STUDENT LEARNING ASSESSMENT REPORT

PROGRAM: Mathematics
SUBMITTED BY: Will Heuett
DATE: 09/30/2018
BRIEFLY DESCRIBE WHERE AND HOW ARE DATA AND DOCUMENTS USED TO GENERATE THIS REPORT BEING STORED:
Each instructor has data and documents stored in his or her office. Each instructor provided a summary and analysis of the information collected from students. To coordinate the collection and aggregation of data, the department created a shared Google Site to allow each instructor to input relevant data at the end of each semester in a format similar to that of the assessment report.

EXECUTIVE SUMMARY

Program description from the Course Catalog:
The study of mathematics introduces students to mathematical abstraction as well as how mathematics can be used to solve practical problems. Many courses in this discipline provide the basic foundations necessary to support study in all majors. Whenever possible, mathematics courses introduce concepts using applications, analytical solutions (equation solving), numerical approximations, and graphical interpretations.

The mathematics major requirements fall into four categories:
- foundation courses, offered each semester, are prerequisites for subsequent courses;
- introduction-to-proof courses, offered on an alternating-year basis, give students a more clear idea of pure mathematics;
- applied or computational mathematics, offered on a rotating basis, encourage students to use mathematics to solve, or elucidate, real-world problems; and
- high-level proof courses, offered on a rotating basis, push students to understand mathematics in a deeper, more abstract way

A special feature of Marymount's mathematics program is the fall seminar series. Faculty members and students meet for one hour each week to hear presentations by professional mathematicians about their career paths. Students also give short presentations on mathematical topics of interest.

Beyond regular coursework, several faculty members have collaborated with students on joint research projects, most notably in mathematics education and in computational biology. Faculty and students regularly present their research findings at national conferences.

Upon successful completion of the mathematics program, students will be able to
- gather, evaluate, and use relevant mathematical definitions and results to create logical, grammatically correct proofs;
- connect mathematical ideas to real-world applications, including the creation and interpretation of mathematical models;
- communicate mathematical ideas through oral and written presentations;
- use a variety of technologies to solve mathematical problems;
- articulate career, internship, and summer program opportunities for mathematicians; and
- pose, research, and address new mathematical questions.

Marymount’s mathematics program prepares students for immediate careers in the field, as well as for graduate study. Computation and modeling are intentionally infused into the major so students are ready for jobs that require strong technical abilities. Marymount mathematics majors can also earn licensure to teach middle school or high school mathematics.

After meeting the Liberal Arts Core and University Requirements, mathematics majors have 20-23 elective credit hours. Students are encouraged to apply those credits toward other options such as teaching licensure in secondary mathematics or a minor or second major in biology, economics, or information technology. Mathematics majors are also eligible to consider participation in the five-year B.S./M.S. in information technology program.

List all of the program's learning outcomes: *(regardless of whether or not they are being assessed this year)*

Learning Outcome	Year of Last Assessment	Assessed This Year	Year of Next Planned Assessment
1. Mathematics graduates gather, evaluate, and use relevant mathematical definitions and results to create logical, grammatically correct proofs.	*2013–2014*	X	*2021–2022*
2. Mathematics graduates connect mathematical ideas to real-world applications, including the creation and interpretation of mathematical models.	*2013–2014*	X	*2021–2022*
3. Mathematics graduates communicate mathematical ideas through oral and written presentations.	*2015–2016*		*2019–2020*
4. Mathematics graduates use a variety of technologies to solve mathematical problems.	*2015–2016*		*2019–2020*
5. Mathematics graduates articulate career, internship, and summer program opportunities for mathematicians.	*2015–2016*		*2019–2020*
6. Mathematics graduates pose, research, and address new mathematical questions.	*2013–2014*	X	*2021–2022*

Describe briefly how the program's outcomes support Marymount's mission, strategic plan, and relevant school plan:

Marymount's Mission:

Marymount University is a comprehensive Catholic university, guided by the traditions of the Religious of the Sacred Heart of Mary, that emphasizes intellectual curiosity, service to others, and a global perspective. A Marymount education is grounded in the liberal arts, promotes career preparation, and provides opportunities for personal and professional growth. A student-centered learning community that values diversity and focuses on the education of the whole person, Marymount guides the intellectual, ethical, and spiritual development of each individual.

Department's Vision:

The mathematics program provides quality instruction in a nurturing environment. The major prepares both excellent high school mathematics educators and career-prepared pure and applied mathematicians. Select students who may attend mathematics graduate programs receive modified advising and preparation, taking full advantage of our consortium membership. All majors and minors will be exposed to mathematical research, and will have the opportunity to participate in undergraduate research. The program focuses on the intellectual development and communication skills of all students studying mathematics at Marymount University.

Our learning outcomes identify key features of the department's vision and the program description. They are skills that students in the program should expect to possess upon graduating. It can be argued that all outcomes indirectly support Marymount's mission. They also speak to the goals of Marymount's liberal arts core and university requirements. Outcomes 1 and 2 are particularly rigorous and directly address inquiry. Outcomes 3 and 4 acknowledge that professional success requires effective communication skills and technical abilities. The mathematics seminars, designed primarily to address Outcome 5, focus on the importance of career preparation and the identification of and success in achieving personal and professional goals. Outcome 6 is high-level inquiry and, quite often, is interdisciplinary in nature.

Provide a brief description of the assessment process used including strengths, challenges and planned improvements to the process, and provide evidence of the existence of a culture of continuous improvement based on assessment:

The mathematics program employs both direct and indirect measures of our learning outcomes. Pre- and post-surveys and reflection questionnaires are used in the department seminar series and for special events such as field trips and conferences. Projects and oral presentations completed within courses are graded using rubrics, which have been developed with assessment of the learning outcomes in mind. Results from students' homework assignments, quizzes, and exams are also included in our assessment data whenever relevant.

The department strives to provide consistent instruction in proofs, modeling, and communication and to increase student awareness of careers and applicability of mathematics. We have focused on including embedded assessment as part of our teaching process. The department continually evaluates its curriculum to determine what changes can and should be made to better address students' needs. If and when we find that we are not meeting our standards, we ask ourselves if our standards can be met, how can we improve performance and/or engagement, and if we should consider making a change.

