Executive Summary

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

<table>
<thead>
<tr>
<th>Learning Outcome</th>
<th>Year of Last Assessment</th>
<th>Year of Next Planned Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(current report)</td>
</tr>
<tr>
<td>2. Mathematics graduates connect mathematical ideas to real world applications; in other words, they can create and interpret mathematical models.</td>
<td>2010 - 2011</td>
<td>2013 – 2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(current report)</td>
</tr>
<tr>
<td>5. Mathematics graduates are able to articulate career, internship, and summer research program opportunities for mathematicians.</td>
<td>2011 – 2012</td>
<td>2014 – 2015</td>
</tr>
<tr>
<td>6. Mathematics graduates will be able to pose, research, and address new mathematical questions.</td>
<td>2010 - 2011</td>
<td>2013 – 2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(current report)</td>
</tr>
</tbody>
</table>

Describe how the program’s outcomes support Marymount’s Mission, Strategic Plan, and relevant school plan:

Marymount’s Mission:
Marymount University is an independent Catholic university that emphasizes academic excellence at the undergraduate and graduate levels. Committed to the liberal arts tradition, the University combines a foundation in the arts and sciences with career preparation and opportunities for personal and professional
development. Marymount is a student-centered learning community that values diversity and focuses on the education of the whole person, promoting the intellectual, spiritual, and moral growth of each individual. Scholarship, leadership, service, and ethics are hallmarks of a Marymount education.

Departmental Vision
The mathematics program provides quality instruction in a nurturing environment. The major prepares both excellent high school mathematics educators and career-prepared 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 through the DISCOVER center. The program focuses on the intellectual development and communication skills of all students studying mathematics at Marymount University.

Relevance of our Vision and Objectives to the 2013 Strategic Plan

Mission:
It can be argued that all objectives indirectly support the mission. In particular, however, Outcome 5 addresses the importance of career preparation.

Shared Strategic Priorities: Using the strategic principles that have guided Marymount University’s recent accomplishments, individuals throughout the University will embrace the following shared priorities in order to achieve Marymount’s vision for the future:

• Offer rigorous, cohesive, integrated undergraduate and graduate curricula that produce superior graduates able to succeed in their positions and communities
Outcome 1 is a particularly rigorous outcome. Outcomes 1 and 2 directly address inquiry. Outcome 6 is high-level inquiry and, quite often, is interdisciplinary in nature. Drs. Gammack and Schaefer both work with undergraduates in mathematical biology. The mathematics seminars, designed primarily to address Outcome 5, are a unique opportunity geared exactly at the identification of and success in achieving personal and professional goals.

• Foster students’ global perspective.

• Strengthen Marymount’s Catholic Identity

• Promote a sense of community among students, alumni, faculty, and staff
Our seminar series, mandatory for mathematics majors for three years of study, have helped us tremendously in building community within our major. Our small meeting and computer space in Caruthers has also helped us with this goal.

• Strengthen Marymount’s ties to the larger community through outreach and collaboration
Our seminar series consists of field trips to many businesses around the region as well as speakers who help enhance our ties to the larger community.

• Promote greater awareness of Marymount and enhance its reputation
Academic Year: 2013-14                  Program: Mathematics

- Strengthen recruitment and retention of undergraduate and graduate students who are able to succeed in, and contribute to the Marymount community
- Maintain current and create future physical spaces that support the needs of students and the larger Marymount community
- Optimize the quality of the work environment for faculty and staff
- Achieve operational efficiency in all of Marymount’s administrative functions
- Secure sufficient financial resources to advance the strategic plan

Critical Success Factors and Strategic Initiatives

How the mathematics learning objectives support A&S goals, which in turn support the University plan.

A. Academic Excellence
1. The faculty in the School will be encouraged to use and develop teaching methods that improve student learning and promote student success.

Learning Outcomes 2, 3, and 6 are being addressed in our curriculum through the development and use of inquiry based learning techniques in many of our mathematics classes, including those at the freshman level. We have tried different methods to engage our students in mathematical discussions at a high level, and to use real-world problems as a way to introduce mathematical concepts. Some faculty are also working on using flipped classrooms, a new approach to the use of our face time with students. They are using class time as a way to engage with the students and to have the students engage with each other while working on real mathematics problems.

4. Faculty will be encouraged and supported in their endeavors to develop and teach interdisciplinary courses and to team teach courses whenever feasible.

