued growth in the statistics program.

2 Learning

2.1 Learning Outcomes for Mathematics Majors

The department has identified five learning outcomes for students majoring in mathematics. The mathematics major at Sacramento State is expected to meet the following.

(LO1) Develop a fundamental understanding of the main strands of mathematics.

Within the mathematical community, it is broadly agreed upon that advanced study in mathematics requires a solid background in modern algebra and real analysis. These two strands represent a classical approach to the subject and are still essential learning for any modern study of the subject. Students are expected to show a basic understanding of the different methods employed in real analysis and modern algebra and be able to explain the different approaches to the material.

(LO2) Develop a fundamental understanding of the process and role of mathematical reasoning.

Professional mathematicians regard mathematical proof as the intrinsic essence of mathematics, and it is expected that undergraduates will arrive at an appreciation for the role of proof in mathematical discourse, as well as a grasp of the methods of proof that permeate all mathematical exposition. As part of the exposure to the methods of proof and the subsequent mastery of proof writing, three aspects arise in this progression.

a) Students should be familiar with common notations and proof techniques.
b) Students should be able to read, understand, and reconstruct rigorous proofs of elementary theorems in various areas of mathematics.
c) Students will be able to write elementary proofs.

(LO3) Have an understanding of and exposure to the breadth of mathematics.

During the past two thousand years the nature of mathematical inquiry has expanded to include a wide range of topics, from the classical studies of geometry and number theory to more modern subjects of interest such as graph theory, combinatorics, numerical analysis, and dynamical systems. Current mathematical studies range over a wide variety of courses and often include interdisciplinary exchanges. Students should be able to recognize the various branches of mathematics, and according to their interests, should be able to describe and understand the basic methods of study in their chosen option.

(LO4) Demonstrate an ability to effectively communicate mathematical thought.

The ability to communicate mathematical thought goes to the heart of the mathematical process and centers on the need for clear logical presentation and exposition. Students should be able to explain their solutions and proofs both orally and in writing. Students are expected to demonstrate effective communication in mathematics in a variety of ways. This could include more traditional written assignments, but also could include presentations of mathematical results such as in the capstone course or in courses where student presentations are required, in responding to questions both in formal class settings and in group settings, or in explaining mathematics to peers. This is not an exhaustive list and we expect students to practice effective communication throughout their academic career.

(LO5) Demonstrate a basic understanding of technology and demonstrate the skill to use technology.

Technological advances have changed the way some mathematical studies are now conducted, particularly in the area of applied mathematics. The use of computer-based and computational methods for certain mathematical exploration means that students need to be aware of the possible uses of technology in the mathematical arena. Students should be able to use technology both for the solving of problems as well as an aid in effective communication of their solutions.

2.2 Assessment of Undergraduate Learning Outcomes

We begin by describing how we attempt to meet each of our learning outcomes and then provide a summary of data and analysis for each of the learning outcomes.

In an effort to achieve LO1, all mathematics majors are required to take a year-long sequence in Modern Algebra as well as a year-long sequence in Real Analysis. Because mathematical reasoning and the communication of that reasoning are prevalent in all of our courses, we are continually working to achieve LO2 and LO4. The level at which students meet these outcomes will most likely progress from emerging in the lower division courses to ideally reaching mastering upon completion of the program. We recognize that not all students will reach the mastering phase and expect some students remain in the developing phase longer than others.

The importance of LO3 is reflected in the design of our program. All mathematics majors take the same set of core courses, but they are then expected, as part of their chosen emphasis, to branch out into areas beyond the core subjects. This provides students the opportunity to explore the breadth of mathematics and to recognize the reach of mathematics beyond modern algebra and real analysis. Similarly, LO5 is addressed through design of our program. All mathematics majors are required to take a lower division programming course. Students may also choose to study more computing than is offered in the basic programming course by choosing appropriate courses in the major. In addition, technology is used throughout the lower division courses to assist with computations during class time and visualizations of mathematical structures being discussed.

2.2.1 Data and Analysis for LO1

To assess LO1, we looked at grade distributions in the modern algebra and real analysis sequence. In particular we looked at grades in MATH 110A and MATH 130A between Fall 2017 and Spring 2021. To assess LO1 we focused on first attempts in each of the courses to determine how well students were meeting LO1 at that time. The table below summarizes the distribution of grades in each of the courses.

Figure 1: Student Grades in 1st Attempt of MATH 110A

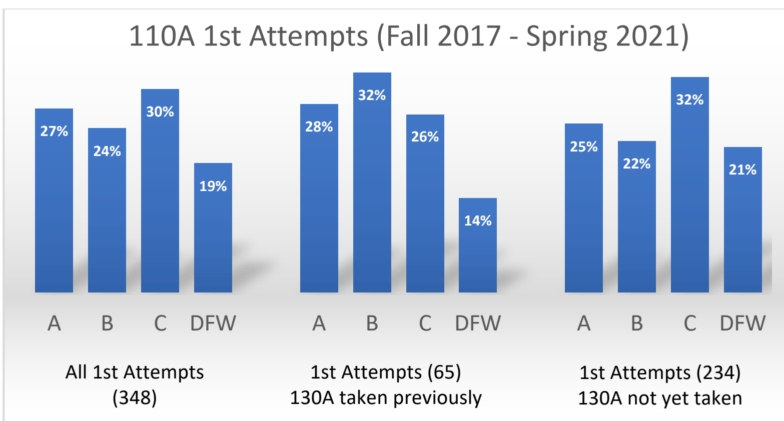
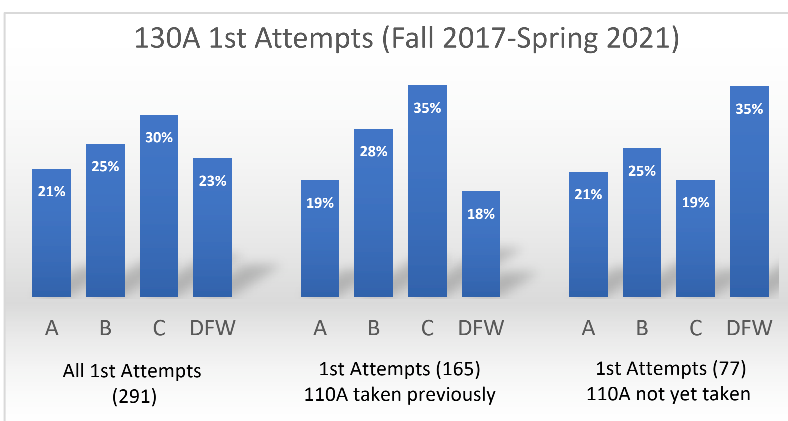


Figure 2: Student Grades in 1st Attempt of MATH 130A



It is reasonable to correlate a grade in the A/B range to be at the mastering level and a grade in the B/C range to be at the developing level. Using those guidelines, we see that about 80% of the students are in the developing or mastering range. To get a more global picture, we also computed the GPA of students' first attempt in each course and found that for MATH 110A it was 2.47 and for MATH 130A it was 2.26. The lower GPA in MATH 130A is expected as most students find MATH 130A more difficult than MATH 110A. However, it is good to see that both are easily above 2.0. It should be noted that these two sequences of courses are the most difficult courses in the major for most students.

When analyzing the grade distributions further some encouraging results were found. Students are strongly advised not to take both 110A and 130A at the same time, and we can see that the students are heeding that advice as only 49 of the 360 students did so. In addition, we usually advise students to take MATH 110A prior to MATH 130A, and again we see students heeding this advice as 234 of the 360 students took MATH 110A first. We also found evidence that this advice is justified. The charts above show the DFW rate disaggregated by prior coursework. Notice that the DFW rate for 110A overall is higher than the DFW rate for students who have previously taken MATH 130A. This is not surprising as students gain mathematical maturity as they proceed through the upper division core courses, so more previous experience should have a positive effect. Similarly, if we compare the overall DFW rate in MATH 110A with those students who have not yet taken MATH 130A we see there is a slight increase in DFW but not drastically so. However, when we make that same comparison for MATH 130A, namely comparing the overall DFW rate with those that have not yet taken MATH 110A we see that there is a drastic increase in the DFW rate going from 23% overall to 35% for those that have not yet taken MATH 110A. This data confirms that we will continue to advise students to take MATH 110A prior to MATH 130A, if possible, even though it is not technically a prerequisite for MATH 130A.

2.2.2 Data and Analysis for LO2 and LO4

Over the past few years, exam files were collected for MATH 35 (*Linear Algebra*), MATH 110B (*Modern Algebra*), and MATH 130A (*Functions of a Real Variable*). The data for MATH 35 and MATH 130A were submitted in previous yearly assessments. For MATH 35, an assessment of LO4 found that 32% were at the emerging level, 40% at the developing level, and 28% were at the mastering level. For MATH 130A, an assessment of LO4 found that 33% were in the developing phase and 67% were in the mastering phase. We note that no students were at the emerging level once they had reached MATH 130A. This progression is indicative of what should happen as students continue through the core courses.

The original intention was to use the final exams to assess both LO2 and LO4, but we found that distinguishing between the two learning outcomes within one problem was difficult. This issue is addressed more carefully in Section 2.5. However, for the current cycle we analyzed student work on MATH 110B finals to assess LO2. On this exam, one of the problems was basically a guided inquiry into a topic. Through the parts on the problem, they had to put different elements together to come to a final conclusion. This gave us the opportunity to focus on the mathematical reasoning because it was broken down in such a way that we could follow the students' logical progression even if they were not able to communicate the mathematics as clearly and concisely.

Analyzing the student work, we found that 43% of the students were at the developing level and 57% were at the mastering level. Although we would like to see a little higher percentage in the mastering level, we must acknowledge that the numbers are most likely affected by COVID. The students assessed here took their entire MATH 110A/B sequence during remote learning and although our faculty worked very hard to create as successful a learning experience as possible there is no denying that both faculty and students struggled during that year.

Further analysis of the student work beyond just assessment of LO2 provided insight into some common struggles the students were having. This information will be shared with the Core Curriculum Committee so they can discuss the results and determine potential curricular changes if needed.

2.2.3 Data and Analysis for LO3

The breadth requirement for our majors is built into the structure of the program. Depending on their emphasis, students take a variety of upper division mathematics or statistics classes. To assess LO3, we chose a random sample of 30 graduates from Fall 2017 through Spring 2021. From the sample of 30, we analyzed the elective courses they chose and their grades in those courses. For each of the students we computed their GPA for the elective courses. Note that only the successful attempts of the courses were recorded, so all GPAs will necessarily be at least 2.0. A summary of this data is shown below.

