STUDENT LEARNING ASSESSMENT REPORT

PROGRAM: Mathematics
SUBMITTED BY: Laurie Lenz
DATE: 9/30/2020

Executive Summary: Description of Assessment Process

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
- 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. 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, as of the assessment year's catalog: *(regardless of whether or not they are being assessed this year)*

Learning Outcome	Year of Last Assessment	Assessed This Year *(Y=Yes)*	Year of Next Planned Assessment
1. Mathematics graduates gather, evaluate, and use relevant mathematical definitions and results to create logical grammatically-correct proofs. [Inquiry Outcome]	2013-2014	Y	2019-2020
2. Mathematics graduates connect mathematical ideas to real world applications; in other words, they can create and interpret mathematical models.	2013-2014	Y	2019-2020
3. Mathematics graduates communicate mathematical ideas through oral and written presentations.	2015-2016	N	2021-2022
4. Mathematics graduates use a variety of technologies to solve mathematical problems.	2015-2016	N	2021-2022
5. Mathematics graduates are able to articulate career, internship, and summer research program opportunities for mathematicians.	2015-2016	N	2021-2022
6. Mathematics graduates will be able to pose, research, and address new mathematical questions.	2013-2014	Y	2019-2020

Provide a brief description of the assessment process used including how results are shared and discussed and strengths, challenges, and planned improvements to the process, providing evidence of a culture of continuous improvement based on assessment. If there is something that is impeding your ability to implement improvements, please comment on those issues *(generally not more than two paragraphs, may use bullet points)***:**

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.

For Outcome 1, students in our proofs-based classes (MA 210, MA 215, MA 257, MA 420, MA 425) are asked to write mathematical proofs for homework assignments and on tests and quizzes. Each of those proofs is assessed using the Math Proof Rubric (attached in the appendix). The proofs are scored as Excellent, Good, Fair, Marginal, or Poor. In our writing intensive classes (MA 420 and MA 425), the students are given an initial score for each proof, and are then asked to revise and resubmit those proofs for re-evaluation. The results for each proof question are recorded and summarized at the end of the semester. Our department regularly discusses the strengths and weaknesses of the various methods used to teach proof writing skills to our students as well as our method of assessing those proofs. We have experimented with different approaches in all of our proof based classes, including using group work and group proof writing in class, and peer review of proofs in and out of class. A mentoring project was added to our math seminar class where more senior students were paired with freshmen and sophomores taking our introductory proof writing course, MA 210. The purpose was to provide feedback and encouragement on proof writing and presenting to the newer math majors. The more senior students were graded on the quality of their feedback, giving them another opportunity to add to their knowledge of the art of mathematical proof writing.

For Outcome 2, students in our applied classes (MA 325, MA 418) are asked to complete a significant project that involves creating and interpreting a mathematical model. These projects are assessed using our Math Project Rubric (attached in the appendix). This is also something we discuss often, and the projects have changed over the years. We try to make them relevant to real-life situations, and to use software tools that students are likely to encounter when they have begun their math related careers. Since those tools change frequently, so do our projects.

For Outcome 6, students in our advanced classes (MA 420 and MA 425) are asked to pose, research, and address new mathematical questions. These questions are also proof-based, and the outcome is assessed using our math proof rubric.

Closing the Loop: Progress on Planned Improvements from Prior Year

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

Outcome	Planned Improvement	Update
Mathematics graduates gather, evaluate, and use relevant mathematical definitions and results to create logical grammatically-correct proofs. [Inquiry Outcome]	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. 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	The students are now taking proof-centered courses every semester starting in their sophomore year, but we have not seen a significant change in the achievement of our goal for this outcome. We continue to try various forms of peer review. Students write proofs during class in groups, providing feedback as they work. More experienced students are assigned to less experienced students in math seminar and provide feedback on two proof/presentations.

