CALIFORNIA STATE UNIVERSITY EAST BAY

ACADEMIC SENATE

Committee on Academic Planning and Review

College	Science
Department	Mathematics
Program	BS and MS
Reporting for Academic Year	2016-2017
Last 5-Year Review	2010-2011
Next 5-Year Review	2017-2018
Department Chair	Julie Glass
Date Submitted	10/20/17

ANNUAL PROGRAM REPORT

I. SELF-STUDY

A. Five-Year Review Planning Goals

Our last five year program review was in 2010-11. The goals listed in the plan for that review included issues regarding students, curriculum, faculty and support. We work to continuously improve in all of these areas.

1. Students
   a. Majors: The Department continues to provide high caliber, creative undergraduate and graduate programs for our majors. The challenge is to retain high quality regular faculty and to maintain a large enough student demand in order to be able to provide courses for our majors. We are working to improve recruitment into the major by incorporating innovative pedagogy, technology, and applications into many lower division service courses. We are also introducing a new Mathematical Software course as part of the major under semesters. We believe such updates and innovations will strengthen the major and make it more attractive to students with a broader range of goals and interests. At the same time, we will continue to offer a relevant and rigorous program that produces students who are knowledgeable and prepared to enter teaching credential programs and graduate programs in mathematics.
   b. Service Courses: As mentioned above, we have several project that seek to more uniformly incorporate active learning, applications, and technology into our lower division service curriculum. In addition, in the move to semesters, the Department will create a course titled Numerical Algorithms and Linear Algebra for Computer Science as well as a combined linear algebra and differential equations course to better serve other STEM departments. The Department, as with mathematics departments across the country, struggles with high DFW rates. Many of the innovations we are exploring,

which will include course coordination and the use of peer learning assistants, are aimed at addressing this challenge.

c. Underprepared Freshmen: The Department is working hard to prepare to address the mandates of two new Executive Orders on Academic Preparation (EO 1110) and General Education (EO 1100 (revised)) which have a significant impact on our work as a service department. We will develop versions of College Algebra and Math for the Arts and Humanities that incorporate additional support for students who are admitted to the university but who are identified as under-prepared in mathematics and quantitative reasoning.

2. Curriculum: Our department prides itself on: being responsive to the needs and requirements of local K-12 schools in the preparation of future teachers; updating curriculum to provide innovative and challenging experiences for our undergraduate and graduate math majors; and investigating ways to improve student success. In particular, we hope to improve DFW rates while ensuring students in our major and service courses are well prepared for success in subsequent coursework. We have also starting meeting with Teacher Education to investigate a possible Integrated Teaching Education Program in Math (ITEP).

3. Faculty: Our goal is always to hire new faculty in appropriate areas of expertise and retain the faculty that the Department already has. We had one full professor retire last year, another will complete their FERP this year, and another will be retiring effective Winter, 2018. We expect yet another full professor to retire in Fall, 2018. With just one hire last year, this will have reduced our tenure-line faculty by 3.5 within a 2 year period. We will not be able to cover our major or graduate courses in Fall, 2018. In fact, many innovations in our service courses may be negatively impacted as well since the regular faculty who are developing and implementing the innovations will be needed at the upper division and thus the implementation will be disrupted. On a brighter note, the new budget process in the College of Science has allowed us to have more predictable funding for travel. We are working hard to leverage this opportunity to increase faculty support funds for travel and research.

4. Support: The new budgeting process in the College of Science has allowed the Department to increase the number of graders. Broad access to graders has allowed us to encourage a culture where students can expect more regular formative feedback on their work. We have also been able to hire student workers to help support the ASC in Mathematics.

Outside Reviewer's Report: First note that the last 5 year review is now quite out of date. We are very much looking forward to completing our 5 year review this year and, in particular, to having an outside reviewer visit and provide feedback and suggestions for our program. In 2011, the main points suggested were (1) increase number of sections of upper division math courses and decrease their size, (2) encourage faculty cohesiveness, (3) encourage faculty research.

Program Response to Outside Reviewer's Report: (1) Our course sections and size have remained stable. With the move to semesters our scheduling will be more regularized so that students will be better able to plan. We have also discontinued all sub-plan options within the BS and MS. This will allow for greater flexibility. Under semesters classes will not be repeated as frequently so students will be forced to plan more carefully and to take a course when it is first

offered after they have taken the prerequisites. Under quarters students would sometimes wait for a "favorite" instructor to appear on the schedule -- under semesters this will no longer be a viable strategy. (2) Also since the last 5 year review the Department moved to a new building. At this time, all tenure line faculty have individual offices on the same floor of the same building. Our department office and staff are also located in this building. This proximity has improved departmental cohesion. However, our lecturers and graduate students are spread all across campus. (3) We continue to try to increase opportunities for student research. Dr. Shirley Yap and Dr. Ehsan Kamalinejad have been working with students, both undergraduate and graduate, on research projects. Several faculty are focusing their professional efforts on STEM Education projects that impact our local K-12 community as well as the quality of instruction in our math courses. This work is not always recognized as research by outside reviewers, but is strongly in line with institutional and college level priorities. It has been the historical stance of the department to value and reward this type of work which brings significant funding and acclaim to our department and campus from surrounding communities. In addition, this work allows for the participation of undergraduates in relevant professional development through the programming provided. Many of our students graduate and become teachers at various levels, as well as teaching for us during their time at CSU East Bay, and thus this work is supportive of their goals and those of CSU East Bay. We also recognize the importance of engaging students in more traditional research of discovery. Our most recent position descriptions have included an emphasis on the ability to work with undergraduates in research and our last search was successful with the hiring of Dr. Jesus Oliver, who started in Fall of 2016. We look forward to successfully completing our search this year with a new colleague who can advance these efforts and help us strengthen this aspect of our program.