Learning Outcome 2 has helped us to teach material common to the Biology major and Learning objective 4 has increased our overlap with the technology major, and the evolution of these efforts is leading to achieved grants (NSF STEM scholarship), proposed grants, and upcoming common courses and minors (Computational Biology minor, and interdisciplinary seminar series, plans to develop an interdisciplinary freshman seminar as part of the DISCOVER goals, and coursework to support the new minor.)

7. Faculty will encourage collaborative student-faculty research at the undergraduate and graduate levels.

Learning Outcome #6

8. Faculty will cooperate with the Career and Internship Center to provide input and feedback about internship sites.
Learning Outcome #5: We will work the new Career Center and our seminar class to help us accomplish this goal.

11. All departments will continue to upgrade the use of technology in teaching and in collection, presentation and analysis of information.

Learning Outcome #4

13. In every course, faculty will support the development of students’ critical thinking, reading, writing, and oral communication skills.

All Outcomes to an extent, but especially Outcomes 1, 2, and 3.

C. Enrollment and Retention

6. Faculty will assist in the improvement of retention rates by maintaining office hours and being available to their students.

Our strong efforts to address Outcome #5 have surely addressed retention efforts

Provide a brief description of the assessment process used including strengths, challenges and planned improvements:

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

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Planned Improvement</th>
<th>Update</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mathematics graduates gather, evaluate, and use relevant mathematical definitions and results to create logical grammatically-correct proofs. [Inquiry Outcome]</td>
<td>To rework both abstract algebra (MA 420) and real analysis (MA 425) into WI courses, focusing to a great degree on the rewriting of proofs in order to improve their quality to an acceptable level.</td>
<td>Both Abstract Algebra and Real Analysis were approved as WI courses. Abstract Algebra was taught as a WI course during the fall semester of 2012, and Real Analysis was taught as a WI course during the spring semester of 2013.</td>
</tr>
<tr>
<td>2. Mathematics graduates connect mathematical ideas to real world applications; in other words, they can create and interpret mathematical models.</td>
<td>To have MA 418 meet in a computer room so that students not only see the implementation during lecture, but actually do it themselves. We also thought that more work needed to be done to incorporate R more seamlessly, from the development of worksheets and more homework problems focused on the software to the investigation and possible adoption of textbooks</td>
<td>MA 418 was did meet in the computer lab in Fall 2013. New software was used, so R was not incorporated. The students were asked to complete several projects in the class, and were graded on their content and their presentation of the topics. All of the presentations and mathematical content were graded using the attached rubrics.</td>
</tr>
</tbody>
</table>
that present the course material with examples in R. In several courses we thought it would be beneficial to ask for creative modeling-development outside of the high-point stakes of a large project. We planned to keep better track of student performance on smaller projects and assignments to determine if they are helping with students’ facility and understanding of the software.

| 6. Mathematics graduates will be able to pose, research, and address new mathematical questions. | This objective was modified from the last report. We planned to assess this objective in MA 427, Euclidean and non-Euclidean geometry. | The students worked on a research project in that class and presented their results. |

Provide a response to last year’s University Assessment Committee review of the program’s learning assessment report: *(List each recommendation and provide a specific response to each).*

<table>
<thead>
<tr>
<th>Report from Academic Year:</th>
<th>Program:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2012</td>
<td>Mathematics</td>
</tr>
</tbody>
</table>

**Critical Area 1 – Learning Outcomes**

<table>
<thead>
<tr>
<th>Learning Outcomes</th>
<th>Met</th>
<th>Partially Met</th>
<th>Not met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning outcomes are present</td>
<td>☐</td>
<td>X</td>
<td>☐</td>
</tr>
</tbody>
</table>

Points to consider for comments

- States learning outcomes in terms of what a student should be able to do (e.g. synthesize, create, develop)
- States learning outcomes in measurable terms
- Establishes an appropriate level for program learning outcomes (e.g. learning outcomes are at appropriate level on Bloom’s taxonomy for a program learning outcome)
- Illustrates support of Marymount’s and the school’s mission
Comments
Considerable effort went into connecting to University mission and strategic plan.
The new strategic plan is difficult to connect to our academics. Many of the points are not academically related and are not in our direct or even indirect control.

Critical Area 2 – Assessing Learning Outcomes

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>Met</th>
<th>Partially Met</th>
<th>Not met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures provided for each outcome</td>
<td>X</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

Points to consider in comments
- Makes evident connection between measures and learning outcomes
- Uses direct and indirect measures appropriately
- Identifies performance standards for each measure
- Includes copy of instruments in appendix (rubrics, survey questions, or other relevant documents)

Comments
Most measures are direct. Consider possible indirect measures instead of the many direct measures used to provide balance and the student perspective.