Outcome	Planned Improvement	Update
	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. 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.	
Mathematics graduates connect mathematical ideas to real world applications; in other words, they can create and interpret 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 has almost doubled in size since the last report, as recruitment of biology majors has been successful. This has added variety to the types of projects the students in MA 218 and MA 418 have been able to pursue.
Mathematics graduates will be able to 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.	We did not add a research project to MA 420, as the amount of material that needs to be covered in the class did not allow for adding anything extra. This outcome is currently only able to be assessed in students who choose to undertake a research project as an elective.

Provide a response to last year's University Assessment Committee review of the program's learning assessment report:
Comment:
LO5 is not as strong as others – articulate for what purpose?

LO5 is definitely one at which we will be taking a closer look when we re-evaluate our program's learning outcomes as a whole. We felt that it is important to help the students understand the varied opportunities that are available to them as a mathematics major, but it does not quite fit as one of the learning outcomes.

Is MA 209/309/409 the same course? Different courses with different outcomes?

It is the same course, but with different outcomes. All of the students meet together each week. The more experienced students have higher level outcomes than the less experienced students. Several of the projects in the class are set up so that the less experienced students can be mentored.

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?

The 200-level students have different projects assigned, so the rubrics and expectations are different for the students at the three different level.

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. V. Analysis of Results and Implications.

For this report, only the results pertaining to math majors were analyzed.

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.

We will be re-evaluating all of our learning outcomes before the end of the next assessment cycle.

Consider making distinctions between expectations for 200-level students and 400-level students.

This will be considered as we discuss and re-evaluate all of our learning outcomes. We will attempt to differentiate between proof writing in MA 210 (the intro to proof class) and, for example, MA 420 (senior level proof writing class).

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Outcomes Assessment 2019-2020

Learning Outcome 1:
Mathematics graduates gather, evaluate, and use relevant mathematical definitions and results to create logical grammatically-correct proofs. [Inquiry Outcome]
MA 210, MA 257, MA 420, MA 215, MA 427, MA 425

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define the acceptable level of student performance.*	**Data Collection** *Discuss the process for collecting this data: who conducted the assessment, when, and how?*	**Result** *Did you meet your target? What was the result?*
MA 210: Seminar with Introduction to Proofs through Discrete Math. A total of 3 students' performances in this 1 credit introductory proof course were tracked. (Rische, Fall 2018)	We would like to have 80% of the students perform at the good or excellent level in the ability write mathematical proofs.	There were 3 majors in the class in Fall 2018. Detailed rubrics were collected for proofs written on midterm (5 proofs) and final exam (7 proofs).	On the Midterm: 15 proofs were graded (5 for each student). The results were 4 scored at the excellent level and 6 scored at the good level for a total of 10/15=66.7%. On the Final: 21 proofs were graded (7 for each student). The results were 5 scored at the excellent level and 5 scored at the good level for a total of 10/21=47.6%. Overall, 20/36=55.6% of the proofs were excellent or good.
MA 210: Seminar with Introduction to Proofs through Discrete Math. Students were graded on proofs written on exams. (O'Donnol, Fall 2019)	We would like to have 80% of the students perform at the good or excellent level in the ability write mathematical proofs.	There were 6 students in the fall 2019. Detailed rubrics were collected for proofs written on the midterm and final exam. For both the midterm and the final had 6 proofs that were evaluated.	In fall 2019 on the midterm: 36 proofs evaluated (6 for 6 students). Out of the 36 there were 13 at the excellent level and 3 at the good level, for a total of 16/36=44.4% In fall 2019 on the final: 36 proofs evaluated (6 for 6 students). Out of the 36 there were 7 at the excellent level and 2 at the good level, for a total of 9/36=25% Combined this gives a final total of 25/72=34.7% of the proofs on exams at an excellent or good level.
MA 215: Linear Algebra. Students were graded on proofs written on exams. (Rische, Spring 2019)	We would like to have 80% of the students perform at the good or excellent level in the ability write mathematical proofs.	There were 7 majors in the class in Spring 2019. Detailed rubrics were collected for proofs written on the 2 in-class	On Exam 1: 14 proofs were graded (2 for each student). The results were 8 scored at the excellent level and 2 scored at the good level for a total of 10/21=47.6%.