B. **Progress Toward Five-Year Review Planning Goals**

Students

Supporting student success: Consistent with the stated intention of our AY 2015-16 annual report, this year graders were provided for all regular and lecturer faculty who requested them. This grader policy was originally for one year while we assess the impact of the support and determine whether the budget will allow ongoing provision of graders at this level. We have requested college funding to continue to support graders for undergraduate classes with at least 30 students and graduate classes will at least 20 students. Instructors who used graders will be surveyed about the usefulness of having graders and those who did not request graders will be surveyed as to why they chose not to make a request. In addition, we will consider surveying student graders to see if they felt the experience was beneficial in terms of solidifying their learning and building stronger relationships with their faculty. We have many other projects in development to support students and instructors in our lower division service courses through calculus. These include course coordination, Learning Assistants, and more robust training for graduate student Teaching Associates.

Major enrollment: Our major enrollment at both the undergraduate and graduate level has remained fairly constant. Our course offerings have remained broad, allowing students' exposure to a variety of topics of current interest. Our semester curriculum streamlines and simplifies our curriculum, allowing for greater flexibility while maintaining the quality and integrity of our offerings.

Student Club(s): We have two student clubs which have been active this past year. The Recreational Math and Computer Science Club had a series of speakers and activities that have attracted a wide range of students and the Association for Women in Mathematics Student Club (directed by Dr. Yap) has met and is making plans for future speakers and activities. Both clubs plan on establishing a web presence and we look forward to continuing to support their efforts.

Student engagement beyond the classroom: Dr. Kamalinejad is continuing to work with students on a research project titled Dynamical Data Clustering. This is a continuation of work done in the previous year and it continues to attract new students at both the undergraduate and graduate level. Right now he is working with Ben Thomas (undergrad) and Will Tran (grad) and is actively recruiting 2 additional students. Mr. Thomas and Mr. Tran plan on presenting their work at the annual Joint Mathematics Meetings symposium on undergraduate research.

Dr. Yap is working with several students, two of whom presented their research at the Mathfest -- the summer meeting of the Mathematical Association of America. The students' talks were on Local Linear Embedding (Linda Beverly) and Vector Word Embeddings (Bi Nguyen).

Supporting underprepared students: With the new Executive Orders (EO 1110 and EO 1100 (revised)) the department has been working hard, and playing a leadership role, in the institutional response and compliance. More detail is provided below in "Program Changes and Needs."

Addressing high DFW rates: The department has expanded its use of Supplemental instruction which is now implemented in several sections of College Algebra, Trigonometry and Analytic Geometry, Calculus I, and Math for Business and Social Sciences. We have made our implementation more robust through better communication with instructors and SCAA trainers and supervisors. Dr. Kathy Hann led a task force for College Algebra/Precalculus during AY 2015-16. Working with two experienced contract lecturers, Sharon Buckley and Sue Benjamin, the task force developed annotated/curated syllabi, sample exams, sample grading rubrics/examples, a coordinator position description, and a "shared experience" document. Each of these served to provide more complete support for instructors and also serve as models for support materials for other course-focused working groups moving forward. We are in the process of developing additional support structures, including a Learning Assistants program and greater course support coordination. Dr. Jesus Oliver, Dr. Julia Olkin and Dr. Shirley Yap are working on a Chancellor's Office course redesign project to infuse more active learning into Calculus I and recently submitted a grant to extend their work into pre-calculus and Calculus II. We are also establishing working groups to create curriculum for multiple versions of college algebra and Math for the Arts and Humanities that can support student success for all students regardless of preparation status.

Curriculum: The department meets monthly throughout the academic year. Our work during AY 2016-17 continued to focus on semester curriculum development. All courses will incorporate transformation elements including a more intentional integration of applications, active learning and technology across our curriculum. New courses for our majors, the departments we serve, and the general education population were discussed. These meetings also serve as opportunities to share ideas for teaching, advising, and building community.

Our new semester curriculum includes changes to the overall structure of our program, eliminating concentrations/options so that students will be able to move more efficiently through the degree and have an opportunity to be exposed to a variety of areas of mathematics based on their interest and department expertise. We developed new program learning outcomes, curriculum maps, degree maps, and all new course and program proposals. Specifically, the major will more clearly include a set of "core" courses required for all majors and sequences and electives more clearly connected and streamlined. Scheduling will be more transparent allowing for better planning and facilitating graduation. Additionally, students will complete a capstone experience modeled on the High Impact Practice advocated by the AAC&U. The revised major was designed so that students interested in high school teaching are able to complete their BS in mathematics and their Single Subject Matter Program in Mathematics in tandem. These students will be qualified to enter a teaching credential program in mathematics without having to pass the three California Subject Examinations for Teachers (CSETs) in mathematics.