When assessing learning outcomes, the department considers only majors within the program. All non-majors are excluded from the analysis.

Describe how the program implemented its planned improvements from last year:

The last year the program assessed Learning Outcomes 1, 2, and 6 was 2013–2014. What the program said it planned to improve with regard to these learning outcomes and what the program has done since that time is detailed in the table below. The program has implemented numerous curriculum changes. Some courses named in the previous assessment no longer exist, some have been modified, and some new courses have been created. The changes are indicated below as they affect the planned improvements. Please note, when reading the planned improvements in the table below as they refer to future dates of assessment under a prior annual assessment report schedule, that the program has since moved to a biennial assessment report schedule and that this is the reason for mismatched dates.

Outcome	**Planned Improvement**	**Update** *(Indicate when, where, and how planned improvement was completed. If planned improvement was not completed, please provide explanation.)*
Mathematics graduates gather, evaluate, and use relevant mathematical definitions and results to create logical, grammatically correct proofs.	MA 215: Linear Algebra This class will now go back to being a purely intro to proof type of class. MA 425: Real Analysis Our measure is 80% of students should score in the Excellent / Good range, and we are aware that we are not meeting this goal. We know that Real Analysis is the most difficult undergraduate proof class worldwide, and we acknowledge that we may not meet this goal. However, we have the following ideas to try: 1. We have rearranged the mathematics rotation and redefined the linear algebra curriculum so	MA 215: Linear Algebra and Proof Techniques The course was redesigned and renamed to reflect a greater focus on introducing proofs. MA 425: Real Analysis The changes previously suggested were made to this course and the general mathematics rotation of courses. Math majors now take a proof-centered course every semester. The data presented in this assessment report portray the outcomes since implementation.

Outcome	Planned Improvement	**Update** *(Indicate when, where, and how planned improvement was completed. If planned improvement was not completed, please provide explanation.)*
	that students take proof-centered courses every semester from fall of the sophomore year through fall of the senior year. Sometimes the terminal proof course will be Abstract Algebra, and sometimes that will be Real Analysis. These current scores reflect students who have taken Real after Abstract, and it may be that our performance here takes a hit, but we believe the constant focus on proofs will make those students who are in their terminal proof course much stronger. 2. The next time real analysis is taught, we will try an approach similar to the one Dr. Lenz employs in Abstract Algebra in which students are given daily activities with key ideas -- definitions, theorem statements, and examples – already typed and with space to fill in the "hard stuff." Perhaps this will make the quick pace of the course less overwhelming. If that does not work then we will have to consider making the course four credits.	
	MA 261: Introduction to Mathematical Reasoning We had been hoping to drop this requirement to shorten the requirements for the major, and this year's assessment helped us to realize that we actually need to redesign the course rather than eliminate the course.	In 2015, the content from MA 261 was combined with the sophomore seminar course to create MA 210 Seminar with Introduction to Proofs through Discrete Math. Key elements of MA 261 that were relevant to developing a solid foundation in writing proofs were repackaged with the first seminar course to focus on the fundamentals of proof writing with each cohort of majors at a sensitive point in their development.
	MA 420: Abstract Algebra The students seem to need to work on their self-assessment of the first draft of their proofs. We will discuss as a department ways in which we can have the students self-assess their proofs in all our proof	One aim in developing MA 210 was to address our need to provide more structure and more clearly defined expectations and assignments for our sophomore majors in the seminar course. We have also started employing both self- and peer-assessments in stages

Outcome	Planned Improvement	**Update** *(Indicate when, where, and how planned improvement was completed. If planned improvement was not completed, please provide explanation.)*
	writing classes so that they can begin to achieve more excellent or good ratings on their first attempt. We will begin incorporating some sort of self-assessment of proofs in our introductory classes next year.	before majors actually present their completed products in the course. The self- and peer-assessments start in MA 210 and carry on as part of all subsequent proof courses.
Mathematics graduates connect mathematical ideas to real-world applications, including the creation and interpretation of mathematical models.	We plan to use MA 218 as a draw for biology majors, particularly those interested in pre-med. The class has been redesigned to incorporate biological applications in order to attract these students, and the assessment shows that the projects have been very successful in allowing students to connect mathematics with real-world applications. We hope to encourage strong biology majors to consider double-majoring in mathematics, or to consider minoring in mathematics or to pursue the interdisciplinary minor. The projects continue to be an important part of this process.	MA 218 now attracts many biology majors and some IT and Business majors. Enrollment in the course has effectively quadrupled compared to what we saw under the old model. Several IT majors and some biology majors have taken advantage of the opportunity to earn a math minor and/or quantitative sciences minor. In a redesign of MA 218, most of the technology assignments were removed from the course and put into a new course, MA 230 Scientific Computing, but the focus on connecting mathematical ideas to real-world applications remains in MA 218. Data presented and assessed in this report focuses on the outcomes observed for the math majors only.
Mathematics graduates pose, research, and address new mathematical questions.	In order to help us reach a larger student population with this learning outcome, we plan to incorporate a small research project into our MA 420, Abstract Algebra class. Students will be asked to come up with a question that arises from the course content, and will be asked to attempt to research whether the problem has already been solved, and if not, attempt to formulate a proof themselves. Unfortunately, since this class is currently being offered, and is offered only every other year, this change will not be in place in time for the next assessment cycle report of this learning outcome, but we will assess it in fall 2016.	The small research project was incorporated into MA 420. Existing project assignments remain in MA 218, MA 418, and MA 427. The data presented in this assessment report focuses on how well the math majors did when completing those projects. All combined, these projects give us insight into our majors' abilities to achieve this outcome in our pure and applied mathematics courses as well as in math education.

Provide a response to last year's University Assessment Committee review of the program's learning assessment report:

Executive Summary – *marked Exemplary*

Comment: Well done!

Implemented Improvements from Previous Year – *marked Exemplary*

Comment: Included UAC 13-14 UAC comments for context.

Outcomes – *marked Exemplary*

Comment: LO5 is not as strong as others – articulate for what purpose?

Assessment Measures and Targets – *marked Acceptable*

Comments: Is MA 209/309/409 the same course? Different courses with different outcomes? Are you using the same rubric to evaluate performance at the 200-level as at the 400-level? Do you have the same performance standards? The first three measures on Outcome 3 are unclear. Are these the separate courses or are you looking at different traits on the rubric? You have 14 measures for this outcome. Despite this large number, you do a good job of analyzing the results for directions for improvement.