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define the acceptable level of student performance.*	**Data Collection** *Discuss the process for collecting this data: who conducted the assessment, when, and how?*	**Result** *Did you meet your target? What was the result?*
		exams and on the final exam.	On Exam 2: 21 proofs were graded (3 for each student). The results were 1 scored at the excellent level and 2 scored at the good level for a total of 3/14=21.4%. On the Final: 14 proofs were graded (2 for each student). The results were 5 scored at the excellent level and 2 scored at the good level for a total of 7/14=50%.
MA 257: Introduction to Proof and Number Theory. Students were graded on proofs written on exams. (Rische, Spring 2020)	We would like to have 80% of the students perform at the good or excellent level in the ability write mathematical proofs.	There were 9 majors in the class in Spring 2020. Detailed rubrics were collected for proofs written on the 2 in-class exams and on the final exam.	On Exam 1: 36 proofs were graded (4 for each student). The results were 11 scored at the excellent level and 3 at the good level for a total of 14/36= 38.9%. On Exam 2: 36 proofs were graded (4 for each student). The results were 15 scored at the excellent level and 5 at the good level for a total of 20/36= 55.6%. On the Final exam: 54 proofs were graded (6 for each student). The results were 24 scored at the excellent level and 14 at the good level for a total of 38/54= 70.4%.
MA 420: Abstract Algebra. Students were graded on proofs written on homework, on in class exams, and on the final exams. (Lenz, Fall 2018)	We would like to have 80% of the students perform at the good or excellent level in the ability write mathematical proofs.	There were 7 majors in the class in Fall 2018. Detailed rubrics were collected for proofs and revisions written on homework and the 2 in-class exams. For the final exam, data was collected for the proofs, but there were no revisions.	There were 7 students in MA 420 in Fall 2018. There were a total of 19 mathematical proofs assigned for homework throughout the semester. Students wrote revisions on all of these proofs. For first attempts, about 68% were rated excellent or good. For revisions, 87% were rated excellent or good. It seems we are meeting our goal for the students on the homework. For

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define the acceptable level of student performance.*	**Data Collection** *Discuss the process for collecting this data: who conducted the assessment, when, and how?*	**Result** *Did you meet your target? What was the result?*
			in class exams, there were a total of 9 mathematical proofs assigned. Students wrote revisions for all 9 of those proofs. For first attempts on the in class exams during the semester, about 55% of the proofs were rated excellent or good on the first attempt, and about 90% were rated excellent or good on the revision. The final exam contained 5 mathematical proofs. About 50% of those proofs were rated excellent or good. There were no revisions on the proofs from the final exam. We are meeting our goal on proof revisions, but not for first time proofs, even on the final exam.
MA 425: Real Analysis. Students were graded on proofs written on homework, on in class exams, and on the final exams. (Lenz, Fall 2019)	We would like to have 80% of the students perform at the good or excellent level in the ability write mathematical proofs.	There were 8 majors in the class in Fall 2019. Detailed rubrics were collected for proofs and revisions written on homework and the 2 in-class exams. For the final exam, data was collected for the proofs, but there were no revisions.	There were 8 students in MA 425 in Fall 2019. There were a total of 30 mathematical proofs assigned for homework throughout the semester. Students wrote revisions on all of these proofs. For first attempts, about 48% were rated excellent or good. For revisions, 75% were rated excellent or good. It seems we are close to meeting our goal for the students on the homework only for revisions. For in class exams, there were a total of 8 mathematical proofs assigned. Students wrote revisions for all 8 of those proofs. For first attempts on the in class exams during the semester, about 73% of the proofs were rated excellent or good on the first attempt, and about 91% were rated excellent or good on the revision. It seems we are meeting or are

Outcome Measures *Explain how student learning will be measured and indicate whether it is direct or indirect.*	**Performance Standard** *Define the acceptable level of student performance.*	**Data Collection** *Discuss the process for collecting this data: who conducted the assessment, when, and how?*	**Result** *Did you meet your target? What was the result?*
			close to meeting our goal on exam proofs, even for first attempts. The final exam contained 5 mathematical proofs. About 33% of those proofs were rated excellent or good. There were no revisions on the proofs from the final exam. We are meeting our goal on proof revisions, but not for first time proofs, even on the final exam.