Table 1: GPA in Elective Courses Taken

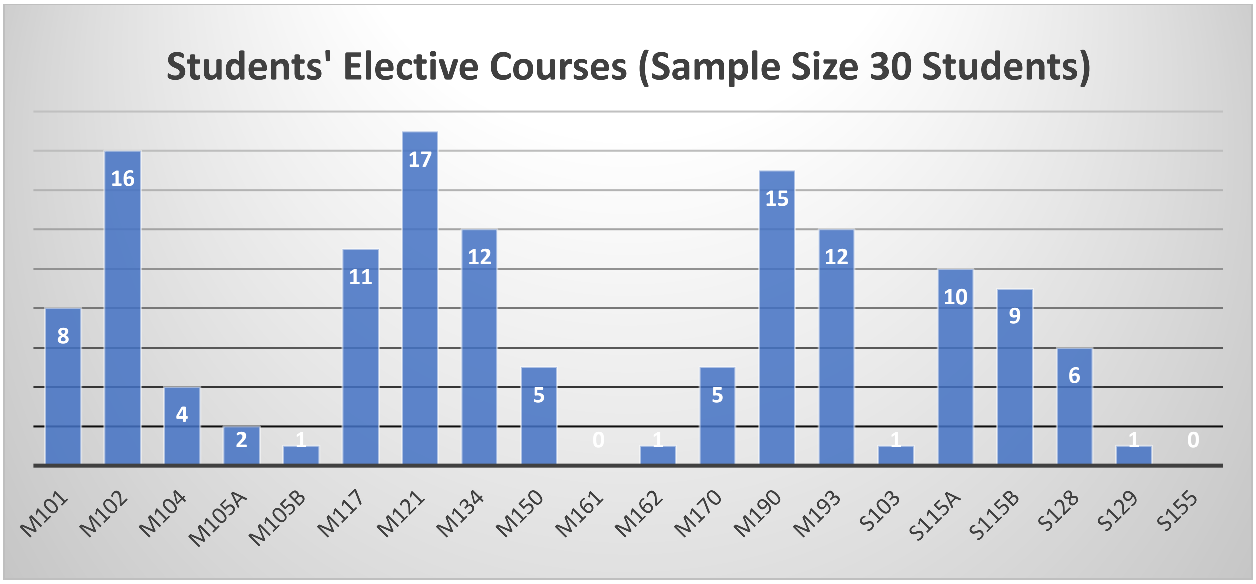
	# of Students	Percentage
GPA > 3.5	13	43%
3.0 < GPA ≤ 3.5	9	30%
2.5 < GPA ≤ 3.0	5	17%
2.0 ≤ GPA ≤ 2.5	3	10%

These numbers are very encouraging. We see that students do quite well in their elective courses, with almost 75% achieving the A/B range. These numbers indicate that students are gaining a good base of knowledge in mathematical topics beyond modern algebra and real analysis.

There are two parts to LO3, namely “exposure to” and “understanding of”. Although there are definitely some issues truly assessing “understanding”, which we discuss further in Section 2.5, the GPA analysis does provide some insight into this part of LO3. For the “exposure” part of LO3, we note that by design of the program, students are exposed to topics beyond the core. However, we still should examine how much exposure they are in fact getting. With the sample of 30 students, we analyzed how varied their choice of electives was. Looking at all of the possible combinations of courses students could take for their elective courses, we note that at the very least students will be exposed to two different mathematical areas beyond the core. Within the sample of 30 students, we found that all of them were exposed to three or more areas of mathematics beyond the core. In fact, 70% of the students took electives in which all four courses hit on a different area of mathematics. We are glad to see that the design of our program is in fact attaining good exposure to the breadth of mathematics.

Because we had already collected the data, we further analyzed the choice of courses to see what courses were chosen the most. The number of students, from the sample of 30, taking each course is shown in the chart below.

Figure 3: Elective Courses Chosen by Sample of 30 Students



We note that some courses are required for certain emphases, so those courses will naturally be taken more often, and that is reflected in the numbers above. Outside of those required courses, MATH 101 and STAT 128 are the next most popular courses to take. The fact that STAT 128 is already so popular is very encouraging because it is a newer course and this supports the department's initiative to grow the statistics program.

2.2.4 Data and Analysis for LO5

As mentioned earlier, by design of the program, students are exposed to technology through the computing requirement. However, this requirement is satisfied by a course offered in the Computer Science Department so assessing this learning outcome through that course seems somewhat inappropriate. Since we had already pulled a sample of 30 students for the assessment of LO3, we decided to look at this same sample of students to see how many of them had taken at least one mathematics or statistics course with a heavy technology component. We found that 11 of the 30 students had done so. The fact that a third of the students had exposure to technology specifically in the setting of mathematics or statistics was encouraging. In reality it is likely that all 30 students had at least some exposure to technology within some of their mathematics or statistics coursework.

The department firmly believes mathematics majors should have exposure to programming, which is why we require the programming course offered by the Computer Science Department. Even with this experience though, there is often a disconnect between the students' knowledge of programming and the application of that knowledge to mathematics or statistics. As mentioned above, we have several classes, in fact two that were recently created, that help with that disconnect by incorporating technology intentionally into the course. However, as evidenced by the data, not all students take these courses. As a result, the department has recognized a need for all majors to have a more authentic computing experience in which they use programming to develop computational skills directly related to problems in mathematics. To this end, the department has developed an experimental course to achieve these goals and plans to offer it in Fall 2022. During implementation and upon completion, assessments of the course and its learning goals will be analyzed before considering next steps in this area. Ideally, this course would become a requirement for all math majors and an obvious place in which to assess LO5.

2.3 Learning Outcomes for the Mathematics Graduate Program

The department has identified four learning outcomes for students completing the graduate program in mathematics. A recipient of an MA in Mathematics from Sacramento State is expected to meet the following.

(GLO1) Have a deep understanding of the fundamental theorems and techniques in both abstract algebra and real analysis.

Students in the master's program are required to take a year of graduate level abstract algebra and a year of graduate level real analysis. Similar to the undergraduate program, these two year-long sequences serve as the core of the program. As the culminating experience, all students must pass a comprehensive exam in abstract algebra and one in real analysis.

(GLO2) Have a mathematical sophistication that allows them to apply their understanding to problems that they have not seen before and in contexts that they have not seen before.

The ability to be creative with the application of basic knowledge is a hallmark of a sophisticated mathematical thinker. Therefore, students at the graduate level are expected to develop beyond just applying learned techniques to similarly structured settings. Students are given problems of this nature through projects, homeworks, and exams. In addition, all comprehensive exams will have at least one problem of this type.

(GLO3) Speak the language of mathematics fluently, to reason with impeccable mathematical rigor, and to do this by designing proofs of mathematical results.

A graduate student is expected to communicate mathematics smoothly and clearly. Mathematical justifications should be provided in a way that allows the reader to easily understand and justify the flow of logic. Throughout the program, students' communication of the mathematics and the rigor of their arguments is assessed and feedback is provided. Students will not pass the comprehensive exams without meeting this learning outcome.

(GLO4) Have an appreciation of the variety of major modern areas of mathematics study and of mathematical applications.

Students in the master's program are required to choose four elective courses from a required list. They are also required to take two more elective courses of their choosing with approval from the graduate coordinator. Students completing the master's program will have, by design, been exposed to a broad range of mathematical topics.

2.4 Data and Analysis of the Graduate Learning Outcomes

Learning outcomes GLO1, GLO2, and GLO3 are all assessed through the comprehensive exams. Students successfully completing the exams will necessarily have meet these three learning outcomes. The comprehensive exams are meant to be a culminating experience, and so the exams are taken after completion of both year-long sequences, and both exams must be taken in the same semester. If students do not pass both exams, they are eligible to retake them the following semester.

We looked at the data for exams taken between Fall 2017 and Spring 2021. During that time 39 students took the exams. Of those students 29 passed both exams on their first attempt, making the success rate of 74% on the 1st attempt. Of the 10 students who did not pass on their first attempt, six passed on their second attempt, leaving only 4 students who have not yet passed both exams. All 4 of those students are still currently in the graduate program, so will have another attempt at passing. Further analysis of the exams, showed that of the ten students who did not pass on their first attempt, three passed algebra but not analysis, three passed analysis but not algebra, and four did not pass either. This data does not show any trends toward one exam being more difficult than the other, so it seems the format of how the exams are written is serving us well.

We also analyzed how grades in the year-long algebra and analysis sequences correlated with pass rates. None of the students who received an A in the first attempt of all four semesters needed a second attempt on the comprehensive exams. This is in line with department expectations as a student receiving an A is deemed prepared for the comprehensive exam. Students receiving a B are deemed to have a sufficient enough handle on the material that with some extra studying on their own they could pass the comprehensive exam. Looking at the data, summarized in the table below, we see that there were students in all categories that did pass both exams on their first attempt, so the passing of the exams is not entirely determined by grades. However, there is a correlation between lower number of As and lower pass rates, so it does appear there is an appropriateness to the assigning of grades in the graduate courses.

Table 2: Pass Rates By Grade Category

	# of Students	% of Students That Passed Both Exams on 1st Attempt
No As	2	50%
One A	9	56%
Two As	8	75%
Three As	11	73%
Four As	9	100%

The comprehensive exams cannot be used to assess GLO4 since the exams cover only the two core areas of algebra and analysis. The department feels strongly that students should be exposed to some breadth of mathematics which is why GLO4 is in place. However, we do not currently have a way to truly assess this learning outcome. This is due in large part to how the learning outcome itself is stated. It is difficult to assess an "appreciation" of something. We will need to explore how to rewrite this learning outcome so that the value we find in this outcome is still met but that it can more easily be assessed. Even with a rewrite of this learning outcome, we will most likely need a less standard form of assessment. Perhaps the use of exit interviews would be helpful here. This will be something the Graduate Committee will need to address. In addition, the committee may want to explore other ways to assess GLO1, GLO2, and GLO3 which could provide learning outcome specific data rather than a global measure provided by the comprehensive exams.

2.5 Assessment Plans

The department recognizes the deficiency over the last few years in the assessment of the program learning outcomes. This is due to two main events affecting the department. The first major disruption came as a result of EO 1110 which has been briefly discussed above. With this executive order, the department's role as a service department was greatly impacted and focus shifted to meeting the needs of students formerly requiring remediation. As a result, much of the assessment focused on changes we were making within the department, but most of those changes did not directly affect our majors since few of our majors start in Math 12. Consequently, the assessment that took place did not address the program learning outcomes but rather the success of our response to EO 1110. Although EO 1110 only affected mathematics and English, the second disruption affected all of us, namely COVID. Right on the tails of our work on EO 1110, the pandemic hit. With this came the huge shift to online teaching and learning. Our faculty worked extremely hard, attending professional development workshops, analyzing the effectiveness of changes they made, and adjusting accordingly. Therefore again, assessment was shifted away from the Program Learning Outcomes during that time.