We are not clear on how to measure most of the learning outcomes we have listed using indirect measures. They seem to lend themselves particularly well to direct measures. In the past, we have used a survey to measure our progress on learning outcome number 5.

<table>
<thead>
<tr>
<th>Collection of student work and responses</th>
<th>Met</th>
<th>Partially Met</th>
<th>Not met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collects student work and responses for each measure</td>
<td>□</td>
<td>X</td>
<td>□</td>
</tr>
</tbody>
</table>

Points to consider in comments
- Identifies origin of student work and responses (e.g. class numbers, portfolio, survey)
- Identifies how student work and responses were collected
- Identifies who collected student work and responses
- Identifies number of participants
- Illustrates that procedures are appropriate for outcome
Academic Year: 2013-14  Program: Mathematics

Comments
State who collected and analyzed the data for all learning outcomes (course instructor, department faculty, chair?). If this is done by more than just the course instructor, and the department faculty analyzed results for purposes of assessment, it is not stated for all learning objectives.

In the future we will list the faculty member who collected the data for each course.

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Met</th>
<th>Partially Met</th>
<th>Not met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyzes results of each measure given for each outcome</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Points to consider in comments
- Explains how student work was evaluated
- Provides data summary (narrative, charts, tables)
- Describes who evaluated student work included in assessment report
- Addresses any previous lessons learned, if applicable

Comments
A lot of work went into analyzing how the outcomes were infused and performed in the relevant courses.

Critical Area 3: Improving the curriculum using assessment

<table>
<thead>
<tr>
<th>Using assessment to make improvements</th>
<th>Met</th>
<th>Partially Met</th>
<th>Not met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presents recommendations for improvement for each outcome based on assessment results</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Points to consider in comments
- Discusses strengths and opportunities relative to the outcome
- Draws conclusions related to data
- Provides recommendations for improvement that follow from conclusions

Comments
Academic Year: 2013-14
Program: Mathematics

<table>
<thead>
<tr>
<th>Implementing improvements</th>
<th>Met</th>
<th>Partially Met</th>
<th>Not met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implements improvements from previous year’s assessment report</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Points to consider in comments
- Provides concrete evidence of how improvements from previous assessment activity were implemented
- Gives explanation for not implementing planned improvements, if applicable

<table>
<thead>
<tr>
<th>Addressing recommendations</th>
<th>Met</th>
<th>Partially Met</th>
<th>Not met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addresses UAC’s recommendations from previous year</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Points to consider in comments
- Addresses all UAC recommendations regarding last year’s report, if applicable
- Gives explanation for not implementing recommendations, if applicable

Comments
By placing the previous year’s feedback in the report, UAC recommendations were addressed in a manner above and beyond what was expected.

**SUMMARY**

**Overall Comments about Assessment Report**

Overall this report is an improvement from the previous year and shows that the program is interested in examining student learning. Including results from the previous year’s strengthened the report.

- Report Accepted as Submitted
- Revisions required to accept report this year

- 1
- 2
Recommendations for next year’s assessment process

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Consistently state who collected the student work</td>
</tr>
<tr>
<td>2</td>
<td>For a quicker response, direct committee questions to Institutional Effectiveness</td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
Learning Outcome 1: Mathematics graduates gather, evaluate, and use relevant mathematical definitions and results to create logical grammatically-correct proofs.

☑ Is this outcome being reexamined? ☑ Yes ☐ No

If yes, give a brief summary of previous results (including trends) and any changes made to the program.

The last time we examined this outcome, we found we were not meeting our standards. We decided to rework both abstract algebra (MA 420) and real analysis (MA 425) into WI courses, focusing to a great degree on the rewriting of proofs in order to improve their quality to an acceptable level. We collected careful data in all offerings of MA 215, 257, 261, 420, 425, 427 in order to aid in our assessment.

### Assessment Activity

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>Performance Standard</th>
<th>Data Collection</th>
<th>Analysis</th>
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<tbody>
<tr>
<td>Explain how student learning will be measured and indicate whether it is direct or indirect.</td>
<td>Define and explain acceptable level of student performance.</td>
<td>Discuss the data collected and student population</td>
<td>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</td>
</tr>
</tbody>
</table>

**MA 257: Introduction to Proof and Number Theory.** Students were graded on proofs written on exams.

- **Completion by Lenz:**
  - We would like to have 80% of the students perform at the good or excellent level in the ability to write mathematical proofs.