For outcome 5, there is nothing in the pre- and post-survey that relates to summer programs or internships. It seems that only questions 2 and 3 on the pre-and-post are related to the outcome.

Please report results only of Math majors. Track results by student, then pull out only those students who are majors. It would be interesting to look at performance of majors v. non-majors.

Analysis of Results and Implications – *marked Exemplary*

Comment: Good job with the analysis.

Use of Assessment to Improve Effectiveness – *marked Exemplary*

Comment: Planned improvements clearly derived from results.

Other comments:

Kudos for an excellent report! The committee appreciates the organization and clear explanation of the process and results.

Page numbers would be helpful. It's a long report.

Report Accepted as Submitted

Recommendations for Next Year's Assessment Process:

Consider looking at trends by comparing to the last time each LO was assessed. Consider ways to "stretch" to move this program to the next level since you are meeting all LOs, for the most part. Please look at majors, rather than at all students. Consider making distinctions between expectations for 200-level students and 400-level students.

Response: The math seminar course, MA 210/309/409, is made up of three different courses but they all meet at the same time on Wednesday afternoons in the fall. MA 210 has an additional meeting on Wednesday mornings to introduce proof techniques and build community. The course numbers indicate the sophomore/junior/senior level of the majors in the course. Students in the different levels of seminar are given different assignments with different levels of expectations, even if the same rubric is used to assess the majors. As students develop in the major, they are given more responsibilities as peer mentors and the focus of their assignments adjust from introductory proofs and relatively simple oral presentations to career-focused development activities and more complex presentation topics. This course is a hallmark of the program.

The department does look for trends. Even when the program meets LOs, the program sees room for improvement and challenges itself to continue to be innovative with curriculum and assessment strategies. As courses are redesigned or newly developed, assessment data collected may not directly match the way the program presented the material many years back. Still a window to the past exists and the program uses that knowledge to gauge the success of all changes implemented. The program only considers majors when assessing LOs. The expectations for 400-level majors are significantly higher than those for 200-level majors, even when the same rubric is used to assess an outcome. We will try to spell that out more clearly in our reports. Due to the small size of the major, the program often does not have enough data to pull meaningful insights by looking at only one cohort. For this reason, the program relies on trends and comparisons across cohorts to gain insight.

Outcomes Assessment 2017-2018

Learning Outcome 1: Mathematics graduates gather, evaluate, and use relevant mathematical definitions and results to create logical, grammatically correct proofs.

Assessment Activity

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process.* *2) Present the findings of the analysis including the numbers participating and deemed acceptable.*
MA 261: direct assessment of student performance on proofs tracked on Quizzes and Exam (Schaefer, Fall 2014)	We hope that 80% of assessed proofs meet the G/E standard.	The class had 5 majors in it, and of these majors 2 frequently missed class or did not hand in homework. Only 3 of the majors met prerequisites to continue.	The detailed analysis can be found in the appendix. It shows that we are only hitting 52% success rate. This was the last time we offered this course. We determined that this 1-credit add-on to the existing 260 Discrete Math requirement did not work well. First, the level of 260 was too easy and lulled majors into a false sense of security for 261, and second the 1 credit hour did not encourage enough attention to the goals in this course. Therefore, we changed this course for the next offering to be part of a 3-credit course that includes seminar, i.e., the formation of MA 210 from MA 261 and the old sophomore seminar MA 209.
MA 210: direct assessment of students graded proofs on their midterm and final. (Lenz, Fall 2016)	We would like to have 80% of the majors perform at the good or excellent level in the ability write mathematical proofs.	There were 3 majors in the fall 2016 class. Detailed rubrics were collected for proofs on the midterm and the final exams.	**Midterm:** 5 proofs were graded on the in-class exams, and revisions to all off those proofs were also graded. A total of 15 proofs were graded for the midterm exam in the class. Results: 12 out of 15 proofs (80%) were excellent or good. **Final Exam:** 7 proofs were graded on the final exam. A total of 21 proofs were graded for the final exam in the class. Results: 14 out of 21 proofs (67%) were excellent or good on the final exam. The majors' proof-writing performance dropped a bit from the midterm to the final exam. This is likely because the proof-writing at the end of the course was much more difficult and involved than the proof-writing at the beginning of the course. It does not really make sense to try and interpret the statistical results since the class only had 3 majors. Two of the majors were quite strong proof writers and one of the majors was fairly weak. The 67% result calculated above for the final exam proof-writing accurately represents this fact.

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process.* *2) Present the findings of the analysis including the numbers participating and deemed acceptable.*
MA 210: direct assessment of students' graded proofs written on their exams. (Lenz, Fall 2017)	We would like to have 80% of the majors perform at the good or excellent level in the ability write mathematical proofs.	There were 7 majors in the fall 2017 class. Detailed rubrics were collected for proofs on the final exam.	**Final Exam:** 7 proofs were graded for each major on the final exam for a total of 49 proofs. Results: 29 out of 49 proofs (59%) were excellent or good The majors were not able to achieve the 80% goal of excellent or good proofs on the final exam. Since this is the very first introduction to proofs for most math majors, the department should rethink whether the 80% goal makes sense. If we include "Fair" proofs in the goal, we have 44 out of 49 proofs at Excellent, Good, or Fair, which is almost 90%.
MA 215: direct assessment of student performance on proofs tracked on tests/final (with some revisions on tests). (Gammack, Spring 2015)	We hope that 80% of assessed proofs will be at the A/C level by the end of the semester.	The class had 8 students in it, all math majors - one of whom was retaking the class. Of these, 1 frequently missed class, another did not complete class prep work and therefore was not "active" during class periods. For the final exam, averaged over all the proof questions, 60% of majors achieved the hoped for level. Of the 8 majors in the class, 3 failed to meet prerequisites to continue.	Assessment included one proof that was repeated (on a test, then revised, then appeared on the final) and five proofs that were on the final exam. There were other proofs throughout the seminar, but we talked about them seminar-style in the class and they would have biased the results (as majors were walked through chunks of each proof). Each proof was graded using the rubric included in the appendix – which is similar to our general proof rubric but with friendlier labels (it's an intro to proof course!) of Acceptable/Close/Fair/Needs Help/Poor. The full findings can also be found in the appendix. This course was modified for this semester. It went from being an applications-oriented course to one used as an introduction to proofs. As the class size was small, a seminar style was used rather than lecture-based approach. It may be better next time to use a more directed approach - more time walking through proofs on the board, less time in groups. Although the goal was not met, this first attempt shows promise. As this is supposed to be an introduction to proofs, the department should discuss the 80% mark we have set ourselves and/or if the A/C (or G/E) level is what we should aim for in every proof course. Not all proofs are equal!
MA 215: direct assessment of students' proofs written for homework and on their exams. Only the proofs on the final exam were included in this assessment.	We would like to have 80% of the majors perform at the good or excellent level in the ability to write mathematical proofs.	There were 8 majors in the class. Detailed rubrics were collected for proofs on exams, including the final exam.	**Midterm:** 4 proofs were graded on the midterm. A total of 32 proofs were graded for the midterm for the class. Results: 20 out of 32 (63%) were excellent or good on the midterm.