Planned content and cognitive change: The major will more clearly include transformed outcomes and objectives which will be introduced, developed and mastered according to a new curriculum map. These outcomes and objectives will be clearly communicated to students via departmental syllabi and through other department guides and publicity materials.

The department is working to systematically incorporate active learning into all its classes.

A list of new courses was included in AY 2014-15's annual CAPR report.

Individual Curricular Innovations

Dr. Jesus Oliver reported several classroom and curricular innovations described below.

- Use of Supplemental Instruction for Calculus I and Calculus II including weekly meetings in order to coordinate group work and content to be discussed in SI sessions. Utilized SI as a leader as a monitor during all in-class group activities.
- "Flipped the classroom" for Calculus 1 (Math 1304) and Calculus II (Math 1305) for one day and in Introduction to Proof (Math 3000). The content for Calculus was "Shortcut Rules for Derivatives/Antiderivatives (respectively)" A preview activity and online quiz was given before the class meeting. During class students then worked in groups on a handout using the online materials and content.
- Developed and implemented active learning strategies in Calculus I and II. Specifically: Utilized Peer Instruction (PI) and ABCD colored response cards. Peer instruction (PI) using signal response cards is an active learning technique that encourages classroom discussion and promotes collaborative learning. PI achieves this by organizing class time around short, conceptual multiple-choice questions that the students answer using ABCD colored response cards. Developed multiple in-class, group discussion questions, and activities for Calculus I. Developed and implemented a Group Activity using Wiki Stix for Graphs of Derivatives (given the graph of a function, use a Wiki Stix to graph the derivative.)
- Utilized Desmos and Wolfram CDF Demonstrations and problem generator to illustrate and visualize concepts and provide practice problems and solutions in Calculus I and II.

- Developed a graduate course on non-linear wave equations. Wrote and developed my own notes and activities in order to illustrate the formation of shocks and the use of energy estimates to control solutions to non-linear wave equations.

Dr. Julia Olkin reported the classroom and curricular innovation described below.

- Redesigned Ordinary Differential Equations (Math 3361) with the goal of including more exploratory group work in class. Lecture was limited to at most 15 minute chunks (2 hour class) and students regularly worked together in groups of four Group problems included concepts not necessarily covered in lecture for students struggle through as a team. As a professional reflection tool, Dr. Julie McNamara from TED videotaped several meetings.Overwhelmingly the student feedback was positive for that class.

Dr. Kathy Hann reported the classroom and curricular innovation described below.

- Used freeware GeoGebra in Calculus III, Geometry, and Topics in Geometry for demonstrations and student exploration. This program is especially helpful for students to make conjectures and test these conjectures in 2 and 3 dimensions.

Faculty: We had a successful search for a new tenure track faculty member during AY 2015-16. Dr. Jesus Oliver received his Ph.D. from UC San Diego and served as a lecturer there for 3 years and also taught at Mesa Community College for a year. His research is in the area of partial differential equations and mathematical physics.

Information regarding retirements and new faculty needs is addressed in "Program Changes and Needs."

Professional Activity Highlights: The department is very active in supporting students who are future teachers as well as providing professional development for current teachers. Faculty are engaged in research projects to identify and measure promising practices for mathematics instructors across educational levels. Faculty are also active in traditional and interdisciplinary research that includes students and collaborations across the CSU and beyond.

Dr. Jesus Oliver reported the following activities and publications submitted and in progress.

- Appeared: J. Oliver, "A Vector Field Method for Non-Trapping Spacetimes," Journal of Hyperbolic Differential Equations, 13 (2016), no. 4, 735-790.
  Submitted: J. Oliver, J. Sterbenz, "A Vector Field Method for Radiating Black Hole Spacetimes." Submitted to Analysis and PDE (June 2017).
- In Progress: "A Vector field Method for the Wave-Klein-Gordon System." Collaborator: Philippe LeFloch, Laboratoire Jacques-Louis Lions, Universite Pierre et Marie Curie, Paris, France.
- Presented Math/Stats Colloquium, San Jose State University, 2017
- Research In Pairs, Institut Henri Poincare, Paris, France, 2017

Dr. Shirley Yap reported the following activities and publications submitted and in progress.

- "Density of Local Maxima of the Distance Function to a Set of Points in the Plane," Women in Computational Topology, AWM Springer Series, 2017.

- Collaboration with Nina Amenta at UC Davis and Erin Chambers at Washington University on Delaunay triangulations
- Submitted: A Continuity Sleight of Hand, to Mathematical Intelligencer
- "Density of Anchor Points on Delaunay Triangulations," invited speaker at AWM Symposium at UCLA, March 2017. Same talk given at Mathfest, Chicago, 2017.

Dr. Kathy Hann reported the following activities.