  There were 6 students in the spring 2012 class and 6 in the spring 2014 class. Detailed rubrics were collected for proofs written on the 2 in class exams and on the final exam.

  - **2012 final exam:** 36 proofs were graded (6 for each student). The results were 22 scored at the excellent level and 7 at the good level for a total of 29/36 = 80%.
  - **2014 in-class exams:** 84 proofs were graded. The results were 52 scored at the excellent or good level, which is 62%. On the final exam 36 proofs were graded. The results were 27 students scored at the excellent or good level, which is 75%.

**MA 420: Abstract Algebra.** Students were graded (with a revision process) on proofs written for homework and on their exams.

- **Completion by Lenz:**
  - We would like to have 80% of the students perform at the good or excellent level in the ability to write mathematical proofs.

  There were 5 students in the fall 2012 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 student, and revisions to those 30 of those proofs were also graded. A total of 315 proofs were graded for homework in the class. **Results:** 86 out of 165 proofs (52%) were excellent or good on the first attempt, 126 out of 150 (84%) were excellent or good on the second attempt.
  - **Exams:** 4 proofs were graded on each in-class exam, and revisions to all of those proofs were also graded. A total of 80 proofs were graded for exams in the class. **Results:** 25 out of 40 proofs (62.5%) were excellent or
**Academic Year:** 2013-14  
**Program:** Mathematics

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Results</th>
</tr>
</thead>
</table>
| MA 215: Linear Algebra. | Effectiveness at proving math concepts. There were three proof questions on the final exam.  
The final exam is attached, and the three proof questions are: Q6, 14, 15.  
Apply math techniques to problems. There was one question on the final asking the students to solve a differential equations problem using techniques from Linear Algebra.  
The question is Q 9. (Gammack) | Good on the first attempt, 38 out of 40 (95%) were excellent or good on the second attempt.  
**Final Exam:** 5 proofs were graded on the final exam with no revisions. A total of 25 proofs were graded for the final exam in the class.  
Results: 14 out of 25 proofs (56%) were excellent or good on the final exam. |
| MA 427 – Geometric proofs related to the properties of triangles and quadrilaterals. | These proofs will be submitted in written form.  
We would like to have 80% of the students perform at an average of 3 or better as defined by the rubric for creating and presenting.  
There were 4 students in the class in Fall 2012. The written student proofs were collected and revisions were made. Each student chose one of | In Fall 2012, all 4 students were able to complete the assigned proofs and give an in-class presentation of their proof. All 4 students earned an average score of greater than 3. |

Percentage of excellent answers:  
Q6 40% (2/5)  
Q14 20% (1/5)  
Q15 40% (2/5)  
Percentage of good answers:  
Q6 0% (0/5)  
Q14 0% (0/5)  
Q15 20% (1/5)  
Percentage of good or excellent answers:  
Q6 40% (2/5)  
Q14 20% (1/5)  
Q15 60% (3/5)  
Percentage of excellent answers:  
Q9 20 % (1/5)  
Percentage of good answers:  
Q9 60% (3/5)  
Percentage of good or excellent answers:  
Q9 80% (4/5)
Each student will also present at least one proof to the class. (Petillo)

<table>
<thead>
<tr>
<th>Course</th>
<th>Goal</th>
<th>Analysis of Proofs</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA 425 Real Analysis Spring 2013: Writing proofs: Seven students wrote and revised proofs for a total of about 1200 graded efforts. (Schaefer)</td>
<td>We would like to have 80% of the proofs considered be at the good or excellent level. The analysis of the proofs is attached, showing the numbers of success as the semester progressed.</td>
<td>The students are performing at the good or excellent level on 62% of the time overall, with no clear trend of changes in performance throughout the semester.</td>
<td></td>
</tr>
<tr>
<td>MA 261 Falls 2013 and Fall 2012: Writing proofs. A total of 9 students’ performances in this 1 credit introductory proof course were tracked. (Schaefer)</td>
<td>We want 80% of the proofs considered to be at the good or excellent level. Because the only focus of this small course is proof-based, we simply tracked student performance on tests and quizzes. Thus, we would like to see at least 80% performing at the A or B level.</td>
<td>In the four assessments considered (see attachment), the best performance was 67%.</td>
<td></td>
</tr>
</tbody>
</table>

**Interpretation of Results**

**Extent this Learning Outcome has been achieved by students (Use both direct and indirect measure results):**

**MA 215: Linear Algebra**

The reformatted MA 215 did not do a great job in this area. As I tried to make linear algebra a combination of proof and application (with technology included) it ended up being more of a survey course (of all the main techniques). On the final, there were 3 “prove this” questions: 40% successfully answered the first; 20% the second; and 40% the third.