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(Lenz, Spring 2017)			**Final Exam:** 4 proofs were graded on the final exam. A total of 32 proofs were graded for the final exam in the class. Results: 18 out of 32 proofs (56%) were excellent or good on the final exam. If we include "Fair" proofs in our total to consider the number of proofs that were Excellent, Good, or Fair, the percentage of proofs achieving the goal on the two exams increases to 70%. This goal was not met, but we realized that we need to re-evaluate our goal and think about what is reasonable.
MA 257: direct assessment of students through graded proofs written for homework and on their exams. (Lenz, Spring 2016)	We would like to have 80% of the majors perform at the good or excellent level in the ability write mathematical proofs.	There were 7 majors in the class. Detailed rubrics were collected for proofs on the midterm and the final exam.	**Midterm Exam:** 4 proofs were graded for each major on midterm, for a total of 28 proofs. Results: 16 out of 28 proofs (57%) were excellent or good **Final Exam:** 6 proofs were graded for each major on the final exam for a total of 42 proofs. Results: 33 out of 42 proofs (78%) were excellent or good on the final exam. The majors were not able to achieve the 80% goal of excellent or good proofs at the midterm point of the semester, however, there was a marked improvement in majors' proof writing by the end of the semester, when the 80% goal was essentially achieved. Since this is an introductory proof writing course for math majors, this type of improvement is exactly what we hope to see by the end of the course.
MA 257: direct assessment of students through graded proofs written for homework and on their exams. (Lenz, Spring 2018)	We would like to have 80% of the majors perform at the good or excellent level in the ability write mathematical proofs.	There were 8 majors in the class. Detailed rubrics were collected for proofs on the two in-class exams and the final exam.	Exams: 4 proofs were graded for each major on exams 1 and 2, for a total of 64 proofs. Results: 28 out of 64 proofs (44%) were excellent or good. Final Exam: 6 proofs were graded for each major on the final exam for a total of 48 proofs. Results: 21 out of 48 proofs (44%) were excellent or good on the final exam. The majors were not able to achieve the 80% goal of excellent or good proofs at any point during the semester. It is disappointing not to see some improvement by the end of the semester. This is the first time since I started teaching this class that there has been no improvement in proof writing on the

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process.* *2) Present the findings of the analysis including the numbers participating and deemed acceptable.*
			final exam. As a department we will continue to discuss ways to improve the proof writing abilities of our introductory majors.
MA 420: direct assessment of students' graded (with a revision process) proofs written for homework and on their exams. (Lenz, Fall 2014)	We would like to have 80% of the majors perform at the good or excellent level in the ability write mathematical proofs.	There were 4 majors in the fall 2014 class. Detailed rubrics were collected for proofs and revisions to proofs on homework assignments, 2 in class exams, and the final exam.	**Homework:** 34 proofs were graded for each major, and revisions to those proofs were also graded. A total of 272 proofs were graded for homework in the class. Results: 70 out of 136 proofs (51%) were excellent or good on the first attempt, 105 out of 136 (77%) were excellent or good on the second attempt. **Exams:** 10 proofs were graded for each major's in-class exams, and revisions to all off those proofs were also graded. A total of 80 proofs were graded for exams in the class. Results: 21 out of 40 proofs (52.5%) were excellent or good on the first attempt, 33 out of 40 (82.5%) were excellent or good on the second attempt. **Final Exam:** 5 proofs were graded for each major on the final exam with no revisions. A total of 20 proofs were graded for the final exam in the class. Results: 18 out of 20 proofs (90%) were excellent or good on the final exam.
MA 420: direct assessment of students' graded (with a revision process) proofs written for homework and on their exams. (Lenz, Fall 2016)	We would like to have 80% of the majors perform at the good or excellent level in the ability write mathematical proofs.	There were 6 majors in the class. Detailed rubrics were collected for proofs and revisions to proofs on homework assignments, 2 in class exams, and the final exam.	**Homework:** 22 proofs were graded for each major, and revisions to those proofs were also graded. A total of 264 proofs were graded for homework in the class. Results: 67 out of 132 proofs (51%) were excellent or good on the first attempt, 109 out of 132 (83%) were excellent or good on the second attempt. **Exams:** 8 proofs were graded for each major's in-class exams, and revisions to all off those proofs were also graded. A total of 96 proofs were graded for exams in the class. Results: 26 out of 48 proofs (54%) were excellent or good on the first attempt, 30 out of 48 (62.5%) were excellent or good on the second attempt. **Final Exam:** 5 proofs were graded for each major on the final exam with no revisions. A total of 30 proofs were graded for the final exam in the class.