Interpretation of Results

Analysis and Implications: *What does this result tell you about the extent to which your students achieved this outcome? What are the strengths and weaknesses that this result highlights, and what are the implications for your curriculum or your program?*

MA 210 (Fall 2018): The best performance was 66.7% of the students performing at the good or excellent level. We are not meeting out goal in this class.

MA 210 (Fall 2019): Seminar with Introduction to Proofs through Discrete Math.
In Fall 2019 there was only 34.7% of the proofs on the exams at the good or excellent level. This semester, freshmen were advised to take MA 210. While there is not a prerequisite for MA 210, a level of mathematical maturity is expected. So, it is generally taken in the sophomore year. The new advisors did not understand this and advised all incoming math majors to take MA 210 as freshman. Half of the students evaluated here where freshmen. They were not ready for the course. While they were able to get a passing grade, they did not develop their proof writing skills to the extent the other students were able to. If the freshmen are not counted in the evaluation the resulting percentage is close to 70%. This is still not meeting our goal but is much closer.
We are not meeting our goal in this class.

MA 215 (Spring 2019): The best performance was 50% of the students performing at the good or excellent level. We are not meeting out goal in this class.

MA 257 (Spring 2020): Although we did not reach the goal of 80% of the students perform at the good or excellent level in the ability write mathematical proofs on the Final, we did see improvement from exam to exam. On Exam 1, 38.9% of the proofs were good or excellent. On Exam 2, 55.6% were good or excellent. On the Final, 70.4% were good or excellent.

MA 420 (Fall 2018): We are meeting our goal in this class on revisions (on homework and exams), where over 80% of proofs were rated excellent or good. We are not meeting our goal for first attempts on either homework or exams. Only about 50% of first attempt proofs were rated excellent or good.

MA 425 (Fall 2019)
We are close to meeting our goal in this class on revisions on homework and exams, where about 75% of proofs were rated excellent or good. We are meeting our goal in this class on exam revisions, where over 80% of revised proofs were rated excellent or good.

We are not meeting our goal for first attempts on either homework or exams. Only about 50% of first attempt proofs were rated excellent or good.

Discuss planned curricular or program improvements <u>for this year based on assessment of outcome:</u>

The math department has not made significant changes to our learning outcomes since before I joined the department in 2005. We plan to re-examine our learning outcomes and hopefully retool or change many of them. One thing we will look at is our 80% goal for excellent or good proofs. We all agree that proof writing is an essential skill that we want our students to leave with, but perhaps our current goal is not realistic, and perhaps the rubric needs to be tweaked as well. We will continue to explore different pedagogical methods for helping our students to achieve this learning outcome.

Learning Outcome 2:
Mathematics graduates connect mathematical ideas to real world applications; in other words, they can create and interpret mathematical models.
MA 418, MA 325

Outcome Measures	Performance Standard	Data Collection	Result
MA 325: Differential Equations. Students were graded on projects focused on real world applications. (Rische, Fall 2018)	We would like to have 80% of the students perform at the good or excellent level in the ability to connect mathematical ideas to real world applications.	There were 6 majors in the class. Detailed rubrics were collected for the 4 projects.	Over the semester, 24 projects were graded (4 for each student). The results were 10 scored at the excellent level and 7 scored at the good level for a total of 17/24=70.8%.
MA 418: Stochastic Modeling. Students were graded on 2 projects focused on real world applications. (Rische, Spring 2020)	We would like to have 80% of the students perform at the good or excellent level in the ability to connect mathematical ideas to real world applications.	There were 7 majors in the class. Detailed rubrics were collected for the 2 projects.	Of the 14 projects that were graded (2 for each student), 6 were scored at the excellent level and 4 were scored at the good level for a total for 10/14=71.4%.