**MA 420: Abstract Algebra**

The students were not able to achieve the 80% goal of excellent or good proofs on their first attempt. They were, however, able to surpass this goal upon revision of their first attempt.

**MA 257: Introduction to Number Theory and Proof**

The students were able to achieve the 80% goal of excellent or good proofs by the final exam in the spring 2012 class. The spring 2014 class was very close, scoring 75% at the excellent or good level, which is very close to our goal of 80%.
Academic Year: 2013-14
Program: Mathematics

MA 261: Introduction to Mathematical Reasoning
The best performance was 67% of the students performing at the good or excellent level. We are not meeting our goal in this class.

MA 425: Real Analysis
62% of the students are performing at the good or excellent level. We are not meeting our goal in this class.

Program strengths and opportunities for improvement relative to assessment of outcome:

We are meeting our goal for proof writing only when students are allowed to revise their proofs, and only the revisions are counted. We would like to find a way for students to achieve close to the revision level proof on their first attempt.

In our previous assessment of this goal (in 2011), we found that in MA 425, 60% of students performing at the excellent or good level for proof writing, so the students have not shown improvement in this class. In MA 420, far less than 50% of the students were performing at the good or excellent level in 2010 as opposed to a bit more than 50% this year, for first drafts, so there has been a small improvement in this class. MA 261 showed improvement, up from 53% in 2010 to 67%. MA 257 showed improvement, up from 36% in 2010, to at least 75% in 2012/2014.

Discuss planned curricular or program improvements for this year based on assessment of outcome:

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 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.
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 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.
Outcome and Past Assessment

Learning Outcome 2: Mathematics graduates connect mathematical ideas to real world applications; in other words, they can create and interpret mathematical models.

Is this outcome being reexamined? □ Yes □ No

If yes, give a brief summary of previous results (including trends) and any changes made to the program.
The last time we examined this outcome we found we are meeting our standards in the upper-level courses. We continued to collect detailed rubrics in MA 325 and 418.

We scheduled MA 418 to meet in a computer room so that students not only see the implementation during lecture, but actually do it themselves. We also thought that more work needed to be done to incorporate R more seamlessly, from the development of worksheets and more homework problems focused on the software to the investigation and possible adoption of textbooks that present the course material with examples in R. In several courses we thought it would be beneficial to ask for creative modeling-development outside of the high-point stakes of a large project. We planned to keep better track of student performance on smaller projects and assignments to determine if they are helping with students’ facility and understanding of the software.

Assessment Activity

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>Performance Standard</th>
<th>Data Collection</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain how student learning will be measured and indicate whether it is direct or indirect.</td>
<td>Define and explain acceptable level of student performance.</td>
<td>Discuss the data collected and student population</td>
<td>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</td>
</tr>
<tr>
<td>MA 218 – Term Project: 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)</td>
<td>We would like to have 80% of the students perform at the good or excellent level in the ability to communicate mathematical ideas in their papers and orally.</td>
<td>There were 10 students in the class in Spring 2013 and 5 students in Spring 2014. The papers were collected and assessed using the attached rubric. Oral presentations were assessed in class using the attached rubric.</td>
<td>In Spring 2013, for the category of project presentation, all 10 students received excellent or good. For mathematical content, 9 of the 10 students, or 90%, received excellent or good. For the interpretation of results and conclusion, 9 of the 10 students received excellent or good. In Spring 2014, for the category of project presentation, all 5 students received excellent or good. For mathematical content, 4 of the 5 students, or 80%, received excellent or good. For the interpretation of results and conclusion, 4 of the 5 students received excellent or good.</td>
</tr>
</tbody>
</table>
### MA 418: Oral presentation:
Students researched and presented real-world applications of stochastic modeling.
(Heuett)