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process.* *2) Present the findings of the analysis including the numbers participating and deemed acceptable.*
			Results: 15 out of 30 proofs (50%) were excellent or good on the final exam.
MA 425: direct assessment of student work graded throughout the semester, including revisions. (Schaefer, Fall 2014)	We hope that 80% of assessed proofs will be at the G/E level.	This class was an independent study for our top two majors who are graduating to accommodate a change to our course rotation. The raw data for all original and revised proofs is attached as a scan and is summarized below: E (212), G (48), F (35), M (12), P (9), showing that 83% of the proofs were at the G/E level.	These were excellent majors who performed at a consistently high level throughout the semester, each completing about 160 proofs. Seeing the summary ratings makes me rethink our standard of 80% scoring E/G. Perhaps this is too high a mark. These two graduates would compete well on a national level in their proof-writing abilities, and part of the inquiry process to be challenged and work on unfamiliar, new problems. With that will come failures, and that's not to be translated as a failure to the student or the program. I didn't think adding these two majors to our assessment would be useful, but it was.
MA 425: direct assessment of student work graded throughout the semester, including revisions. (Schaefer, Fall 2015)	A new rubric for this course (see attached), so we were unsure what the level should have been. Our standard goal is to have 80% of the majors perform at the good or excellent level in the ability write mathematical proofs.	This course was taught to only three math majors, all of whom should have been successful. The majors struggled, as every major is expected to struggle for this course, and ultimately the instructor was satisfied with the majors' growth in reasoning and proof-writing. Each major performed at the 70% or above mark, as measured by rubric points earned over rubric points possible. Perhaps this is a better standard than the good/excellent for prior proofs?	Majors observed that the one major who had taken MA 215 and not MA 257 or MA 420 as a prerequisite were at a disadvantage, particularly given the intense attention given to their writing in this course. The instructor was satisfied with student learning and performance, but notes the huge time commitment required of the majors. The instructor urges the 4 credits earned by majors to become the standard (offered as a temp course this year).
MA 425: direct assessment of students' graded (with a revision process) proofs written for homework and on their exams.	We would like to have 80% of the majors perform at the good or excellent level in the ability write mathematical proofs.	There were 6 majors in the class. Detailed rubrics were collected for proofs and revisions to proofs on homework assignments, 2 in class exams, and the final exam.	**Homework:** 33 proofs were graded for each major, and revisions to those proofs were also graded. A total of 396 proofs were graded for homework in the class.

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(Lenz, Fall 2017)			Results: 142 out of 198 proofs (72%) were excellent or good on the first attempt, 169 out of 198 (85%) were excellent or good on the second attempt. **Exams:** 8 proofs were graded on the in-class exams, and revisions to all off those proofs were also graded. A total of 96 proofs were graded for exams in the class. Results: 31 out of 48 proofs (65%) were excellent or good on the first attempt, 40 out of 48 (83%) were excellent or good on the second attempt. **Final Exam:** 4 proofs were graded on the final exam with no revisions. A total of 24 proofs were graded for the final exam in the class. Results: 18 out of 24 proofs (75%) were excellent or good on the final exam.
MA 427: direct assessment of multiple geometric proofs related to congruence properties of triangles and quadrilaterals. Proofs are submitted in written form. At least one revision is required for any proof not meeting E or G guidelines. (Petillo, Spring 2017)	We would like to have 80% of the proofs considered be at the good or excellent level when submitted.	There was one major in the class (offered as an independent study). The major was graded on proofs as classwork and also on exams. Revisions were allowed for each of the proofs.	The major needed guidance to not assume statements that had not yet been proven and to not overly interpret or rely on diagrams. Proofs on the midterm and final exam were rated G. The majority of proofs were assigned a rating of G. A smaller number of proofs were rated E, F or P. Approximately 85% of the proofs were at the G or E level.

Interpretation of Results

Describe the extent to which this learning outcome has been achieved by students:
MA 210 / MA 261: The department recognized that the format of the 1-credit MA 261 was hindering our ability to achieve what we hoped for in the course. We therefore combined the content of the course with our sophomore seminar course, formerly MA 209, to create the 3-credit MA 210 course. The new model showed promise, but majors were still unable to achieve the 80% goal of excellent or good proofs on their ability to write mathematical proofs. The department will rethink whether the 80% goal makes sense and whether including “Fair”proofs in the goal is reasonable.

MA 215: The majors were not able to achieve the 80% goal of excellent or good proofs on their first attempt. Perhaps this goal is set a bit too high considering first that this is an introduction to proof class, and second that Excellent and Good represent receiving an “A” or a “B” on the proof, and we do not have 80% of our majors receiving an A or B in most classes. We can consider either lowering the 80% expectation, or we can include “Fair” proofs in our total (the equivalent of receiving a “C” on the proof). We will re-evaluate this goal as a department to determine whether it is a reasonable expectation.

MA 257: Mixed results were seen in this course during this assessment cycle. One class saw improvements during the semester to essentially achieve the goal we hope to reach. However, another very recent class showed no such improvement and was far from achieving the goal we set. We have seen difficult years in the past. Such times make us to do a lot of soul searching. We will be discussing ways to improve the proof writing abilities of our introductory majors.

MA 420: The majors were not able to achieve the 80% goal of excellent or good proofs on their first attempt. They were, however, able to meet this goal upon revision of their first attempt. This confirms the discovery in our previous assessment that the majors need to work on their self-assessment of the first draft of their proofs. To address this, we added peer-assessment of proofs into the seminar class for the first time during the Fall 2015 semester. We also added peer-assessment into MA 257 (Spring 2016) and MA 420 (Fall 2016). We hope to see improvement in our majors’ first draft proof writing in future proof writing courses as we improve this process and self-assessment becomes more familiar. At this point, we have not seen the improvement in our majors’ first draft proof writing in this course as a result of this. The revision process has typically been driven entirely by professor feedback, which does not seem to be producing the desired effect. The majors are handing in deficient proofs even after receiving the feedback. It seems we need to add in some process for self as well as peer evaluation of proofs in order for the majors to more clearly understand when their final product has met the expectation.

MA 425: A new rubric was developed for this course. In the most recent iteration of the course, majors were not always able to achieve the 80% goal of excellent or good proofs on their first attempt. They were, however, able to meet this goal upon revision of their first attempt. We have included some peer assessment into all of our proof writing classes, and as such, have seen some improvement in the majors’ first drafts of proofs. For example, in Fall 2014, majors in MA 420, a comparable senior level proof writing course, had only a 51% achievement for excellent or good first draft proofs on the homework assignments. The majors in this class had a 72% achievement for excellent or good first drafts. We will continue to use peer review in all of our proof writing classes in order to increase our majors’ self-assessment abilities.

MA 427: The goal was met, but we have only had one major take this course since our last assessment, and that major was one of our top majors. It was useful to see where this major struggled with proofs after having already taken all of the introductory proofs courses and one advanced proofs course.