- Presented "CSUEB Subject Matter Programs in Math and Foundational Math," CMC North Conference, December 2016
- Workshop Participant: MTEP annual conference, New Orleans, July 2017

Dr. Julia Olkin reported the following activities.

- Workshop: one week, 8:30-2:30PM, at Oakland High School for incoming freshmen. Strengthen math skills and build math confidence heading into Algebra I. Growth mindset activities were included.
- Outreach: Ran the orientation for Math tutors in SCAA at the beginning of Academic Year in conjunction with the SCAA orientation.

Dr. Ehsan Kamalinejad reported the following activities and publications submitted and in progress.

- Submitted "IsoClustering: A Generalized Framework for Local Data Clustering" for publication.
- Presented at the Faculty Research Symposium at CSUEB.

Service to the University: The department is very active in service at the college and university level and in state and national organizations in support of K-16 education. We have representatives on the College RTP and Curriculum committees, the General Education Subcommittee of CIC, Academic Senate, FAC and COBRA. We have had representatives on the Search Committee for the AVP of University Advancement and the Provost and Vice President for Academic Affairs. Dr. Olkin serves as co-chair of the Board of Directors of the STEM institute. Dr. Hann is a member of the California Association of Mathematics Teachers (CAMTE) Advising Committee and the Purposeful Recruitment, Exploration, and Preparation (PREP) Initiative Task Force, the California Association of Mathematics Teacher Educators Advocacy Committee and the Mathematics Teacher Education Project (MTEP). Dr. Yap serves as our regional section governor to the Mathematical Association of America, is on the founding team of the East Bay Teachers' Math Circle, and as Director of the University Honors Program.

Funding awarded and proposals submitted: Dr. Julie Glass is campus lead on an Irvine Foundation funded project, "Bridging the Gap," that brings together a partnership among CSUEB, Peralta Community Colleges, Oakland Unified School District and Berkeley Unified School District. The goal of the project is to support student success across High School – Community College – University transitions. She is PI for the Greater Bay Area P20 Basic Skills Consortium (GBA K20BSC), a collaborative among Ohlone Community College District (lead), CSUEB, Berkeley City College, Chabot College, Diablo Valley College, Las Positas College, Mission College, Peralta Community College District, San Francisco State and San Jose State. The GBA K20BSC was formed to increase retention and graduation rates in two and four-year college

degree and certificate programs through newly (re)designed developmental mathematics courses and course sequences that address needs of high school and college students. The work of both of these grants has been impacted by EO 1110 and EO 1100 (revised).

Dr. Julia Olkin, Dr. Jesus Oliver and Dr. Shirley Yap were awarded a CSU Chancellor's Office "Course Redesign with Technology" grant (2017-2018). Together they also submitted a proposal to become partners in the Student Engagement in Mathematics through a Network for Active Learning (SEMINAL). The proposal is to create, pilot, and refine a course redesign for pre-calculus, Calculus I and Calculus II. In alignment with the definition of Active Learning Mathematics (ALM) in the SEMINAL Phase II RFP, the three main objectives in of the course redesign are to:

- Promote a classroom environment where the students are more engaged in the learning experience.
- Encourage discussion, group work, and collaboration among students.
- Support instructor use of student thinking during class time.

Dr. Kathy Hann continues to be the PI for the CSUEB Noyce Teaching Fellows Program and CSUEB Noyce Scholarship program. These grants provide scholarships and professional development for future math and science teachers committed to teaching in high needs schools. In addition, she submitted: Supporting Excellence, Effectiveness & Diversity in STEM Teacher Education Noyce Scholars Program, Track I. A $1.2 million proposal submitted to NSF in August 2017. The Supporting Excellence, Effectiveness and Diversity in STEM Teacher Education (SEED) project, a Robert Noyce Scholarship Track I project, will build on and expand past efforts to recruit and support diverse, academically successful senior mathematics and science majors and STEM professionals in entering a credential program and becoming highly effective teachers in high need, urban school districts. This five-year joint project, in collaboration with K-12 districts across Alameda and Contra Costa counties, will focus on three areas: 1) continuing to increase the number of middle and high school math and science teachers obtaining their credentials at CSUEB by recruiting new cohorts of Noyce Scholarship and Stipend Scholars across the grant period, 2) continuing and improving professional development for the Noyce Scholars to provide guidance and support as they become highly effective teachers in schools with diverse student bodies and 3) informing understanding of how best to attract, prepare, and provide ongoing support in order to retain highly effective STEM teachers by evaluation examination of program efforts and the effectiveness of participating scholars.

Dr. Ehsan Kamalinejad was awarded, together with five other faculty members from CSUEB and Fresno State University, a National Science Foundation FURST, Faculty and Undergraduate Research Student Teams, grant. So far the funding has supported a 1 month intensive research camp at CSU Fresno. This funding has supported the development of software that uses a HoloLens camera and depth camera for robust object detection. The software is also capable of recognizing people, more details can be found at http://ehsan-kamalinejad.pagecloud.com/projects2

Dr. Jesus Oliver submitted Faculty Support Grant to CSU East Bay (May of 2017). The proposal requested release time in order to establish collaborations with UC Berkeley and Stanford Math departments, as well as to work on a manuscript and turn it into a publication.