<table>
<thead>
<tr>
<th>MA 418: Oral presentation: Students researched and presented real-world applications of stochastic modeling. (Heuett)</th>
<th>We would like to have 80% of the students perform at the good or excellent level in the ability to communicate mathematical ideas in oral presentations.</th>
<th>There were 4 students in the class in Fall 2013. The presentations were assessed using the attached rubric.</th>
<th>For the category of project presentation, all 3 of the 4 students, or 75%, received excellent or good. For mathematical content, 3 of the 4 students received excellent or good. For the interpretation of results and conclusion, all 4 students received excellent or good.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA 325: Project 1: Working tying bifurcation analysis to real world problem of logistic growth with different harvesting schemes. Project 2: Analysis of differing types of population growth -- Holling Types I and II (Schaefer)</td>
<td>We would like to have 80% of the students perform at the good or excellent level in the ability to communicate mathematical ideas in oral presentations.</td>
<td>There were 7 students in the class in Fall 2012.</td>
<td>in the category of connecting mathematical modeling to real work problems: Project 1: there were 3 different scenarios students worked on. In scenario 1, 5 of the 7 students, or 70%, scored excellent or good. In scenario 2, 4 of the 7 students, or 57%, scored excellent or good. In scenario 3, 5 of the 7 students, or 70% scored excellent or good. Project 2: 3 of the 7 students, or 43%, scored excellent or good. Overall ratings for modeling in the course, including ratings from homework assignments and final exam: there were 41 ratings of excellent and 19 ratings of good of of a total of 80 ratings (for 7 different students). This means 75% of the ratings were at the excellent or good level.</td>
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### Interpretation of Results

**Extent this Learning Outcome has been achieved by students (Use both direct and indirect measure results):**

**MA 218: Probability and Statistics**
The students were required to do an individual term project, submit a written report, and present their results orally to the class. Ten students were registered for the course in Spring 2013, and 5 students were registered for the course in Spring 2014. 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. Students generally did very well when conveying statistical results in terms of the real-world application. All students received praise for their insightful comments, discussions, and their ability to convey their work. Students 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 418: Stochastic Modeling
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.

For the most part, presentations were visually appealing and the students showed great communication skills. 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. The students presented fun, interesting examples of stochastic modeling techniques used in a wide range of industrial applications. They generally did an exceptional job identifying and presenting the connections between the course content and the applications. One student, although exceptional in his mathematical abilities, procrastinated in completing his project, and his lack of preparation showed when he tried to explain the application to the class.

MA 325: Differential Equations
We are slightly below our goal for modeling, but very close. Also, the number of items assessed is good evidence of exposure to the ideas in this course. We should compare with modeling in Stochastic and see if there is improvement.

Program strengths and opportunities for improvement relative to assessment of outcome:

It seems that we are meeting our goal in this area. We collected a lot more data on projects and presentations this cycle. 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.

Discuss planned curricular or program improvements for this year based on assessment of outcome:

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.
Outcome and Past Assessment

Learning Outcome 3: Mathematics graduates will be able to pose, research, and address new mathematical questions.

Is this outcome being reexamined? ☑ Yes ☐ No

If yes, give a brief summary of previous results (including trends) and any changes made to the program.
This objective has been modified from the last time it was assessed. We assessed this modified objective in MA 427, Euclidean and non-Euclidean geometry. The students worked on a small research project in that class and wrote a paper.

**Assessment Activity**

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>Performance Standard</th>
<th>Data Collection</th>
<th>Analysis</th>
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</table>
| Explain how student learning will be measured and indicate whether it is direct or indirect. | Define and explain acceptable level of student performance. | Discuss the data collected and student population | 1) Describe the analysis process.  
2) Present the findings of the analysis including the numbers participating and deemed acceptable. |
| MA 427 – Triangle Centers Project: students had to create the four classic triangle centers using dynamic geometry software. They then researched and investigated one of several additional geometric theorems. Students used the software to pose the questions, provide verification and demonstration of their conjectures. The project description and rubrics are attached. (Petillo) | We would like to have 75% of the students 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 were 4 students in the class in Fall 2012. The projects were collected and assessed using the attached rubric. All four students earned above a 90% on the project. | In Fall 2012, all 4 students were able to complete the triangle centers project as well as the independent investigation at the 90% level or above. |
Interpretation of Results

Extent this Learning Outcome has been achieved by students (Use both direct and indirect measure results):
We have achieved our goal with this learning outcome as all the students achieved a 90% or better on the project.

Program strengths and opportunities for improvement relative to assessment of outcome:
Our sample size is limited, so we will continue to assess this goal in future semesters.

Discuss planned curricular or program improvements for this year based on assessment of outcome:
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.