Briefly describe program strengths and opportunities for improvement <u>relative to assessment of outcome</u>:
The data shows that we are meeting our goal for proof writing only when majors are allowed to revise their proofs, and only the revisions are counted. Following our previous assessment of this goal, we determined that changes needed to be made to address this LO, especially in our introductory proof courses. We merged the content from MA 261 with the sophomore seminar course to create a more structured introduction to proofs course in MA 210. We have also added self- and peer-assessment activities to all proof courses with the aim of training majors to recognize where their work stands with respect to our expectations. We will likely get a fuller picture of the effects of these changes in our next assessment of this LO. At this point, we are not meeting our goals and it is apparent we need to do more.

In our last assessment of this goal (2014), we found that in MA 215 less than 40% of proofs were at the excellent or good level, which means that removing the technology component of the course to focus on the proofs had a marked effect. In MA 257, majors were at or very close to the 80% goal of excellent or good proofs, which means we slipped in the latest results for this course. There was evidence that MA 261 was faltering in the previous assessment, which was the beginning of our decision to redesign that course. In MA 420, majors were not able to achieve the 80% goal of excellent or good proofs on their first attempt; however, they were able to surpass the goal upon revision of their first attempt, which is similar to what we saw this time around. In MA 425, 62% of majors performing at the excellent or good level for proof writing, which means we did see some improvements in this course, but we are still not entirely satisfied with the outcome.

Discuss planned curricular or program improvements <u>for this year based on assessment of outcome:</u>
We continue to explore ways for majors to achieve close to the revision level proof on their first attempt. Incorporating more self- and peer-assessment at all levels of proof courses will, we hope, help address this issue. We will rethink our expectations, especially with regard to the introduction level courses, to determine what is realistic and reasonable. We may also revisit the credit hour expectations for the upper-level proof courses, MA 420 and MA 425, as the amount of work required may justify an adjustment there.

Learning Outcome 2: Mathematics graduates connect mathematical ideas to real-world applications, including the creation and interpretation of mathematical models.

<u>Assessment Activity</u>

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process.* *2) Present the findings of the analysis including the numbers participating and deemed acceptable.*
MA 218: direct assessment of a term project in which students had to come up with testable hypotheses on their own, design an experiment, gather data, and analyze and interpret their results. They had to submit a written report and present their results orally in class. The project description and rubrics are attached. (Heuett, Spring 2015)	We hope that 80% of majors perform at the G/E level according to the attached rubric.	There were 28 students enrolled in the course, 10 of which were math majors and three (3) were minors. Project reports were collected and the ability to connect mathematical ideas to the real-world application was assessed as part of the attached rubric.	As part of their term project, students were required to make clear connections between the data collected and the aims of the project, properly and adequately interpret their results/conclusions, and state their conclusions in terms of the physical questions posed. This fell under the Conclusion/accuracy of interpretation section of the rubric. Nine of the 10 (90%) majors received excellent or good ratings in this area, while all three (100%) of the minors achieved this rating. The standard was met.
MA 218: direct assessment of a term project in which students had to come up with testable hypotheses on their own, design an experiment, gather data, and analyze and interpret their results. They had to submit a written report and present their results orally in class. The project description and rubrics are attached.	Same as above.	There were 20 students enrolled in the course, four (4) of which were math majors and three (3) were minors. Project reports were collected and the ability to connect mathematical ideas to the real-world application was assessed as part of the attached rubric.	As part of their term project, students were required to make clear connections between the data collected and the aims of the project, properly and adequately interpret their results/conclusions, and state their conclusions in terms of the physical questions posed. This fell under the Conclusion/accuracy of interpretation section of the rubric. All four (100%) of the majors received excellent or good ratings in this area. Two of the three minors received excellent or good ratings in this area. The standard was met.

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process.* *2) Present the findings of the analysis including the numbers participating and deemed acceptable.*
(Heuett, Spring 2016)			
MA 218: direct assessment of a term project in which students had to come up with testable hypotheses on their own, design an experiment, gather data, and analyze and interpret their results. They had to submit a written report and present their results orally in class. The project description and rubrics are attached. (Heuett, Spring 2017)	Same as above.	There were 21 students enrolled in the course, two (2) of which were math majors. Project reports were collected and the ability to connect mathematical ideas to the real-world application was assessed as part of the attached rubric.	As part of their term project, students were required to make clear connections between the data collected and the aims of the project, properly and adequately interpret their results/conclusions, and state their conclusions in terms of the physical questions posed. This fell under the Conclusion/accuracy of interpretation section of the rubric. Both (100%) of the majors received excellent or good ratings in this area. The standard was met.
MA 218: direct assessment of a term project in which students had to come up with testable hypotheses on their own, design an experiment, gather data, and analyze and interpret their results. They had to submit a written report and present their results orally in class. The project description and rubrics are attached. (Heuett, Spring 2018)	Same as above.	There were 19 students enrolled in the course, four (4) of which were math majors and two (2) were minors. Project reports were collected and the ability to connect mathematical ideas to the real-world application was assessed as part of the attached rubric.	As part of their term project, students were required to make clear connections between the data collected and the aims of the project, properly and adequately interpret their results/conclusions, and state their conclusions in terms of the physical questions posed. This fell under the Conclusion/accuracy of interpretation section of the rubric. All six (100%) of the majors received excellent or good ratings in this area. The standard was met.
MA 325: direct assessment of two projects – one that linked bifurcation analysis to a real world problem of logistic growth with different harvesting	We hope that 80% of majors perform at the G/E level according to the attached rubric.	Details about the data collected and the assessment analysis for this class of 11 majors are attached.	Students were instructed to complete assignments that required drawing connections to real-world applications. Their submitted reports were graded for correct analysis and synthesis when drawing connections among ideas. The data shows good