Even with the disruption to the assessment of learning outcomes, we provide some analysis and steps moving forward. A departmental assessment plan was drafted in 2017. The intended plan for assessing LO1, LO2, and LO4 was to collect exam files in the core courses to analyze. A rubric was created to assess LO2 and LO4. As described above, the rubric was used multiple times for assessing LO4. The intention was to use the same problem on an exam to assess both LO2 and LO4. However, we found that distinguishing between the two learning outcomes was difficult. In other words, being able to separate a student's mathematical reasoning from the student's ability to communicate that reasoning was difficult. As a result, the department needs to readdress these two learning outcomes. This will require either a redevelopment of the learning outcomes themselves or a redevelopment of the assessments. In reality, it will most likely be a combination of the two. We will need to discuss ways to keep the essence of the two outcomes while also rewriting them in a way that is more readily assessable. Not only will this be a good discussion for our assessment plan, but it also has the potential to drive some curricular changes in the process.

The department is hopeful that over the next few years we will be able to develop and implement a more robust assessment plan that is both sustainable and valuable. As mentioned above, this may include a rethinking and rewriting some of our learning outcomes. However, the most immediate adjustment that needs to be made is to get the department as a whole more involved in the assessment of our programs and learning outcomes. We have two standing committees that should naturally be involved with assessment, namely the Graduate Committee and the Core Curriculum Committee. The department could also consider creating an Assessment Committee if there seems to be a need beyond our current committees.

To assess LO2, and LO4 we will continue to use the final exams for the core courses. This work could be completed by the Core Curriculum Committee. In the past we have had difficulty separating the assessment of the two learning outcomes from each other. If we plan to use the final exams for assessment, then some care will need to be given to the types of problems placed on an exam. If the committee does not feel a learning outcome can be clearly assessed via a problem on the final exam, they will need to develop an alternative assessment. It is imperative that the Core Curriculum Committee is involved in this process because choices made here could affect the writing of exams and the classroom activities in the core courses. Instructors will need to be aware of the learning outcome assessment occurring within their courses.

For LO1 we will continue to analyze the grade distributions in the core courses. This provides some numerical data as to the success of students in the two main core areas of algebra and analysis. This quantitative data is valuable, but the department may want to consider a more qualitative assessment of this learning outcome. This could be achieved by use of the exit interview. Asking students to answer a question as simple as "Describe in your own words what Abstract Algebra/Real Analysis is" could provide useful information. This qualitative data may be more useful in assessing LO1 and could provide evidence of a need for curricular changes.

In assessing LO3 there are two aspects of this, namely "exposure" and "understanding". Students are definitely exposed to the breadth of mathematics by design of our program. However, this does not address the "understanding" aspect. Again, this learning outcome is difficult to assess and may need to be reconsidered. At this time, the most plausible way to assess whether or not a student understands the breadth of mathematics would be to have a question related to this in an exit interview.

In the past, the department has not found a good way to assess LO5. Students achieve this learning outcome in a multitude of ways in a variety of courses, so there is no clear means to assess this outcome. This problem is similar in nature to assessing LO3, where students achieve the breadth requirement in a multitude of ways. Obviously, a passing grade in a computing course is an indication of meeting this learning outcome, so continuing to look at grades in these courses is of some value. However, this is another area where we may want to rethink the learning outcome. The department has already begun discussions of a more specific "computing requirement" as evidenced by the creation of an experimental mathematical computing course to be offered in the fall.

In summary, a general assessment plan for the undergraduate learning outcomes is as follows.

- Final Exams in the core courses to assess LO2 and LO4
- Grade distributions provide quantitative data for LO1, LO3, and LO5.
- Exit Interview provides qualitative data for LO1 and LO3

Exit Interviews have been attempted by the department in the past, but the process used proved to be unsustainable. The schedule of the interviews was difficult and the completion rate was low. In addition, recording of the data received during the interviews was difficult to analyze because the questions were too open ended. In moving forward, the department plans to use a more streamlined process for these Exit Interviews. First of all "interview" is probably a misnomer because this implies a conversation, but we instead plan to create interview questions that the students can answer in writing. We will limit the number of questions to increase the chance of participation. In addition, the questions will be developed with specific goals in mind making the analysis of the reported answers achievable. In this document we are focusing on the assessment of the learning outcomes, however the Exit Interview will serve a purpose beyond just the learning outcomes.

For the graduate program we will continue to primarily use the comprehensive exams as an assessment of our graduate learning outcomes. However, as discussed above, the Graduate Committee will revisit the learning outcomes and revise as needed. The Graduate Committee will become more involved in the assessment and determine if a broader range of assessments would be beneficial.

3 Student Success Analysis

In order to assess student success for our majors, we will analyze graduation rates for first-time freshman and transfer students and compare these rates across gender and ethnicity subgroups. We will also assess retention by considering the percent of students who are no longer enrolled (but have not graduated) after 6.5 years for first-time freshman and after 4.5 years for transfer students in addition to the two, three, and four-year retention rates for selected cohorts of students.

When analyzing retention and graduation rates by gender and ethnicity, it is important to note that the cohort size for some subgroups within the math major can be small as shown in Tables 3 and 4 below. For instance, there were only 5 Hispanic students in the 2015-6 transfer cohort. Small cohort sizes can result in high variability in year-to-year retention or graduation rates, i.e. 2 out of 5 students graduating appears significantly different from 3 out of 5 when viewed as a percentage.

Table 3: Cohort Size and Composition for First-time Freshman Math Majors

	Total First-time Freshman	% female among Freshman	% Hispanic among Freshman
2013-2014	23	48%	30%
2014-2015	39	62%	34%
2015-2016	21	43%	32%

Table 4: Cohort Size and Composition for Transfer Student Math Majors

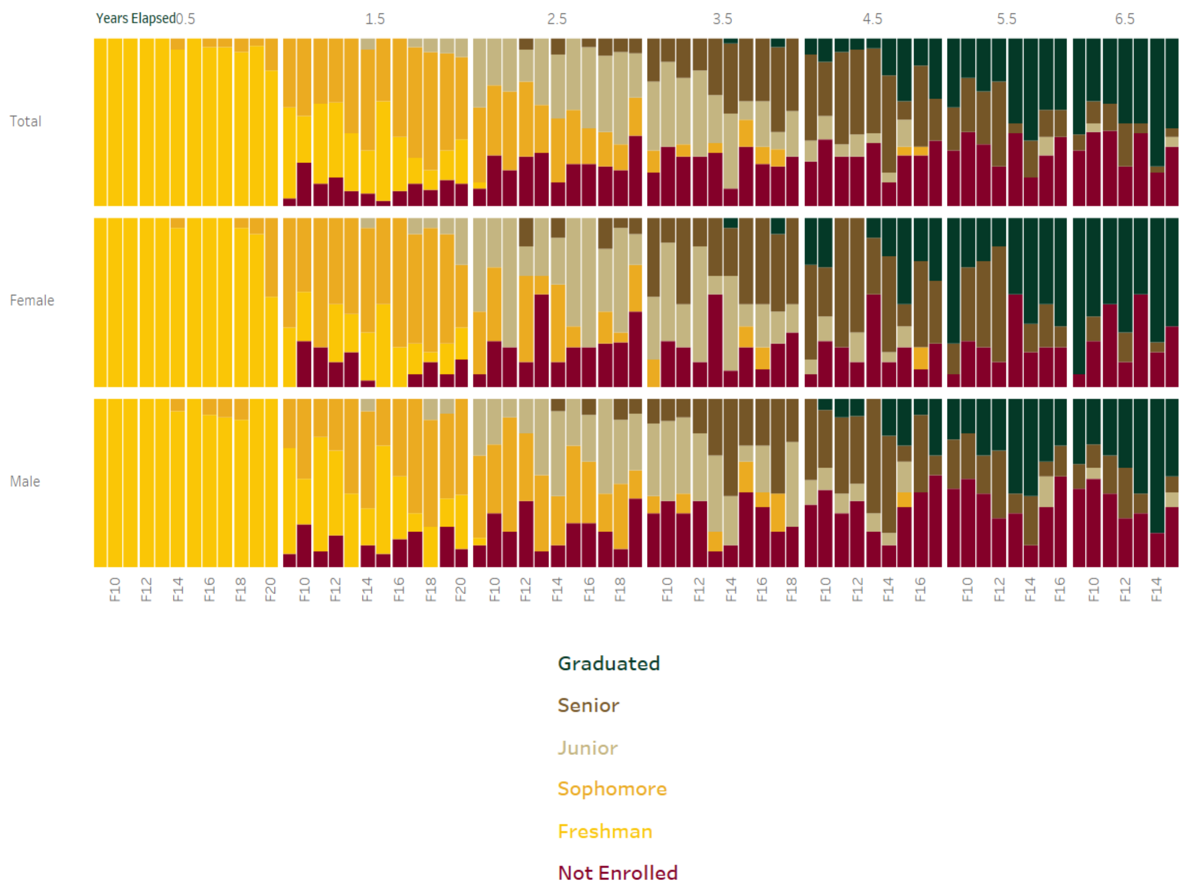
	Total Transfer Students	% Female among Transfers	% Hispanic among Transfers
2015-2016	51	41%	10%
2016-2017	55	33%	22%
2017-2018	43	44%	28%

3.1 Analysis of Graduation and Retention by Gender

3.1.1 First-time Freshman

Figure 4 shows the progression of twelve yearly cohorts of math majors who enrolled as first-time freshman from 2009 through 2020. Class level, graduation and not enrolled status are displayed using the color codes at the bottom of the graph. The top panel displays progression for all first-time freshman while the lower two panels show progression by gender. Each column represents a given elapsed time at which progression of the cohorts is measured: 0.5, 1.5,…5.5 or 6.5 years, and each column starts with the Fall 2009 cohort. The enrollment year of each cohort is shown at the bottom of the graph.