<u>Interpretation of Results</u>
Analysis and Implications: *What does this result tell you about the extent to which your students achieved this outcome? What are the strengths and weaknesses that this result highlights, and what are the implications for your curriculum or your program?*

MA 325: 70.8% of the projects were at the good or excellent level, so we did not quite meet our goal of 80%.

MA 418: 71.4% of the projects were at the good or excellent level, so we did not quite meet our goal of 80%.

Discuss planned curricular or program improvements <u>for this year based on assessment of outcome:</u>
We were close to meeting out goal for this learning outcome. Student projects are an important part of the math major experience, and these types of projects tend to be helpful for students in determining what kinds of careers they might be interested in, and also gives the students practical experience with tools and software that are used in real jobs. When we re-evaluate our learning outcomes, some version of this will likely remain, but we need to determine whether different expectations for different course levels is appropriate.

Learning Outcome 6:
Mathematics graduates will be able to pose, research, and address new mathematical questions.
MA 427, MA 433

Outcome Measures	Performance Standard	Data Collection	Result
MA 433: Research. After background in the course is established the students have one assignment to pose research questions in the area. Once the research question is established, then the students work to make weekly progress in the research. (O'Donnol, Spring 2020)	We would like to have 80% of the students perform at the good or excellent level in both posing new questions and research progress as defined in the rubric.	There was 1 student in this class in Fall 2019 and Spring 2020. There was one assignment to pose research questions assessed and 3 weeks of weekly progress on research assessed.	Assignment to pose research questions was at the excellent level. So, 100% was at the good or excellent level. Three weekly research progress was assessed with 1 at the excellent level and 2 at the good level. So, 100% was at the good or excellent level. In Fall 2019 and Spring 2020, the student went above the expectations set. The outcome of this project was new research that is at a publishable level.
MA 433: indirect assessment of student-faculty research collaboration. (Rische, Spring/Summer 2020)		One major worked on the project "Agent-Based Modeling using NetLogo." Major submitted presentation slides as a part of the project.	This major received summer funding from DISCOVER to continue working on the project in Summer 2020. They excelled in the computer programming part of this project (creating the model in the programming software NetLogo). However, they were not particularly interested in analyzing the model. The major does not plan to pursue a career in research.

Interpretation of Results
Analysis and Implications: *What does this result tell you about the extent to which your students achieved this outcome? What are the strengths and weaknesses that this result highlights, and what are the implications for your curriculum or your program?*

MA 433: Research (Spring 2020 O'Donnol)
All of the work was at the excellent and good level. We exceeded our goals in this outcome.

MA 427 was not taught during this assessment period. It is required only for secondary education majors, and we have not had enough of them at once to actually run the class.

Discuss planned curricular or program improvements for this year based on assessment of outcome:
This learning outcome, in particular, needs to be revised or discarded. It is not a standard outcome for undergraduate mathematics majors, and only really applies to students who undertake mathematical research projects. Since this is not a requirement for our majors, this outcome is not able to be regularly assessed.

Appendices *(please only include items that will help reviewers understand your process – for example, test questions, rubrics, survey questions, more detailed description of assessment measures, summary tables of survey results, etc.)*

Rubrics appear in the following order:

Proof Evaluation Rubric (MA 210, MA 215, MA 257, MA 420, MA 425)
Project Evaluation Rubric (MA 418, MA 325)
Posing Questions Rubric (MA 433)
Math Research Progress Rubric (MA 433)