Dr. Julia Olkin is Co-PI on an NSF Faculty Learning Grant which works with a cohort of 12 teachers (7 from CSUEB and 5 from community colleges) to incorporate active learning strategies into STEM classes. She is also co-PI for the 2nd year of TEEM (Teaming for Effectiveness and Equity in Mathematics) working with K-3rd teachers in Hayward Unified. She continues to serve as PI for the MSTI (Math and Science Teacher Initiative) grant to encourage undergrads to enter the credential program in STEM fields. Finally, she was awarded a grant from Warriors Community Foundation to run a one-week math program in Oakland for incoming 9th graders.

Dr. Shirley Yap received a Chancellor's Office Course Redesign with Technology grant for Math for Business and Social Sciences (Math 1810).

C. Program Changes and Needs

Overview: Mathematics is a gateway to STEM and Business majors as well as a primary provider of courses for General Education Mathematics/Quantitative Reasoning courses (B4). We take our role as a service department very seriously. There has been a lot of attention paid to DFW rates across the university with much focus on mathematics. Math is unique in its deep and significant importance in other disciplines. Students who major in STEM or Business who don't have a strong mastery of basic mathematical concepts will struggle in their major courses. We have many projects focused on supporting students in all majors, including the Arts and Humanities, because we strongly believe in the important role of mathematical literacy for an educated citizenry. These projects include the use of Supplemental Instruction, Learning Assistants, course coordination, and active learning.

Curriculum: With the new Executive Orders (EO 1110 and EO 1100 (revised)) the department has been working hard, and playing a leadership role, in the institutional response and compliance. We are developing curriculum in support of STEM and Business students and we are also well positioned to support students in all majors to successfully advance in their degrees and to address any deficiencies identified through the new multiple measures placement process. This year we initiated a joint training event for Math Teaching Associates and General Studies instructors. These two groups work closely with incoming freshman, face many of the same challenges, and have many of the same opportunities to support students in transition to the university. We are optimistic that our partnership with General Education will strengthen and that it can be leveraged as we move into semesters to help us implement structures in keeping with the new EOs.

Students: We are particularly committed to ensuring that compliance with the new EOs does not lead to a decrease in diversity among STEM and Business majors, something we see as a substantial risk in implementation. Students come to use from a wide variety of educational backgrounds and it is our responsibility to provide the same opportunities to all students. We should not allow our university to perpetuate inequities our students might have experienced in the K-12 education.

Faculty: Dr. Donald Wolitzer will retire effective Winter, 2018, and we anticipate the retirement of Dr. Chung-Hsing Ouyang effective Fall, 2018. Dr. Stuart Smith will end his FERP in Spring, 2018.

Staff: At this time our office support staffing is stable and sufficient. With new anticipated programming in support of student success we are in the process of hiring a Student Services Professional.

Resources: As we work towards stronger student support outside the classroom, we may have a need for student/tutor workspace and an Open Math Lab facility.

Assessment: We plan on continuing to use our current process of re-examining approrpiate final exam problems using an RVF rubric. We have reduced the number of courses we assess per year with a focus on mastery in all areas.

Other: We are working towards implementation of our curricular transformation as described in our Semester Conversion plans. This includes the incorporation of applications, technology use, and active learning, especially in our service courses. Some of this work is supported by Chancellor's Office grants, and we also have a proposal pending as a partnership subaward from NSF.

II. SUMMARY OF ASSESSMENT

Assessment for the BS and MS degrees are included below.

BACHELOR'S OF SCIENCE IN MATHEMATICS

A. **Program Learning Outcomes (PLO)**

Students graduating with a Bachelor of Science in Mathematics will be able to:

1. Apply the definitions, techniques and theorems of abstract mathematics (ILO's #1 & #6)
2. Apply the definitions, techniques and theorems of applied mathematics (ILO's #1 & #6)
3. Apply mathematical algorithms to solve problems, both individually and in teams (ILO's #2 & #4)
4. Creatively conjecture and rigorously write, analyze and critique proofs (ILO's #1 & #6)
5. Communicate mathematics to others in written and/or oral form with precision, clarity and organization (ILO's #2 & #4)
6. Apply techniques of at least one area of mathematics in depth (ILO's #1 & #6)

B. **Program Learning Outcome(s) Assessed**

PLO 2: Apply the definitions, techniques and theorems of applied mathematics
PLO 4: Creatively conjecture and rigorously write, analyze and critique proofs

This is the first year that these PLO's have been assessed.

C. **Summary of Assessment Process**
Summarize your assessment process briefly using the following sub-headings.

Instrument(s): The department used final exam questions and a rubric for each PLO. The rubrics were used to re-score the exam questions for readability, validity and fluency using the rubrics below included in Appendix A.

Sampling Procedure: The courses for this year's assessment were chosen by the department when we created our five-year assessment plan. For each course assessed, a final exam question was identified as a typical problem for the course that assessed the given PLO. These problems were chosen by the department during one of our monthly department meetings.

Sample Characteristics: The courses selected include both required courses for all options in the major and required courses for the Applied and Teaching options. The exam questions were selected carefully to ensure they tested material that is essential in the courses.