Figure 4: Student Progression for First-time Freshman – Comparison by Gender

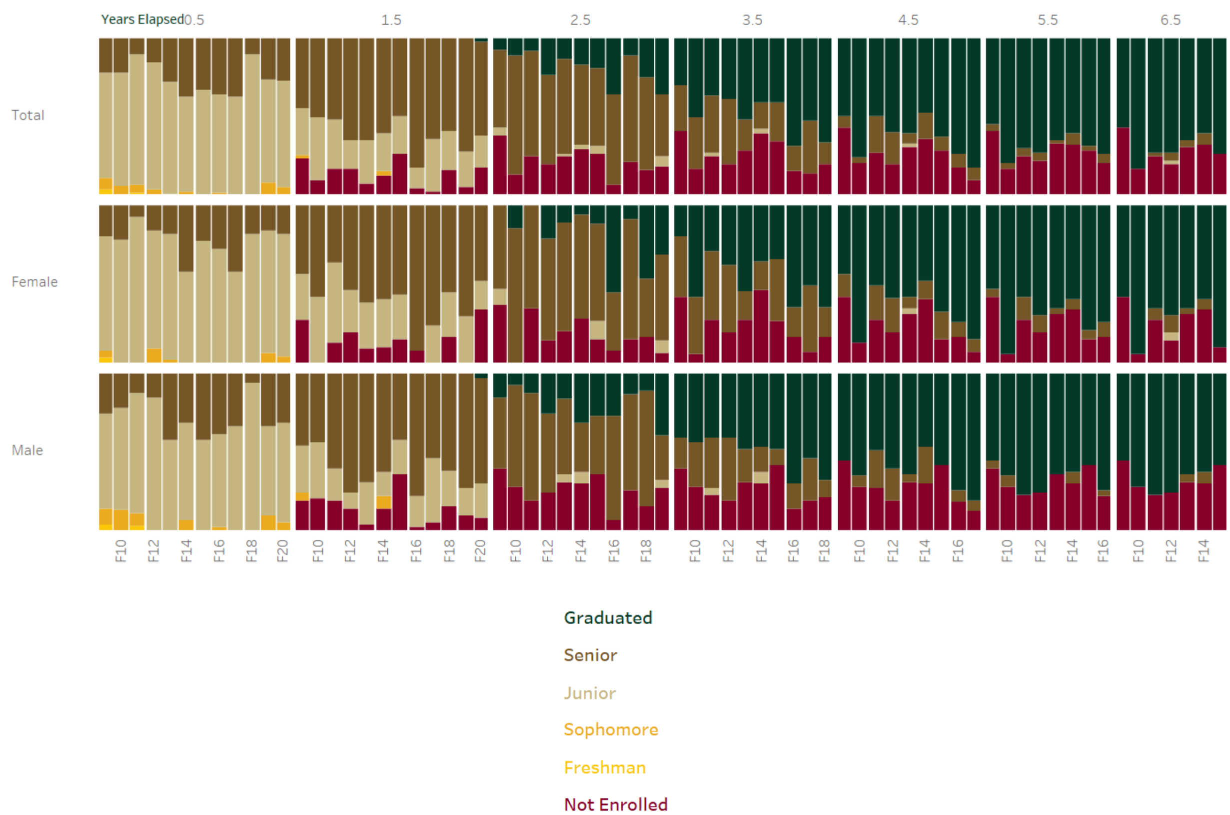


Averages of 4.5-year graduation rates include nine cohorts of first-time freshman starting with the freshman cohort which enrolled in Fall 2009 and ending with the freshman cohort which enrolled in Fall 2017 (the average of the values represented by the dark green bars in the column labeled Years elapsed=4.5 years). 6.5-year graduation rate averages include seven freshman cohorts beginning with the Fall 2009 cohort and ending with the Fall 2015 cohort. For all first-time freshman math majors, the average 4.5- and 6.5-year graduation rates were 16% and 49%, respectively. Comparing by gender, the graduation rates were lower for males at both the 4.5- and 6.5-year marks, 12% and 43%, compared to the same rates for females, 21% and 60%. In addition, the percent of males not enrolled after 6.5 years, 40%, was higher than the percent of females not enrolled after this same time period, 36%. Although there is significant variability in the 6.5-year graduation rates from year to year, there appears to be an increasing trend in the 6.5-year graduation rates for males (as shown by the generally increasing lengths of the dark green bars in the last column of the bottom panel of Figure 4.

3.1.2 Transfer Students

Figure 5 displays the progression of twelve yearly cohorts of math majors who enrolled as transfer students from 2009 through 2020.

Figure 5: Student Progression for Transfer Students – Comparison by Gender



Averages of 2.5-year graduation rates include eleven cohorts of transfer students starting with the transfer cohort which enrolled during the 2009-10 academic year (AY) and ending with the transfer cohort which enrolled in the 2019-20 AY (represented by the green bars in the column labeled Years Elapsed=2.5 in Figure 5). The 4.5-year graduation rate averages include nine transfer student cohorts beginning with the 2009-10 AY cohort and ending with the 2017-8 transfer cohort.

If we assume that transfer students begin with roughly 2 years of coursework completed, we can compare the 4.5-year graduation rate of first-time freshman with the 2.5-year graduation rate of transfer student, and the 6.5-yr graduation rate of freshman with the 4.5-year graduation rate of transfer students. We note that the 4.5-year graduation rate of first-time freshman, 16%, is slightly lower than the 2.5-year graduation rate of transfer students, 18%. Also, the 6.5-year graduation rate of first-time freshman, 49%, is lower than the 4.5-year graduation rate of transfer students, 62%.

For transfer students who are math majors, males and females have similar 2.5 and 4.5-year graduation rates. The average 2.5-year graduation rate for females is 18% compared to 20% for males. The average 4.5-year graduation rates for males and females are 63% and 61%, respectively. In addition, the percent of males not enrolled after 4.5 years, 29%, was only slightly higher than the percent of females not enrolled after this same time period, 25%.

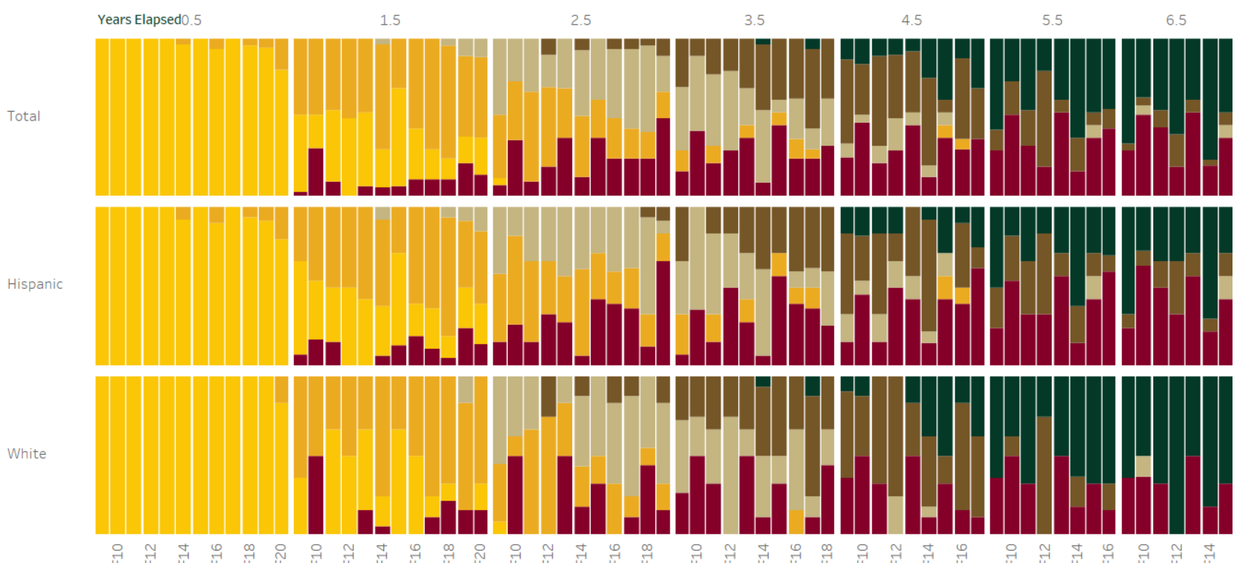
3.2 Analysis of Graduation and Retention by Ethnicity

Since the total number of math majors in an academic year cohort averages 28 for first-time freshman and 50 for transfer students, our analysis by ethnicity only considers the two largest ethnic subgroups, White and Hispanic. The number of students in other ethnic groups is too small to provide a useful analysis of graduation and retention rates.

3.2.1 First-time Freshman

Figure 6 shows the progression of Hispanic and White ethnic groups in the twelve yearly cohorts of math majors who enroll as first-time freshman from 2009 through 2020.

Figure 6: Student Progression for First-time Freshman – Comparison by Ethnicity

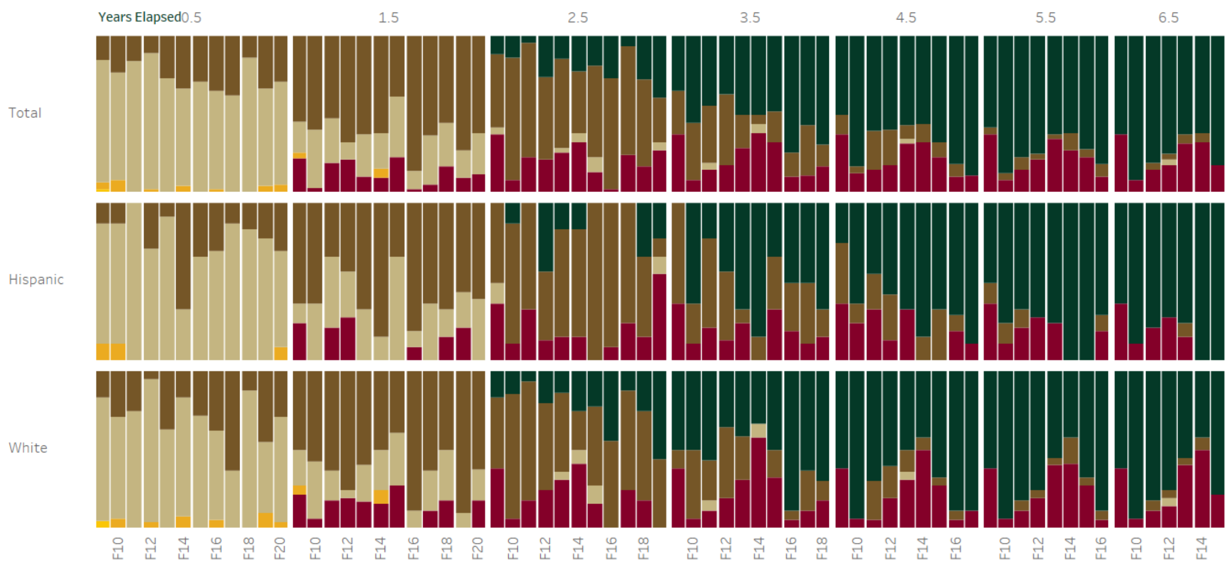


When comparing 4.5 and 6.5-year graduation rates for Hispanic and White students, we see that Hispanic rates lag behind White rates. The average 4.5-year graduation rate for Hispanics is 15% compared to 20% for Whites for first-time freshman math majors. Similarly, the 6.5-year graduation rates for Hispanic math majors, 41%, is lower than the same rate for Whites, 68%. Moreover, the percent of Hispanic students not enrolled after 6.5 years is 42% compared to 30% for White students.

3.2.2 Transfer Students

Figure 7 shows the progression of Hispanic and White ethnic groups in the twelve yearly cohorts of math majors who enroll as transfer students from 2009 through 2020.

Figure 7: Student Progression for Transfer Students – Comparison by Ethnicity



For transfer students, the average 2.5-year graduation rate for Hispanics, 13%, is lower than the same rate for whites, 20%. The 4.5-year graduation rate is also slightly lower for Hispanics compared to Whites, 63% versus 68%. However, the 6.5-year graduation rate for Hispanics, 82%, is higher than that of Whites, 69%. In addition, the percent of Hispanics not enrolled after 6.5 years is 17% compared to 27% of Whites. Thus, Hispanic transfer students tend to take longer to complete their degrees but have higher persistence than White transfer students.

3.3 Graduation and Retention Comparison to University Averages

As shown in Figure 8 below, the 4 and 6-year graduation rates for first-time freshman math majors vary from year to year (due to small cohort sizes) but are similar to university averages. Also, second, third, and fourth-year retention rates for the 2018 cohort are higher or similar to university averages.