Detailed assessment analyses for each class are available upon request

Math Proof Rubric

Exellent (E)	A well-written, refined proof that incorporates relevant theory and reveals a true understanding of the material. It is carefully organized and no irrelevant information is included.
Good (G)	A correct and complete proof is given. Some irrelevant information may be included but does not affect the logic of the proof.
Fair (F)	A correct approach to proving the theorem is attempted. Some statements may be unjustified or improperly justified, but errors are minor and are easily fixed.
Marginal (M)	Statements linked into a reasonable (though perhaps misguided) attempt to prove the theorem. The proof may be left incomplete or may depend upon a major unjustified leap. ---------- or ---------- Unconnected, mostly true statements properly deduced from the given. Listing facts without a sense of how to link them to get a correct proof. May just jump to the conclusion without justification.
Poor	Mainly incorrect consequences improperly deduced from the given. Little or no sense of how to prove the result.
Not Attempted	

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Discover Assessment Tool (DAT)-Differential Equations Project

Assignment: _____

Student Name/Number_____

I. Central Question/Project Focus						
Element	**Poor**	**Marginal**	**Fair**	**Good**	**Excellent**	**N/A**
Focus	Inquiry topic inappropriate, unfocused. Identifies issues that are too general or trivial	Inquiry topic somewhat appropriate broadly focused. Identifies somewhat relevant issues. States topic in a general way that may lack focus	Inquiry topic somewhat appropriate broadly focused. Identifies relevant issues. States topic in a clear and somewhat focused way	Inquiry topic appropriate, focus appropriate. Identifies important and relevant issues. States topic in a reasonably clear and appropriately focused way.	Inquiry topic excellent, focus excellent. Identifies important and relevant issues. States topic in a clear and appropriately focused way. Topic has appropriate mathematical content.	
II. Information Seeking, Selecting, and Evaluating						
Element	**Poor**	**Marginal**	**Fair**	**Good**	**Excellent**	**N/A**
Gather the Needed Information and Knowledge	Presents information from few, weak, or inappropriate sources, shows a lack of understanding of the system and the mathematics.	Presents limited information from relevant sources pertaining to the real world application and/or mathematical techniques that could be used to model the real world system.	Presents adequate information from multiple, relevant sources of both the real world application and mathematical techniques that could be used to model the real world system.	Presents compelling and relevant coverage of existing knowledge pertaining to the real world application and/or mathematical techniques that could be used to model the real world system.	Presents thorough and relevant coverage of existing knowledge of both the real world application and mathematical techniques used in modeling the real world systems.	
Evaluate Information and Knowledge	Either the source of information has not been evaluated or the evaluation has been based on primarily irrelevant material.	While the source of information and any biases has been considered, there are substantial considerations that have been omitted and/or irrelevant criteria that have been considered.	Considers the question of the source of the information, but perhaps lacks some depth in the analysis.	Considers the strengths of the references for the information gathered above, as well as a cursory look at weaknesses or biases.	Critically evaluates the validity and sense of the information gathered, as well as the authority of the source. Considers biases and/or holes in source information.	

Posing Questions Rubric

Exellent (E)	Clear well-written questions, or conjectures that exhibit understanding of the material and go beyond the scope of the students knowledge. Ideally, these would be open questions, but could be well-posed questions that are known but material the student has not yet learned about.
Good (G)	Questions, or conjectures that exhibit understanding of the material and go beyond the scope of the students knowledge, but are missing precision.
Fair (F)	Questions are only those they have seen before, or questions that they should know the answer to based on background preparation.
Marginal (M)	Question show clear misunderstanding of definitions and material.
Poor	Questions make little or no sense.
Not Attempted	

Math Research Progress Rubric

Exellent (E)	Using tools that make sense to make progress on the problem. Being able to identify if the tool can move your question forward or if it will not work. Working through the details of a new proof carefully and correctly.
Good (G)	Using tools that make sense to make progress on the problem. Sometimes being able to identify if the tool can move your question forward or if it will not work. Working through the details of a new proof carefully and correctly, with minor errors.
Fair (F)	Using tools that make sense to make progress on the problem most of the time. Has trouble being able to identify if the tool can move your question forward or if it will not work. New proof lack clarity and needs further justification.
Marginal (M)	Given an approach does not know how to use it or does not know if they can make progress, or cannot tell if they have made progress.
Poor	Approach and results make little to no sense.
Not Attempted	