Data Collection: Final exams were collected by the department assessment coordinator. Each problem was scored by the undergraduate committee for readability, validity and fluency using the rubric in Appendix A.

Data Analysis: Courses Assessed:

MATH 3121, 3301, 3331, 3600, 3750, 3841

Math 3121 Abstract Algebra, SLO 4/Mastered (15 Students)
Problem: Prove a function is a group homomorphism.

	Missing	Emerging	Developing	Mastering
Readability	7%	13%	53%	27%
Validity	0%	25%	25%	50%
Fluency	0%	37%	57%	6%

These scores indicate 27% of the students have mastered the ability to write a readable proof using a basic definition, 50% mastered the ability to write a valid proof, and 6% of the students mastered the ability to write a proof with fluency.

Math 3301 Real Analysis II, SLO 4/Mastered (9 students)
Problem: Prove if f: [-1,1] to [-1,1] is continuous then f has a fixed point

	Missing	Emerging	Developing	Mastering
Readability	0.00%	0%	11%	89%
Validity	0.00%	11%	44%	44%
Fluency	0.00%	33%	34%	33%

These scores indicate most of the students have developed or mastered the ability to write a readable proof about a continuous function, most of the students have developed or mastered the ability to write a valid proof and 67% of the students have developed or mastered the ability to write a proof with fluency.

Math 3331 Differential Equations, SLO 2/Mastered (13 students)
Problem: Solve a linear, first-order initial value problem.

	Missing	Emerging	Developing	Mastering
Readability	0.00%	15%	23%	62%
Validity	0.00%	15%	23%	62%
Fluency	8%	0%	54%	38%

These scores indicate most of the students have mastered the ability to apply techniques of applied mathematics although only 38% are able to write a fluent solution.

Math 3600 Number Theory, SLO 2/Mastered (7 students)
Problem: Prove congruence properties of even and odd integers

	Missing	Emerging	Developing	Mastering
Readability	0%	0%	29%	71%
Validity	0%	28%	29%	43%
Fluency	0%	28%	29%	43%

These scores indicate most of the students have mastered the ability to write a readable proof using theorems of applied mathematics, 43% have mastered the ability to write a valid proof, and 43% have mastered the ability to write a proof with fluency.

Math 3750 Numerical Analysis I, SLO 3/Mastered (27 students)
Problem: Use an $O(h^2)$ approximation of a derivative to generate an $O(h^3)$ approximation.

	Missing	Emerging	Developing	Mastering
Readability	11%	4%	15%	70%
Validity	11%	11%	33%	44%
Fluency	11%	11%	15 %	63%

These scores indicate most of the students have mastered the ability to write a readable and fluid solution to a problem in applied mathematics and 77% are developing or mastering writing a valid solution.

Math 3841 Linear Programing, SLO 2/Mastered (24 students)
Problem: Use Complementary Slackness to prove a vector is an optimal solution to maximize a linear function under given restrictions.

	Missing	Emerging	Developing	Mastering
Readability	0%	0%	17%	83%
Validity	0%	4%	8%	88%
Fluency	0%	0%	12%	88%

These scores indicate the majority of the students have mastered the ability to write a readable, valid and fluid solution to a problem applying a technique in applied mathematics

D. **Summary of Assessment Results**

Main Findings: Students perform uniformly well at the readability and validity level. The department needs to find ways to increase performance at the fluency level.

Recommendations for Program Improvement: The department needs to work on setting and communicating to instructors and students the essential topics for its courses and how to include fluency assessment throughout the coursework.

Next Step(s) for Closing the Loop: The department is creating new expanding syllabi for the semester courses which will include more in depth details regarding course topics, depth of study, grading guidelines, and assessment expectations at the introductory, developing or mastery level for readability, validity and fluency in student work.

Other Reflections: The work described above is a huge project. We will have guidelines ready once semesters begin but will need to continuously improve our course packets for instructors.

E. **Assessment Plans for Next Year**

We plan to assess program student learning outcomes 2 and 4 listed above. We will use two courses for this assessment: Math 330 Analysis I and Math 370 Numerical Analysis I. This is a change from our original plan, which uses nine courses. We plan to spend more time analyzing the data and planning for program improvement instead of time on redundant data collection.

MASTER'S OF SCIENCE IN MATHEMATICS

A. **Program Learning Outcomes (PLO)**

Students graduating with a Master's of Science in Mathematics will be able to:

1. Apply the fundamental definitions and theorems of pure mathematics (ILOs #1 & #4)
2. Apply the fundamental definitions and theorems of applied mathematics (ILOs #1 & #4)

B. **Program Learning Outcome(S) Assessed**

PLO 2: Apply the fundamental definitions and theorems of applied mathematics.

This is the first year PLO 2 is being assessment. PLO 1 was assessed last year.

C. Summary of Assessment Process

Instrument(s): The department used final exam questions and a rubric for each PLO. The rubrics were used to re-score the exam questions for readability, validity and fluency.

Sampling Procedure: The courses for this year's assessment were chosen by the department when we created our five-year assessment plan. For each course assessed, a final exam question was identified as a typical problem for the course that assessed the given PLO. These problems were chosen by the department during one of our monthly department meetings.