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process.* *2) Present the findings of the analysis including the numbers participating and deemed acceptable.*
schemes and another that involved the analysis of differing Holling types of population growth. (Heuett, Fall 2014)			achievement for this goal. We averaged 79% at the G/E level in associated rubrics. The standard was essentially met.
MA 325: direct assessment of two projects – one that linked bifurcation analysis to a real world problem of logistic growth with different harvesting schemes and another that involved the analysis of differing Holling types of population growth. (Heuett, Fall 2016)	Same as above.	Details about the data collected and the assessment analysis for this class of eight (8) majors are attached.	Students were instructed to complete assignments that required drawing connections to real-world applications. Their submitted reports were graded for correct analysis and synthesis when drawing connections among ideas. The data shows good achievement for this goal. We averaged 100% at the G/E level in associated rubrics. The standard was met.
MA 418: direct assessment of an oral presentation for which students researched and presented real-world applications of stochastic modeling. (Heuett, Spring 2016)	We would like to have 80% of the majors perform at the good or excellent level in the ability to communicate mathematical ideas in oral presentations.	There were three (3) majors in the class. The presentations were assessed using the attached rubric.	For the category of *connections among ideas*, all three (100%) of the majors received ratings of excellent or good. The standard was met.
MA 418: direct assessment of an oral presentation for which students researched and presented real-world applications of stochastic modeling. (Heuett, Spring 2018)	Same as above.	There were seven (7) majors in the class. The presentations were assessed using the attached rubric.	For the category of *connections among ideas*, six (86%) of the seven majors received ratings of excellent or good. The standard was met.

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.*

Interpretation of Results

Describe the extent to which this learning outcomes has been achieved by students:
MA 218: Students were required to complete a term project, submit a written report, and present their results orally to the class. For the project, students had to come up with testable hypotheses on their own, design an experiment and gather the data to address their hypotheses, and then use statistical procedures to analyze and interpret their results. The grading rubrics for the project included sections that focused on the mathematical content as well as the interpretation of results and conclusions to assess the students' ability to properly convey statistical results in real-world situations. Majors generally did very well when conveying statistical results in terms of the real-world application. Most majors received praise for their insightful comments, discussions, and their ability to convey their work. Majors whose grades were deducted received those deductions as a result of an incorrect application of a statistical significance test, not because they incorrectly interpreted a result per se.

MA 325: This is the programs primary inquiry courses. As such, we are happy to see that we have met our goal for this LO in this course. We further support the lessons of this course in MA 418 as both are upper-level applied mathematics courses with an emphasis on real-world applications and their interpretations.

MA 418: The students were required to research and present a real-world application of the stochastic modeling techniques they had learned during the semester. The presentation was an oral presentation to the class. Students were graded on the mathematical content of their presentations as well as their ability to understand and explain the stochastic modeling techniques used in the real-world application. Majors generally did an exceptional job identifying and presenting the connections between the course content and the applications.

Briefly describe program strengths and opportunities for improvement <u>relative to assessment of outcome</u>:
It seems that we are continuing to meet our goal in this area. We are collected a lot of data on projects and presentations that involve connections between mathematical models and real-world applications. We will continue to collect as much data as possible on our projects in our modeling classes in order to make sure we continue to meet our goal in this area.

When we compare the data between MA 218, MA 325, and MA 418 we see that majors are retaining what they have learned about drawing real-world connections. Our expectations for upper-level courses are significantly higher than for lower-level courses. The fact that the majors continue to achieve our goal indicates that the majors are growing in this respect.

Discuss planned curricular or program improvements <u>for this year based on assessment of outcome:</u>
There is a growing interest among our majors to pursue research and careers that are data-centric and statistical in nature. There is a growing synergy among the faculty and the math, IT, and economics majors with an interest in having more data analytics and statistics opportunities in the curriculum. To address these demands, we are considering developing a new 300-level data analytics course that will require MA 218 and MA 230 prerequisites. That course will surely have real-world applications and projects that we

can use to add to our assessment of this LO. We are also currently working with the other majors to develop a Statistics minor as well as a Professional Sciences Masters degree in data analytics. Once in place, these new opportunities will open doors for our majors and perhaps draw more students into the math major and/or minor.

Learning Outcome 6: Mathematics graduates pose, research, and address new mathematical questions.

Assessment Activity

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process.* *2) Present the findings of the analysis including the numbers participating and deemed acceptable.*
MA 218: direct assessment of a term project in which students had to come up with testable hypotheses on their own, design an experiment, gather data, and analyze and interpret their results. They had to submit a written report and present their results orally in class. The project description and rubrics are attached. (Heuett, Spring 2015)	We hope that 80% of majors perform at the G/E level according to the attached rubric.	There were 28 students enrolled in the course, 10 of which were math majors and three (3) were minors. Project reports were collected and the LO was assessed using the overall project grade as determined by the attached rubric.	One math major performed at the F (for Fine) level, two performed at the G level, and seven performed at the E level. In total, nine (90%) of the 10 majors received excellent or good ratings in this area. All three (100%) of the minors achieved the excellent rating. The standard was met.
MA 218: direct assessment of a term project in which students had to come up with testable hypotheses on their own, design an experiment, gather data, and analyze and interpret their results. They had to submit a written report and present their results orally in class. The project description and rubrics are attached. (Heuett, Spring 2016)	Same as above.	There were 20 students enrolled in the course, four (4) of which were math majors and three (3) were minors. Project reports were collected and the LO was assessed using the overall project grade as determined by the attached rubric.	Two majors performed at the G level and two performed at the E level. Combined, all four (100%) of the majors received excellent or good ratings in this area. One minor performed at the P level, having not turned in a report, one performed at the G level, and one at the E level, so that two of the three minors received excellent or good ratings in this area. The standard was met.

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process.* *2) Present the findings of the analysis including the numbers participating and deemed acceptable.*
MA 218: direct assessment of a term project in which students had to come up with testable hypotheses on their own, design an experiment, gather data, and analyze and interpret their results. They had to submit a written report and present their results orally in class. The project description and rubrics are attached. (Heuett, Spring 2017)	Same as above.	There were 21 students enrolled in the course, two (2) of which were math majors. Project reports were collected and the LO was assessed using the overall project grade as determined by the attached rubric.	One of the majors performed at the G level and one performed at the E level. Thus both (100%) of the majors received excellent or good ratings in this area. The standard was met.
MA 218: direct assessment of a term project in which students had to come up with testable hypotheses on their own, design an experiment, gather data, and analyze and interpret their results. They had to submit a written report and present their results orally in class. The project description and rubrics are attached. (Heuett, Spring 2018)	Same as above.	There were 19 students enrolled in the course, four (4) of which were math majors and two (2) were minors. Project reports were collected and the LO was assessed using the overall project grade as determined by the attached rubric.	One of the majors performed at the G level, while the other three performed at the E level. One of the minors performed at the G level, while the other one performed at the E level. Combined, all six (100%) of the majors received excellent or good ratings in this area. The standard was met.
MA 427: direct assessment of the Triangle Centers Project. Students create the four classic triangle centers using dynamic geometry software. Students then research and investigate one of several additional geometric theorems. Students use the software to pose	We would like to have 75% of the majors perform at the 80% level as defined by the rubric in the ability to use dynamic geometry software to pose, research and address mathematical questions.	There was one major in the class (it was offered as an independent study). The project was collected and assessed using the attached rubric. The major earned above a 90% on the project.	The major was able to complete the triangle centers project as well as the independent investigation at the 90% level or above.