Figure 8: Graduation and Retention of First-time Freshman Compared to University Averages

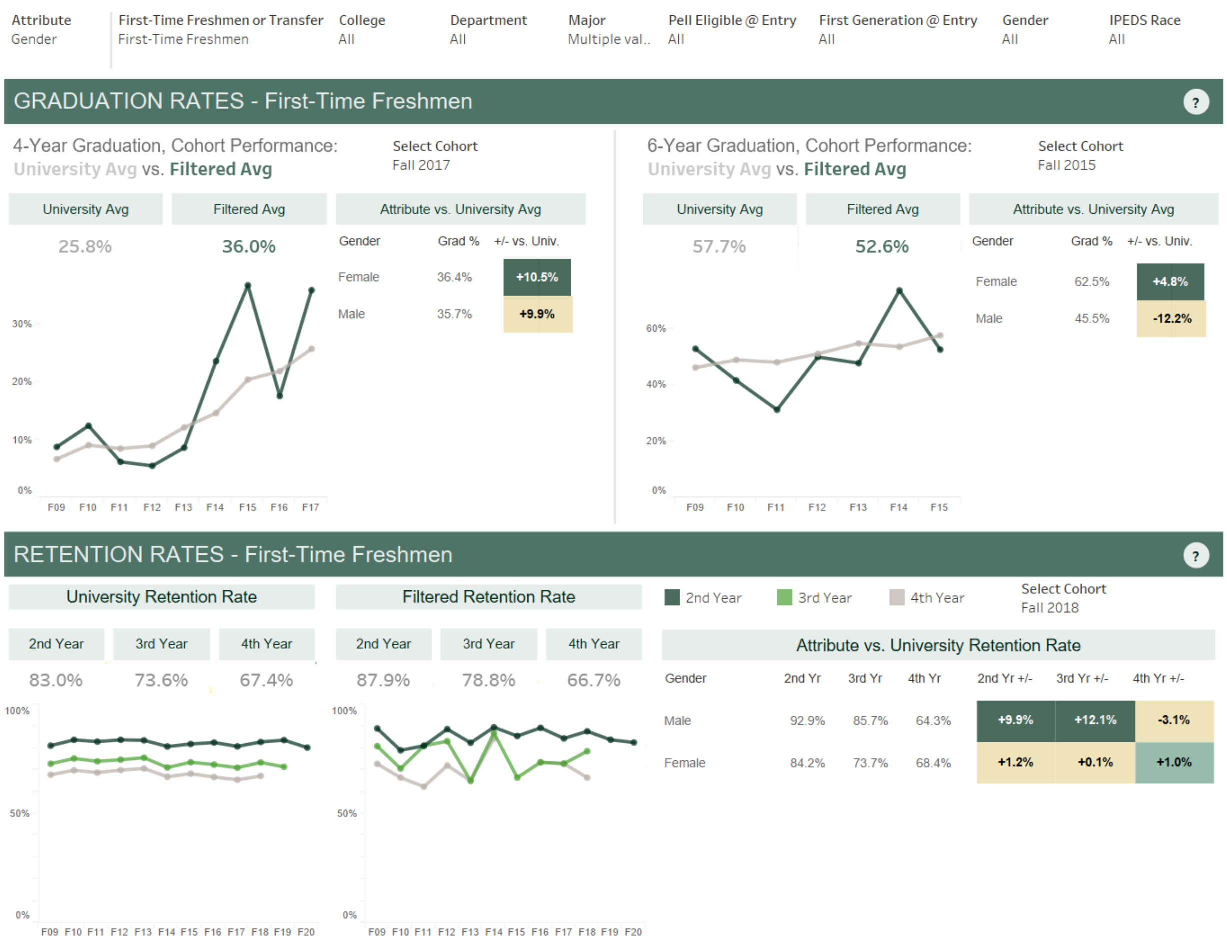
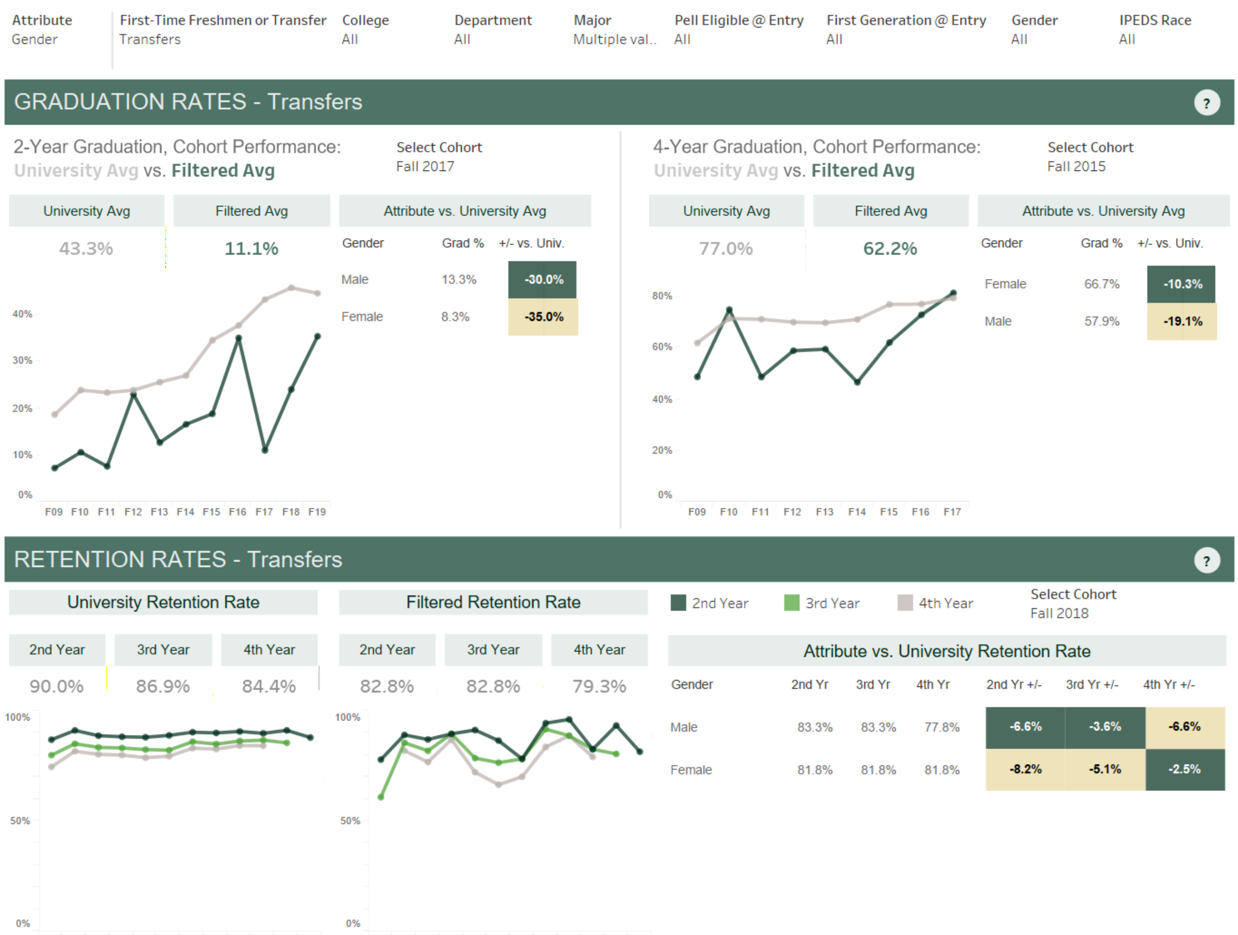


Figure 9 below shows graduation and retention rates for transfer students who are math majors by enrollment year. Transfer students have 2 and 4-year graduation rates that tend to be lower than the corresponding university rates. Second, third, and fourth-year retention rates for the Fall 2018 cohort also tended to be somewhat lower than the analogous university rates. Further research is needed to identify the reasons why transfer students in the math major lag behind university average graduation and retention rates. One possible reason is the sequential nature of the upper division core curriculum. Even if a transfer student is fully prepared to begin math major upper division coursework upon enrolling at Sacramento State, the standard recommended sequencing requires four semesters to complete due to prerequisites. If the student does not pass a core course in the standard sequence, the student's graduation must usually be pushed forward a semester.

Figure 9: Graduation and Retention of Transfer Students Compared to University Averages



3.4 Maintaining Success and Improving Time to Degree

In order to maintain our current graduation rates, the department will continue mandatory yearly advising for all math majors to ensure that students are advised of prerequisites and appropriate course sequencing. In addition, we have made some recent improvements to our major advising process so that it is more convenient for students to sign up for and receive advising. In Fall 2021, the department began offering virtual advising appointments, in addition to the traditional in-person advising, and students now have the ability to schedule advising appointments online year-round through EAB. In the past (during non-COVID times), advising was done primarily in-person during the Spring semester. It is hoped that these changes will streamline the process for students to get needed advising. They also have the potential to help our transfer students determine a more efficient path to graduation.

As discussed in Section 1.7, several departmental faculty serve leadership roles in the Peer-assisted Learning Program (PAL). A careful analysis of data for the PAL program shows that, on average, PAL students' grades are 0.32 GPA points higher than comparable non-PAL students' grades in Math 29, 30 and 31 (Shanbrom et al, to appear[1]). Thus, continuing to offer PAL supplemental instruction and encouraging our first-time freshman to enroll in PAL could help improve the graduation rates of male and Hispanic first-time freshman. Likewise, the PARC SI program discussed in Section 1.7 has the potential to contribute to the success of our majors since all math majors in the teaching emphasis take Stat 1 which is a course supported by PARC SI. In addition, PAL and PARC SI hire math majors as facilitators, and it has been shown that on-campus employment has a positive effect on student retention.

In order to ensure that we have the faculty to offer a sufficient number of sections of mandatory upper division major courses so that our majors are not delayed in graduating, it is critical that the department continue to hire tenure-track faculty. Section 4.2 further details the department's hiring needs.

4 Developing Resources to Ensure Sustainability

4.1 Strategic Initiatives

The department is in the process of planning and implementing programmatic changes at the undergraduate and graduate levels. At the undergraduate level, the department has been working over the past several years to expand our course and program offerings in statistics, data science, and computation. More recently, we have begun work on a graduate certificate in College Teaching. In addition, faculty have developed two programs, the Math Tutoring Buddies and Math Literacy Programs, that support the Anchor University initiative.