Sample Characteristics: The courses selected include required courses for both the Applied and Pure options in the master's degree. The exam questions were selected carefully to ensure they tested material that is essential in the courses.

Data Collection: Final exams were collected by the department assessment coordinator. Each problem was scored by a curriculum committee for readability, validity and fluency using RVF rubrics similar to those used for undergraduate assessment.

Data Analysis: The results were organized and discussed by the graduate committee.

Courses Assessed: MATH 6200, 6331, 6349

Math 6200 Topology, SLO 1/Mastered (9 Students)
Problem: Prove the continuous image of compact/connected set is compact/connected.

	Missing	Emerging	Developing	Mastering
Readability	0%	11%	45%	44%
Validity	0%	22%	45%	33%
Fluency	0%	11%	45%	44%

These scores indicate 44% of the students have mastered the ability to write a readable and fluent proof about continuous functions on a compact/connected set, yes only 33% mastered the ability to write a valid proof.

Math 6331 Topics in Differential Equations, SLO 2/Mastered (9 students)
Problem: For an initial value problem, show no solutions exist or infinitely many solutions exist under certain conditions.

	Missing	Emerging	Developing	Mastering
Readability	0%	0%	0%	100%
Validity	0%	0%	56%	44%
Fluency	0%	0%	44%	56%

These scores indicate all of the students have mastered the ability to write readable solutions to problems in applied mathematics and all of the students have developed or mastered the ability to write a valid and a fluid solution.

Math 6349 Real Analysis, SLO 1/Mastered (16 students)
Problem: A function f is measurable on A union B iff f is measurable on A and B.

	Missing	Emerging	Developing	Mastering
Readability	0%	50%	31%	19%
Validity	6%	20%	27%	47%
Fluency	35%	28%	31%	6%

These scores indicate 47% of the students have mastered and 27% are devloping the ability to write a valid proof about measurable functions and 31% are developing the ability to write a

readable and fluent proof. Very few students have mastered writing a fluent proof about measurable functions.

D. **Summary of Assessment Results**

Main Findings: Students in the applied course performed well at all levels. Students in the pure courses had mixed results, which may be due to the courses themselves. In general, the departments needs to find ways to increase performance at the fluency level.

Recommendations for Program Improvement: The department needs to work on agreeing to the level and standards for its graduate courses, especially for the abstract courses.

Next Step(s) for Closing the Loop: The department is creating new expanding syllabi for the semester courses which will include more in depth details regarding course topics, depth of study, grading guidelines, and assessment expectations at the introductory, developing or mastery level for readability, validity and fluency in student work.

Other Reflections: The work described above is a huge project. We will have guidelines ready once semesters begin but will need to continuously improve our course packets for instructors.

E. **Assessment Plans for Next Year**

We plan to assess PLO #1 listed above. We will use two courses for this assessment, one "pure" and one "applied." This is a change from our original plan, which uses 4 courses. We plan to spend more time analyzing the data and planning for program improvement instead of time on redundant data collection.

III. DISCUSSION OF PROGRAM DATA & RESOURCE REQUESTS

A. **Discussion of Trends & Reflections**

Notable Trends:

One notable trend observed in the provided data is a move towards a higher percentage of undergraduate majors vs. graduate majors. This trend may be a natural fluctuation or may be a result strong recruitment for mathematics teachers in our surrounding community. Our department has several programs and scholarships for "future teachers" and is in conversation with Teacher Education on the development of an Integrated Teacher Pathway that would result in a BS in Mathematics and a Single Subject Teacher Credential in 5 years. We are excited about this possibility. We hope to leverage this strength as part of a campaign in coordination with Teacher Education and University Advancement, "Our best students are the best teachers."

The data provided show a strong uptick in Hispanic students within the Math Major (19.6% in 2012 up to 26.9% in 2016). We are excited about the potential to leverage this growth within the context of our new HMI status.

Another interesting trend is the increase in full-time enrollment (57% in 2010 to 72% in 2016). This, along with the increase in undergraduate majors as a percentage of all our majors shows the potential for improvement in graduation rates in the short term.

Lastly, we have had a significant increase in the percentage of lecturer FTEF (28.5% in 2013 to 35.4% in 2016) as compared to tenure track faculty FTEF (44.3% in 2013 to 40.2% in 2016). Our lecturer headcount (33.3% in 2013 to 40% in 2016) vs. tenure track faculty headcount (29.2% in 2013 to 26% in 2016) has gone in the same direction. This trend is likely to accelerate with the elimination of developmental math leading to a potential increase in demand for entry level college courses taught by lecturer faculty.