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.*
questions, provide verification and demonstrate their conjectures. The project description and rubric are attached. (Petillo, Spring 2017)			
MA 433: indirect assessment of student-faculty research collaboration. (Schaefer, Spring 2014 – Spring 2015)	Model selection for many models for cholera.	One major worked with Dr. Schaefer and another faculty member from Illinois State University. Student presented at MU Student Research Conference in Spring 2015. Also, student is coauthor in a non-student research paper published in the Bulletin for Mathematical Biology.	Major went on to pursue a PhD in Mathematics at the University of Illinois Chicago. Student says the research experience was pivotal to this decision.
MA 433: indirect assessment of student-faculty research collaboration. (Schaefer, Spring/Summer 2015)	Parameter analysis for a West Nile virus model.	Two majors worked with Dr. Schaefer and another faculty member from VCU. The majors presented their findings at an MAA Mathfest, a national meeting, in August, 2015.	Student presentation was well-performed. Majors cited research opportunity as inspiring and encouraging many times. Majors received summer funding from DISCOVER and from Jeffress grant.
MA 433: indirect assessment of student-faculty research collaboration. (Schaefer and Heuett, Fall 2015)	Spatial Models for West Nile virus.	Major submitted presentation slides and annotated bibliography as part of project. Major presented at MU Student Research Conference in 2016.	This major probably learned from the project that a career in researcher is not a match. The major definitely appreciated the exposure. In the future, we would advise against research credits concurrent with enrollment in Real Analysis.
MA 433: indirect assessment of student-faculty research collaboration.	Analysis and Exploration of Spatial Epidemic Models.	Major submitted presentation slides and annotated bibliography as part of project.	This major also learned that a career in research is not a match, but very much appreciated the exposure and experience.

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define and explain acceptable level of student performance.*	**Data Collection** *Discuss how the data was collected and describe the student population*	**Analysis** *1) Describe the analysis process.* *2) Present the findings of the analysis including the numbers participating and deemed acceptable.*
(Heuett and Schaefer, Fall 2015 – Spring 2016)			
MA 433: indirect assessment of student-faculty research collaboration. (Heuett, Spring 2017)	Data analysis and modeling of female long distance running injuries.	Major submitted thesis and annotated bibliography as part of project.	This major conducted this research in conjunction with an honors thesis. The project provided an additional learning experience for the major to do more mathematical modeling with real data than what was involved in the thesis. Major does not plan to pursue a career in research.

<u>**Interpretation of Results**</u>

Describe the extent to which this learning outcomes has been achieved by students:
MA 218: Students are expected to come up with original questions, turn them into testable hypotheses, and then design a procedure to collect data and perform an analysis that will address their hypotheses. This is a term project that draws from the course content throughout the semester. Statistics lends itself nicely to this type of project. Students respond very well to the opportunity and usually get a lot out of the experience. We can see that we are meeting our expectations for this LO in this particular course. Many majors are inspired to pursue more data-oriented research with faculty after taking this course and ask what other courses they might take in this area.

MA 427: The goal was met, but we have only had one major take this course since our last assessment, and that major was one of our top majors. It was useful to see where this major struggled when completing the project.

Briefly describe program strengths and opportunities for improvement <u>relative to assessment of outcome</u>:
The data shows that we are meeting our goal in this area. However, we feel that we would like to collect more data about this LO as most of what we have at this time is limited to MA 218 projects and anecdotal evidence from (usually top) majors who pursue research with faculty.

Discuss planned curricular or program improvements <u>for this year based on assessment of outcome:</u>
We may take a look at some of our other courses, e.g., MA 230, MA 325, MA 418, and think about how we might add or revise projects in those courses to provide additional opportunities for majors to pose, research, and address new mathematical questions. We may also create a survey or some sort of formal assessment tool for those majors who conduct research with faculty so that we can get more relevant data to incorporate into our assessment.

As described above, we are planning to develop a new 300-level data analytics course that will require MA 218 and MA 230 prerequisites. This course would meet demand for a follow-up course to MA 218 and produce additional opportunities for us to assess this LO.

Appendices

- *Rubrics appear in the following order:*
    - Standard Math Proof Rubric (*used in MA 261, MA 210, MA 257, and MA 420*)
    - MA 215 – Proof Rubric
    - MA 425 – Proof Rubric
    - Project Evaluation Rubric (*MA 218*)
    - Discover Assessment Tool (DAT) – Differential Equations Project (*MA 325*)
    - Discover Assessment Tool (DAT) – Stochastic Modeling Project (*MA 418*)
    - Rubric for Short Oral Presentation (*standard rubric used for oral presentations in MA 210/309/409, MA 218, and MA 418*)
    - Grading Rubric (*MA 427*)
- *Detailed assessment analyses appear in the following order:*
    - MA 261 – Fall 2014 Assessment Summary (LO1)
    - MA 210 – Fall 2016 Assessment Summary (LO1)
    - MA 215 – Spring 2015 Assessment Summary (LO1)
    - MA 257 – Spring 2016 Assessment Summary (LO1)
    - MA 420 – Fall 2014 Assessment Summary (LO1)
    - MA 420 – Fall 2016 Assessment Summary (LO1)
    - MA 425 – Fall 2015 Assessment Summary (LO1)
    - MA 325 Differential Equations – Fall 2014 Assessment Summary (LO2)
    - MA 325 Differential Equations – Fall 2016 Assessment Summary (LO2)