To prepare our majors and minors for expanding career opportunities in data science, we are in the early stages of developing new courses and curriculum in Statistics and Data Science. Since 2019,

[1] "Assessing student success in a Peer Assisted Learning program using propensity score matching" (with C. Esgana, M. Krauel, J. Lundmark, M. Norris, V. Pigno) *Journal of College Science Teaching*, to appear

we have hired three new tenure-line faculty with expertise in statistics, expanding our statistics faculty from three to six. The intention of the department has been to build up our statistics faculty in order to provide the human resources needed to develop and teach a well-rounded curriculum in statistics and data science. We plan for this curricular development to culminate in a program leading to an undergraduate degree in statistics as well as more options for data-science oriented minors. Curricular work began in 2015 with the offering of a new course in statistical computing (Stat 128) and has continued with a new big data course (Stat 129) which was first offered in Spring 2021. As mentioned in Section 2.2.4, the department has developed an experimental lower division computing course which we plan to offer in Fall 2022. This course will provide our majors with the opportunity to learn fundamental computational skills needed by mathematicians and statisticians -- making them more competitive for jobs in applied mathematics and better prepared for the more advanced computational work needed in some of our upper division applied mathematics and statistics courses.

At the graduate level, faculty members have proposed an outline for a program leading to a Certificate of College Teaching. Many of our master's degree students are pursuing careers that involve teaching at the post-secondary level. This program would provide these students with the opportunity to pursue pedagogical training which would increase their competence and marketability for post-secondary teaching positions. This proposal is currently being evaluated by the Graduate Committee.

Mathematics faculty members have developed two community outreach programs, the Math Tutoring Buddies and Math Literacy programs, that support the Anchor University initiative. The Tutoring Buddies Program matches students at local area high schools with no-cost math tutoring by Sacramento State students. There has been a total of 156 student visits since the program started. The Math Literacy Program is a partnership where faculty and Sacramento State students visit local elementary and middle school classes to conduct math enrichment activities. These activities are conducted in coordination with the students' teachers to ensure alignment with the classroom curriculum.

The department has long had a connection with K-12 teachers in the community through the California Mathematics Project (CMP). The purpose of the CMP is to provide professional development opportunities for mathematics teachers. The Sac State chapter of CMP is partially funded by the state, and they actively secure other funding, that allows them to offer a wide range of activities for teachers. These activities include Saturday Seminars, Reading Groups, and Summer Institutes. The Sac State chapter has been active in the community for over 15 years. During that time, we have had a faculty member from our department serve as the faculty advisor for the program. In addition, we have had several more faculty involved with the program. These faculty are involved in the development and implementation of curriculum for the professional development activities. Thousands of teachers in the area have participated in programs administered by the Sac State chapter of CMP.

4.2 Future Hiring

A major area of concern for this department is our tenure density. We currently have 27 full-time faculty and close to 50 part-time faculty. The department feels very strongly that all of our upper division courses should be taught by full-time faculty. Traditionally, faculty would only be expected to teach at most one upper-division course per semester. This is due to both the heavy preparation load as well as the heavy grading/feedback load. The majority of our upper division courses require a great deal of proof writing which is time consuming to grade. In addition, feedback on the proofs is of utmost importance, so grades alone are not sufficient for students to improve. Consequently, a much higher proportion of time is spent reading and responding to student work in upper division courses than lower division courses. Currently we are having a difficult time covering all of our upper division courses and several faculty have been asked to teach more than one upper division course in a semester.

A secondary result of the low number of full-time faculty is that very few of our full-time faculty are teaching in our calculus sequence. This means that our lower division math majors have much less exposure to our full-time faculty than in the past. Our department prides itself on our student/faculty engagement, so we see this as a major concern. If students do not get to know our full-time faculty very well until they are in upper division courses, their sense of belonging and connection could be affected. In addition, full-time faculty provide advising for our majors and if students do not get to know the faculty early they may be less likely to take advantage of advising.

Finally, over the past several years there has been an increase in students participating in undergraduate research. The department is very excited about this increase in activity and continuing to provide these opportunities is a priority. With the low number of full-time faculty we have a concern that we will not be able to continue to support all of the students interested in undergraduate research.

A large majority of the California State Universities with student populations above 30,000, have well over 30 full-time faculty with some above 40. We rank among the lowest for CSUs with more than 30,000 students. There is no doubt that we hope to hire several new tenure-track faculty over the next several years. However, the hiring process is intensive and time-consuming, so trying to hire every year may not be the best option for our department. We would like to proceed with an alternating hiring plan in which we hope to offer multiple positions during a hiring cycle, followed by a year with no hiring. Although we are in need of faculty now, we also need to balance our ability to function as a department while also going through multiple hiring cycles. Therefore, we believe a reasonable plan would be to search for three positions each in Fall 2022, Fall 2024, and Fall 2026. We are in such need that we could hire in any area at the moment. As the hiring cycles proceed, we will make decisions pertaining to areas of focus based on the current makeup of the department.

4.3 Budget Concerns and Revenue Opportunities

As COVID restrictions lift, we anticipate an increase in faculty travel for conferences and collaborations. To keep a robust research agenda, this travel is crucial for many of our faculty. In

the past, funds for travel have been limited, so we are concerned that support for these activities will again be limited post-pandemic.
The second area of concern is funding for student assistants. The funds currently being used for many student assistants are tied to COVID. With that support gone, we are concerned that the number of student assistants hired may need to be reduced. With students coming back to campus, we anticipate high demand in the Math Lab which is staffed by student assistants. In addition, the current practice for the ALEKS placement exam is for students to take it unproctored due to the COVID limitations. However, with the COVID restrictions lifted the department is considering returning to proctored placement exams. Proctoring these exams will produce an increase in the need for student assistants as well.

Technology is also a cause for budgetary concerns. Since the department is expanding its offerings of courses using modern technology, it will be important to have funding to purchase and update the computing resources used by our students. Currently, the department has a computing lab in Brighton 205 with about thirty stand-alone PCs which has been quite beneficial to our students. However, these computers will need to be updated periodically, and more computing resources may be needed as we implement additional computational classes. Also, as state-of-the-art technology evolves we may need to purchase new types of computing resources that are consistent with industry standards.

As far as revenue opportunities, the department has begun working with the NSM Director of Development, Jennifer Navarro. We will be participating in the Insider Update Event for the first time in April. This event will bring members of the community and alumni to hear about current activities in the department. This will provide opportunities for us to stay connected with the community and our alumni and recruit interested donors to support our activities. In addition to these events, the department plans to develop an internal mechanism to stay connected with our alumni. Continual connection with alumni could have potential revenue benefits, but it will also be beneficial to our program on a holistic level as well. In addition, access to alumni could also prove beneficial to the assessment of our programs.

5 Areas of Concern

5.1 Tenure Density

The department currently has far more part-time faculty than tenure-track faculty. The need for more tenure-track faculty has been addressed in multiple sections above, so we will not address it further here, but we do want to reiterate that it is in fact one of our major concerns.

5.2 Multi-section Courses

The department offers a large number of sections of several lower division courses. With the low number of tenure-track faculty, we have seen a large increase in the number of part-time faculty teaching these courses. Consistency across multi-section courses is always a concern, but with fewer full-time faculty teaching these courses there is an even greater concern because in any given semester there may be multiple part-time faculty teaching the course for the first time. In particular, the department has begun focusing on the pre-calculus to calculus sequence (MATH 29, 30, 31). Over the past few years, we have had a very active coordinator for these courses, and he has been working on providing resources to instructors of these courses. In addition, he communicates with instructors during the semester answering questions and providing support.

Although these courses are not coordinated in the way that MATH 10 and MATH 12 are, the coordinator has provided a much-needed support system to help the department offer a more consistent pre-calculus/calculus sequence. There are still concerns about the consistency of content within the courses, so the department is continuing to discuss how coordinated we would like pre-calculus and calculus to be. For example, in MATH 10 and MATH 12 weekly schedules are followed and exams are coordinated. The department does not anticipate proceeding quite that far into coordination in these courses, but we are still exploring improvements that we may want to make in this arena. With that in mind, we recently collected a sampling of final exams in these courses over the past few years. A small group of faculty plan to analyze these final exams for consistency in content and difficulty. We hope that collecting this data will highlight areas to focus on in improving the coordination. We anticipate this to be an ongoing effort over the next several years. We recognize that there will always be differences across sections, but we want to address any issues we see that could potentially affect overall student success both in the calculus sequence and beyond.

5.3 The Two-Building Problem

Another significant obstacle to the effective functioning of our department is the physical separation of our faculty, staff, graduate students, and allocated classroom space into two different buildings, Brighton Hall and Shasta Hall, that are quite distant from each other. It takes about 20 minutes for a round trip walk between these two buildings -- making it difficult for faculty, staff and students to have the frequent casual interactions that came to be the norm when everyone was housed in Brighton Hall. Faculty frequently bumped into each other when checking their mailboxes, making copies, or simply walking down the hall in Brighton to and from their offices. These interactions created a natural space for conversations about teaching, research, students, and other departmental concerns and facilitated the integration of new faculty into the department in an organic manner.

Since the department was split between Brighton and Shasta Halls in 2018, nine new tenure-track faculty members and about twenty new part-time faculty have been hired, and the department anticipates hiring many new faculty in the coming years to keep up with the growth in demand for classes. Many of these new faculty members have just finished their graduate degree and are new to teaching and/or to our university. Consequently, it is especially critical that they have access to and tangible support from our administrative staff and the chair as well as mentoring from a broad spectrum of departmental colleagues including members of the Primary RTP committee. However, the current physical split means that the administrative support staff and chair reside in Shasta and the faculty are split roughly 50-50 between Brighton and Shasta. As a result, new faculty receive less than ideal support as they transition to their role as a tenure-track faculty member or part-time lecturer here at Sacramento State. Not only does the separation effect new faculty, numerous faculty collaborating on research, committee work, workshop/conference organization, or other professional projects have found themselves residing in separate buildings, which unnecessarily hinders their progress.

In addition, when all faculty offices were in Brighton and classes were held in close proximity, vital student-faculty interactions were more common. Students were more likely to follow faculty to their offices after class to ask questions or to drop into a faculty member's office for a quick clarification on homework they were working on in the Math Lab (also in Brighton Hall). These frequent, impromptu faculty-student interactions build a support system which is critical to many of our students' success. However, under the current circumstances, students may have class in locations very remote from their instructor's office and remote from their other classes. Thus, instead of getting needed help, students sometimes have to rush off to make it to their next class on time and may be more reluctant to make a 20-minute round trip to get 10-15 minutes of help on a problem they are stuck on.

Another problem with our current configuration is that students are often confused about where to access various department resources (administrative help with class registration, in-person advising, meeting with the chair, etc), and faculty in Brighton report often having to direct students to the department office in Shasta. Many of our students juggle work, family and school -- figuring out how and where they can get help with their math should be as uncomplicated as possible. Placing all math department faculty, staff, and resources close together in a convenient location on campus will go a long way toward providing robust support for our students' academic goals as well as enabling our faculty to function and collaborate as effectively as possible.

We spoke with several students about their thoughts on how the distance between the two buildings has affected them, which we have summarized above. Both faculty and students agree that in spite of all of us making our best efforts, this is still a major problem. In the words of one of our students, "Overall, there is a sense of brokenness, like a separation, not united." Although we will continue to work on building a sense of community as best we can, we hope to find a more appropriate location that will once again allow us to be united.