Reflections on Trends and Program Statistics:

It is of note that for a service department such as Mathematics, data about majors simply does not tell the full story. We teach a large number of FTEs in our service courses as well as developmental math. As the university continues to strengthen its reputation in STEM and Business, we expect this responsibility to increase and enrollment to continue to grow. Also with the Graduation Initiative in place and the bottleneck/gateway positioning of many of our courses, we are seeking to make significant changes and improvements in the instructional practices in our service courses. All such moves require permanent faculty leadership, a role that is most naturally played by our tenure/tenure track faculty. At this time we have no tenure/tenure track faculty teaching classes below the level of Calculus I, and even Calculus I and II have significant number of lecturers serving as instructors. The data provided shows a decline in the number of tenure/tenure track faculty as well as a reduction of FTEF relative to lecturers. In addition, as mentioned above, by next fall we will have lost 1 tenured full professor, 1 tenured associate professor, and a 0.5 FERP full professor. This will have an enormous impact on our ability to cover our upper division major courses, let alone having tenure line faculty teaching calculus or below.

Another significant concern, not reflected in the data yet, is the fact that changes in policy represented by EO 1110 and EO 1100 (revised) impacting developmental education will have a significant effect on our work, on our demographics, on student success, and the attractiveness of our graduate program, which employs graduate students as Teaching Associates. As mentioned earlier, students come to use from a wide variety of educational backgrounds and it is our responsibility to provide the same opportunities to all students. We should not allow our university to perpetuate inequities our students might have experienced in the K-12 education.

As noted in various places above, we expect an impact from the new EOs on our graduate program which will no longer have as easily available opportunities for building teaching experience. That said, we intend to use the new co-requisite model courses to provide a new training program for graduate students, especially those who intend to pursue teaching at the community college level – something for which we are well known and very successful. Incoming graduate students will be offered teaching positions in co-requisite courses along with course work on university teaching. Then, based on their performance, they may be offered the opportunity to teach a college credit bearing course. This may actually strengthen the instructional skills of our graduates. We continue to think creatively within the boundaries of systemwide mandates to support all students at the university, from those who come in as underprepared freshman through our Master's students.

B. **Request for Resources**

1. Request for Tenure-Track Hires: As mentioned above in notable trends, the number of lecturers by headcount and FTEF has been increasing relative to tenure track. In addition, the overall headcount of tenure track faculty will drop again by 2.5 this academic year. We have an active Tenure-Track search is year. With the reduction in our tenure track faculty beyond even that shown in the provided data, we will definitely need another search in 2017-18. Without such a search, we may not be able to cover our upper division major courses and graduate courses with tenure line faculty. In support of the Graduation Initiative, we are committed to having tenure track faculty teaching a majority of our calculus classes, and think our overall program would benefit from having tenure line faculty teaching in college algebra, precalculus, and Math for the Arts and Humanities.

2. Request for Other Resources: At this time we are leveraging Graduation Initiative efforts to support many curricular innovations and support structures such as Supplemental Instruction and Learning Assistants. We have not specific requests beyond this support at this time.

APPENDIX A: SAMPLE RUBRICS

SLO 1: Apply the definitions, techniques and theorems of abstract mathematics

SLO 1 RVF Rubric – Readability, Validity, Fluency

	Missing (0)	Emerging (1)	Developing (2)	Mastering (3)
Readability	Informal or non-mathematical language is used. There is misuse of notation/symbols.	Some improper mathematical language or notation is used.	Mostly proper mathematical language and notation is used.	Proper mathematical language and notation is used.
Validity	Significantly inaccurate or irrelevant statements in definitions, techniques and/or theorems are present. Important information is missing.	Mostly accurate statements in definitions, techniques and/or theorems are present. May include some irrelevant or unjustified statements.	Statements in definitions, techniques and/or theorems are accurate and relevant.	Statements in definitions, techniques and/or theorems are accurate and relevant and connected/deduced correctly.
Fluency	No coherent flow of ideas Listing facts without a sense of how to link them to obtain or apply a valid definition, technique or proof of a theorem.	Partially coherent and organized, but inconsistent. Appeals to intuition. Some unjustified or improperly justified statements/ conclusions in definitions, techniques or proofs of theorems are present.	A correct and essentially complete definition, solution, or proof given. Logic and flow overall sound. Some small gaps in presentation may require "benefit of the doubt."	A correct and complete definition, solution, or proof given. Elegance or mathematical maturity present.

SLO 3: Apply mathematical algorithms to solve problems, both individually and in teams

SLO 3 RVF Rubric – Readability, Validity, Fluency

	Missing (0)	Emerging (1)	Developing (2)	Mastering (3)

Readability	Informal or non-mathematical language is used. There is misuse of notation/symbols.	Some improper mathematical language or notation is used.	Mostly proper mathematical language and notation is used.	Proper mathematical language and notation is used.
Validity	Significantly inaccurate or irrelevant steps in algorithms are present. Important information is missing.	Mostly accurate steps in algorithms are present. May include some irrelevant or unjustified statements.	Steps in algorithms are accurate and relevant.	Steps in algorithms are accurate and relevant and connected/deduced correctly.
Fluency	No coherent flow of ideas Listing facts without a sense of how to link them to get a correct solution.	Partially coherent and organized, but inconsistent. Appeals to intuition. Some unjustified or improperly justified steps in algorithms are present.	A correct and essentially complete solution given. Logic, steps in algorithms, and flow overall sound. Some small gaps in solution may require "benefit of the doubt."	A correct, fully justified, and complete solution given. Elegance or mathematical maturity present.