California State University, Sacramento Mathematics Department External Review

By Matthew G. Jones and Michael Bice

Conducted based on a virtual visit on February 28 and March 1, 2022 and accompanying materials, primarily the department self-report. The virtual visit consisted of meetings with Chair Kimberly Elce, Graduate Coordinator Tracy Hamilton, a meeting with five graduate students, a meeting with undergraduate students, a meeting with department professional staff, a meeting with Interim Associate Dean Shannon Datwyler, and three meetings with Math Department faculty, one with full-time faculty, one with statistics faculty, and one with lecturer faculty.

The department **mission, learning outcomes and assessments, and goals** align well with the campus and are appropriate to the program. The report provides appropriate data and analysis of learning outcomes for each program, graduate and undergraduate. Students receive appropriate support, particularly in lower-division courses, through the math lab, and are supported throughout the program by caring and committed faculty.

The department is focused on **student success**. Data provided in the self-report show that males and females have similar graduation rates. Hispanic students entering as first-year students lag in their graduation rates, and transfer students of Hispanic origin have lower graduation rates at 2.5 and 4.5 years, but higher rates at 6.5 years.

The department utilizes its **resources** to the best of its ability, particularly with regard to operating tutoring and learning assistance through the math lab, PARC, PAL, and SI programs. However, the department seems to be under-resourced and struggling to maintain basic functions in some areas, such as contact and communication with students, primarily due to a lack of faculty. The department also struggles with its split physical presence, with space in two buildings located across campus from each other.

The department has an advisory board and is engaged in **planning** for the future with stakeholders in mind.

Commendations:

- The department coordinates Math 12, the college algebra course for STEM majors, an assignment of a lecturer faculty member. This is particularly critical as this course is taught by graduate students, many of whom have no prior teaching experience, or who have only been Supplemental Instruction leaders in the past. This effort at coordination also has the benefit of providing a more equitable learning experience for all the students in the course, and ensuring greater student success through the pedagogy advocated in the course training and meetings.
- The department makes an effort to support instructors in other lower-division courses through coordination. These faculty were seen as helpful resources by the lecturer faculty teaching those courses.

- The department has made several successful hires, particularly in the area of statistics and data science.
- The department has developed some coursework in statistics and data science.
- Department harmony and the sense of community is high. There were no signs of competing factions or rival groups among faculty, and staff expressed appreciation for the department and the work of current and past chairs. Lecturer faculty felt that they were included and that their opinions were given due consideration, particularly as they impact the teaching and revision of introductory courses.
- Undergraduate students expressed their appreciation for most department faculty, whom they felt were largely using active learning and who they believed demonstrated caring for their students.
- Undergraduate students appreciated many aspects of the structure of the major and expressed support for the training in pure mathematics as an avenue for their development.
- Undergraduate students appreciated the math lab and Peer Assisted Learning (PAL) as a source of support for lower-division courses.
- Program faculty made significant changes in the wake of EO 1110 that have sustained the success of the students, particularly in foundational coursework.

Recommendations:

- Faculty may wish to examine the alignment of the undergraduate curriculum and faculty advising. Undergraduate students expressed some interest in improving the alignment of coursework, particularly to make for more common prerequisites for some upper division proof-based courses. They also felt that students were sometimes steered away from particular emphases, and from courses that were being made especially and unnecessarily difficult based on the faculty assigned to teach that course.
- Undergraduate students reported that website information was out of date and there was a need for updated information about requirements, due dates, and events. The department may wish to consider setting up a group in the campus LMS (Learning Management System) to communicate information to majors.
- The department's tenure density appears to be far out of alignment with other CSU campuses and a major impediment to the department's ongoing efforts to serve students. Data suggest that very few courses at the level of calculus 1 and 2 are taught by tenure/tenure-track faculty. This has negative consequences for the kind of relationship-building that is important for long-term success of individual majors as well as the health of the program, since students are recruited and retained in the major based on their experience in these core lower-division courses. The department faculty were praised for their commitment to students, yet few students in lower-division courses get to know these committed tenure/tenure-track faculty. Both reviewers found the lack of tenure-track faculty teaching calculus to be a departure from their own departments as well as several other CSU mathematics departments with which they are familiar.
- Tenure/tenure-track faculty demonstrate signs of significant fatigue. The department service burden is an impediment to the kind of productive work necessary to move the

department forward, for instance in curriculum development. The campus and the college would benefit from an investment in the department.

- The department tenure-track search process is unnecessarily burdensome on the department. Currently, a committee of the entire department does the work after the initial screening. This is contributing to faculty fatigue. Given the urgency of the need for more faculty, the department needs to find ways to entrust a small committee to conduct the vast majority of the search, and to enable that committee to seek consultation with the entire department at the stage of formulating its final recommendations.
- Department harmony and the sense of community shared with students is threatened by the current physical separation of the department into separate locations some distance apart on campus. This was a strong concern expressed by faculty and students alike at most meetings during the site visit. While a long-term solution is unclear, it would seem that a swap of some offices with other departments in the current building or in the adjacent buildings might provide a temporary and low-cost solution.
- Given the faculty fatigue, the college and the department are encouraged to explore other efforts to relieve overly burdensome workloads. This might include managing class sizes and using the savings to employ course graders.
- The department may wish to examine its practices regarding building and office access, as lecturer faculty reported being unable to access their offices, the break room, or classrooms outside of normal building hours. The current practice prevents these faculty from being able to grade or print exams on weekends, for instance.
- Ensure that regular observations of part-time faculty teaching are performed, especially since the number of part-time faculty has grown recently. Based on the small sample of instructors who met with reviewers during the visit, there was a wide variety of experiences with the frequency of observations. A variety of full-time faculty performing the reviews would allow part-time faculty to benefit from different viewpoints and perspectives.
- Statistics faculty are currently exploring the development of additional curriculum, a statistics major, and a certificate in data science. The department may wish to explore how to allocate resources and release time for statistics faculty to pursue these in more depth.

Graduate program:

Commendations:

- The department coordinates Math 12, the college algebra course for STEM majors. This is particularly critical as this course is taught by graduate students, many of whom have no prior teaching experience, or who have only been Supplemental Instruction leaders in the past. This effort at coordination also has the benefit of providing a more equitable learning experience for all the students in the course, and ensuring greater student success through the pedagogy advocated in the course training and meetings. (This commendation is repeated since it impacts both programs.)
- Department harmony and the sense of community is high. Graduates cited a strong sense of community which manifested both as a cooperative atmosphere among students and a sense of support and welcome they felt from faculty.
- The graduate coordinator runs an orientation that sets the tone for the sense of community felt by the students in the program.
- The department has offered some panels of master's program graduates to provide an opportunity for students to understand career opportunities. (The department would benefit from continuing and perhaps increasing this practice.)

Recommendations:

- Communication with graduate students: Graduate students expressed confusion at some key points, particularly prior to orientation, when they did not yet understand the implications of their course choices, as well as expressing a desire for reminders about campus deadlines (e.g., for the application for graduation). The department may wish to consider how Canvas is used to communicate information to graduate students.
- Graduate students showed significant interest in receiving more advising support at the beginning and throughout their graduate program. This could be done through a second faculty graduate advisor or the graduate student representative, a position that seems to be underutilized.
- The department would benefit from greater support and more substantial training of graduate TAs prior to the start of the semester. Again, these are often students with no prior experience as classroom instructors. This would likely require additional support for the Math 12 course coordinator. Graduate TAs would also benefit from teaching a wider variety of classes beyond Math 12, as several students are pursuing community college teaching careers.
- While the comprehensive exams appear to be operating successfully, graduate students expressed interest in a thesis option. Given systematic obstacles to appropriate compensation for supervision, this may or may not be a worthwhile option to consider.

Internal Review Report

Internal Review Report:	Department of Mathematics & Statistics
College:	Natural Sciences and Mathematics
Mathematics and Statistics Degree Programs:	BA in Mathematics
	MA in Mathematics
Internal Reviewers:	Sharon Furtak, Department of Psychology, SSIS
	Clinton Collins, Department of Biological Sciences, NSM
Date Submitted:	April 12, 2022

I. Self-Study:

The Department of Mathematics and Statistics submitted its self-study in Fall 2021. It consisted of a 30-page document that included five sections that described their mission and programs, outlined program learning objectives and assessments, analyzed student success in their programs, described strategies to develop resources to ensure sustainability, and addressed areas of concerns. The Department offers an undergraduate major with one of four possible emphases (Applied Mathematics, Pure Mathematics, Statistics, or Teacher Preparation), two undergraduate minors (mathematics and statistics) and a graduate master's degree. The undergraduate major focuses on building a foundation in real analysis, modern algebra, and mathematical reasoning while providing an exposure to the breadth of mathematics. In addition, the major requires basic knowledge on the use of technology in computing mathematics and the ability to communicate mathematical thought. In the graduate program, the focus is on a deep understanding of theorems and techniques in abstract algebra and real analysis, the application of mathematics to new problems and contexts, the communication of mathematics by designing proofs, and an appreciation of modern areas of mathematic study and application. In the curriculum at the undergraduate and the graduate level, there are yearlong sequences of courses in algebra and real analysis. There are approximately 300 majors, 110 minors, and 30 graduate students.

The Department of Mathematics and Statistics is also a large-scale service department. The Department supports 13 courses that fulfill the GE Area B4 requirement. The Department also serves several majors outside Mathematics by offering courses required by several majors on campus. In 2017, there were widespread curricular changes due to Executive Order 1110 that mandated removing remediation courses. As a result, the Department has dedicated significant effort and time during the period under review to developing and offering two new courses serve students in need of remedial instruction. The Department maintains an external educational partnership with the PAL (Peer Assisted Learning) Program and created a new external partnership with PARC (Peer and Academic Resources, Supplemental Instruction) to support student success in these new courses. There have been three recent hires in the area of statistics and the Department has been working to expand its offerings in statistics and data science, two quickly growing and high-demand fields.

<u>Student learning</u>: The Self-Study assessed student attainment of all five undergraduate Student Learning Outcomes (SLOs) and three of the four Graduate Learning Outcomes (GLOs). There was acknowledgment that while a robust plan for assessment of the LOs was created in 2017, this plan was not implemented due to disruptions related to addressing EO 1110 and the pandemic. The assessment presented in the Self-Study was extensive and conducted with accessible data.

BA in Mathematics: The SLOs were assessed using final course grades, final exam performance in a subset of courses, and course selection in 30 randomly selected students. Data was examined between Fall 2017 and Spring 2021. Grades in the A/B and B/C range were viewed as mastery of concepts and developing knowledge of concepts, respectively, in the coursework. Analysis suggests that 80% of students were either at a developing or mastering range for SLO1 (fundamentals of the main strands of mathematics). Additional evidence supported those students that adhere to advising in sequencing of courses are more successful in the coursework. Analysis of data related to LO2 and LO4 found that students progress in their acquisition of these SLOs over the courses required in the major. For example, SLO4 was examined by final exams in MATH 130A; at this stage in the curriculum there are no students at an emerging level and the large majority show mastery of the content. For LO3 and LO5 the Department randomly sampled 30 students between 2017 and 2021 and analyzed GPA, course selection and final grades. Based on GPA, roughly three-quarters of this sample were mastering mathematics beyond core math of modern algebra and real analysis, displaying good breath. In that same group of students, one-third of students had taken at least one course with heavy integration of technology, suggesting a greater emphasis on computing experience using programming.

MA in Mathematics: The assessment of Graduate Learning Outcomes (GLOs) focused on the first three. Successful passing of the two comprehensive exams necessary for degree completion between Fall 2017 and Spring 2021 were used to assess GLO1, GLO2, and GLO3. Three-quarters of students were successful at passing both exams on their first attempt, with an additional 15% passing on the second attempt and the remaining students currently still in the program. Additional analysis indicated that grades in graduate coursework were positively correlated with successful completion on the first attempt of the exams. There is need to develop an assessment strategy for GLO4.

<u>Student Success</u>: The Self-Study examined retention and graduation rates in first-time freshman by gender that included nine cohorts from Fall 2009 to Fall 2017. It was noted that some groups have low representation within the math major. Analysis indicated that the graduation rates between males and females were similar at the 4.5-year mark and females outperform males at the 6.5-year graduation rate. In transfer students, graduation rates were similar between males and females at both 2.5 year and 4.5-year time points. A similar analysis was conducted by ethnic groups in first-time freshman from 2009 through 2020. Results indicate some inequities among groups. For example, Hispanic math majors graduated at lower rates relative to White math majors at the 4.5- and 6.5-year time points. This difference in graduate rates between White and Hispanic math majors is apparent in transfer students although low sample sizes resulted in high variability in graduation rates. Additional analyses show that students engaged in educational resources, such as PAL and PARC SI, graduate sooner.

<u>Operations</u>: The Self-Study notes the addition of three new faculty to help expand offerings in statistics and data science. There was also a stated need to develop further the number of faculty within these areas where demand is quickly increasing. There is a necessity for additional full-time faculty to increase tenure density and to support core curriculum offerings. Currently, the number of full-time faculty can't support these courses due to workload issues. The lack of student contact with full-time faculty early on in the major could result in a lack of students' sense of belonging. The Self-Study also remarked on the significant impact of the physical division of the Department across two buildings that have led to a breakdown in communication and feelings of concern expressed by faculty, staff and students.

II. External Review:

The external reviewers were appropriate given their positions within other mathematics departments at other CSUs. Dr. Matthew Jones is a full professor and chair of the Department of Mathematics at CSU Dominguez Hills. Dr. Michael Bice is a professor and chair of the Mathematics Department at CSU Stanislaus. A visit occurred virtually on Feb. 28th and March 1st of this year (2022). The visit agenda allocated time with the Chair, Graduate Coordinator, the Associate Dean, full-time and part-time faculty, staff, and students. The resulting report was thoughtful and provided useful context in the evaluation of the Self-Study. In particular, the external report noted the impact that EO 1110 had on the department and the level of sustained success of students in foundational courses. Several strengths were noted, including the role of graduate students in instructing Math 12, coordinating lower-division courses among lectures, expanding the statistics faculty and a focus on new course offerings in this topic, the sense of harmony among stakeholders, and appreciation from students in the support and care faculty devote to training in mathematics. The external reviewers acknowledged the importance of student support structures such as the math lab and Peer Assistant Learning (PAL). The external reviewers also noted several recommendations pertinent to the long-term success of the programs in the Department. For example, needing to address that students voiced being advised away from courses and topics within mathematics due to difficulty of the instructor, the need to overhaul an out-of-date website, an immediate need to address tenure density issues in light of the large service role of the Department, the amount of fatigue expressed by the faculty, the impact on stakeholders by the physical split in the Department by location on campus, a need for regular observation of part-time faculty due to high variability in student experiences, and resources to support new statistics and data science offerings.

III. Internal Feedback:

The internal review is based on the consideration of the Self-Study and the external review report. Many of the recommendations outlined by the external review were routed in contextual impressions from the visit. This allowed the internal reviewers a broader understanding of the Department from the viewpoint of students and faculty. Here, the internal review offers feedback that at times reiterates external reviewers' recommendations, while also extending to provide feedback on some seemingly immediate needs. Of note, assessment results conveyed in the Self-Study supports that the overall curriculum for the major and the graduate program are effectively supporting students' ability to accomplish the stated Learning Outcomes. As part of the program review the Department of Mathematics and Statistics will develop an Action Plan for the next six years to outline priorities and next steps most relevant to the future success of the Department.

Undergraduate Programs

- To maintain success the Department is encouraged to explore additional external educational partnerships that could extend support and resources to students in foundational mathematics courses. The Department should continue its current engagement in the PALs and PARC SI programs.
- To improve student learning reconsider whether sequencing courses through pre-requisites would be a good alternative to current student advising strategies on preferred order of courses. Students voiced a desire for additional pre-requisites for courses to support suggested sequencing. Moreover, assessment of the SLOs highlighted the importance of course sequencing to student success. The Self-Study reported that students who completed course work in sequence as advised (taking MATH 110A prior to MATH 130A) experienced success at higher rates than those who did not.

- To improve acquisition of Student Learning Outcomes (SLO) 5, prioritize the development of experimental courses that incorporate technology in the classroom. As noted in the Self-Study this will help to connect students' knowledge in programming to applications in mathematics and statistics.
- To improve assessment of the SLOs, revisit your assessment plan of all five SLOs. As stated in the Self-Study, original assessment strategies were not implemented due to disruption from addressing EO 1110 and the pandemic. The Department outlined an appropriate assessment plan moving forward. The Department is encouraged to create a plan on how to implement data collection needed for the assessment in the next review cycle.
- To improve student success in graduation rates among ethnic minorities consider targeted support of resources and advising. In particular, consider addressing how Hispanic math majors could be better supported through advising and/or support resources (PALS and PARC SI) to increase graduation rates.
- To build resources that enhance the student experience consider strategies or allocate staff support dedicated to maintaining an up-to-date website for current majors.

<u>Graduate Programs</u>

- To improve the students' experiences consider strategies that would increase support, resources and advising to graduate students. Students expressed a need for an increase in communication and advising. Consider whether a Canvas course for graduate students could serve as a secondary mode of communication about important University deadlines. Creating an advising tool could help students to self-monitor their progress in the program and suggest a preferred course sequence.
- To improve the students' experiences with instruction of mathematics courses consider how the Department could help development of core teaching practices prior to instruction experience through workshops, resources on campus (such as CTL) or the development of a required course. Another possibility maybe to create an offering that could serve both the undergraduate Teacher Preparation emphasis and the graduate program simultaneously.
- To improve the assessment of student learning create an assessment that aligns with evaluation of Graduate Learning Outcome (GLO) 4. Currently, this GLO is not assessed.

<u>Operations:</u>

- To improve operational effectiveness, begin conversations with the Dean regarding an immediate need to address tenure density, faculty fatigue, and advocating for temporary resources necessary to build the statistics and data science offerings. Attention should be drawn to the large number of resources the Department dedicates to GE offerings and serving other Departments. The conversation should also highlight the consequences of students not having the opportunity to build rapport with the full-time faculty in introductory courses. Additional hires of full-time faculty could help address this issue. Currently, students rarely interact with full-time faculty as they begin the major, which could lead to a lack in the sense of belonging among majors, especially in underrepresented student populations.
- To ensure sustained harmony among faculty, staff and students begin advocating for shared space that isn't physically divided or create innovative ways to bring stakeholders together regularly in collaborative environment.
- The integrated major/credential blended program does not appear sustainable in its current form. Consider whether these resources could be put to better use elsewhere or consider pausing the program until it is restructured in a manner that ensures sustainability.

Action Plan

Program: MA in Mathematics
College: Natural Sciences & Mathematics
Date: 8/11/2022

Program Review Finding	2 YR	4 YR	6 YR
To Maintain Success			
Graduate students report a strong sense of community which manifested both as a cooperative atmosphere among students and a sense of support and welcome they felt from faculty.	Continue to support and refine the graduate student orientation that sets the tone for the sense of community felt by the students in the program.		
The department has offered some panels of program graduates to provide an opportunity for students to understand career opportunities.	Seek community and career partners and sponsorships to expand the panels that share opportunities for MA Mathematics.		
To Improve Student Learning			
Program learning outcomes and assessment plan need to be re-examined.	Create a Department Assessment Committee. Revise the learning outcomes and assessment tools for the MA in Mathematics Comprehensive Assessment Plan.	Assess at least half of the program learning outcomes and produce considerations for improvement.	Assess all of the program learning outcomes and produce considerations for improvement.
Graduate students gain valuable experience by teaching Math 12. However, most graduate students have no or minimal teaching experience. The department would benefit from greater support and more substantial training of graduate TAs.	Offer a professional development workshop for all Math 12 TAs prior to the start of fall semester.	Provide ongoing support and training for Math 12 TAs via a 1-unit course.	
To Improve Student Success			
Graduate students expressed confusion at	Convene focus groups to identify	Experiment with new or enhanced	Gauge impact of new or enhanced

some key points and a desire for better communication.	opportunities on when and how to communicate information to the graduate students.	communication methods.	communication methods and adjust as needed.
Graduate students showed significant interest in receiving more advising support at the beginning and throughout their graduate program.	Graduate Committee considers options to improve the advising plan. Consider using peer advising.	Experiment with the recommendations from the Graduate Committee for a new advising plan.	Gauge impact of new advising plan and adjust as needed.
Department harmony and the sense of community is threatened by the current physical separation of the department into separate locations some distance apart on campus. This was a strong concern expressed by faculty and students alike.	Work with the dean to advocate for options inside and outside NSM that can bring the department physically closer together.	If no internal solution can be found, work with the dean to broaden the scope of potential solutions by making the department's space concerns a university priority.	Entire department is located in a single or adjacent buildings.
To Build Partnerships and Resource Development to Enhance the Student Experience			
There is the potential to work with other graduate programs that utilize a significant number of TAs to enhance TA support and training on campus.	Define potential graduate programs with which collaboration is feasible and explore opportunities for collaboration.	Experiment with cross department collaborations to enhance TA support and training.	Gauge impact of the new collaborations and adjust as needed.
To Improve Strategic & Budget and Operational Effectiveness and to Ensure Sustainability			
The department's tenure density appears to be far out of alignment with other CSU campuses and a major impediment to the department's ongoing efforts to serve students. With the growth of the graduate program, coverage of graduate courses has become extremely difficult.	Add 1-3 tenure line faculty capable of contributing to instruction within the graduate program.	Reassess graduate program instruction needs and adjust the hiring plan accordingly.	Attain a sufficient pool of tenure line faculty to sustain and potentially grow graduate program offerings.

Department Chair: Kimberly R. Elce Signature: Kimberly Elce (Aug 11, 2022 11:57 PDT)

College Dean: Lisa Hammersley Signature: