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| **Assurance of Student Learning Report**  **2023-2024** | | |
| Ogden College of Science and Engineering | | Mathematics |
| 049 Master of Arts in Mathematics | | |
| Nick Fortune | | |
| ***Is this an online program***?  Yes  No | Please make sure the Program Learning Outcomes listed match those in CourseLeaf . Indicate verification here  Yes, they match! (If they don’t match, explain on this page under **Assessment Cycle)** | |

**\*\*\* Please include Curriculum Map as part of this document (at the end), NOT as a separate file.**

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| ***Use this page to list learning outcomes, measurements, and summarize results for your program. Detailed information must be completed in the subsequent pages. Add more Outcomes as needed.*** | | | | |
| **Program Student Learning Outcome 1:** Students will be able to communicate mathematics in a written form at a level commensurate with that of students completing a master’s degree. | | | | |
| **Instrument 1** | Discussion boards, regularly assigned quizzes, and assessments from MATH 501, Introduction to Probability and Statistics I. A score of 8 or higher on a 10-point multipart rubric for each course will demonstrate students’ ability to communicate mathematically. We expect at least 75% of students to meet this learning. | | | |
| **Instrument 2** | Discussion boards, regularly assigned quizzes, and assessments from MATH 511, Algebra from an Advanced Perspective. I. A score of 8 or higher on a 10-point multipart rubric for each course will demonstrate students’ ability to communicate mathematically. We expect at least 75% of students to meet this learning. | | | |
| **Based on your results, check whether the program met the goal Student Learning Outcome 1.** | | | **Met** | **Not Met** |
| **Program Student Learning Outcome 2:**  Students will be able to write proofs of theorems in mathematics. | | | | |
| **Instrument 1** | Assessments from MATH 503, Introduction to Analysis. A score of 8 or higher on a 10-point multipart rubric for problems given on assessments will indicate that students are able to use multiple strategies in problem solving situations. We expect at least 75% of students to meet this learning outcome. | | | |
| **Instrument 2** | Assessments from MATH 515, Introduction to Number Theory. A score of 8 or higher on a 10-point multipart rubric for problems given on assessments will indicate that students are able to use multiple strategies in problem solving situations. We expect at least 75% of students to meet this learning outcome. | | | |
| **Based on your results, check whether the program met the goal Student Learning Outcome 2.** | | | **Met** | **Not Met** |
| **Program Student Learning Outcome 3:**  Students will demonstrate their capacity to use multiple strategies and appropriate technology to apply mathematics in problem solving situations and will justify their solutions with sound logic. | | | | |
| **Instrument 1** | Assessments from MATH 512, Geometry from an Advanced Perspective. A score of 8 or higher on a 10-point multipart rubric will demonstrate students’ ability to choose appropriate strategies, including the use of technology, to solve problems and justify their solutions. We expect at least 75% of students to meet this learning outcome. | | | |
| **Based on your results, check whether the program met the goal Student Learning Outcome 3.** | | | **Met** | **Not Met** |
| **Program Student Learning Outcome 4:**  Students will demonstrate their capacity for collaboration in the mathematics classroom as a learner and as a teacher. | | | | |
| **Instrument 1** | Discussion boards from MATH 503, Introduction to Analysis. A score of 8 or higher on a 10-point multipart rubric will demonstrate students’ ability to collaborate when working towards solutions to problems. We expect at least 75% of students to meet this learning outcome. | | | |
| **Instrument 2** | Discussion boards from MATH 512, Geometry from an Advanced Perspective. A score of 8 or higher on a 10-point multipart rubric will demonstrate students’ ability to collaborate when working towards solutions to problems. We expect at least 75% of students to meet this learning outcome. | | | |
| **Based on your results, check whether the program met the goal Student Learning Outcome 4.** | | | **Met** | **Not Met** |
| **Program Student Learning Outcome 5:**  Students will be able to communicate about research in mathematics education in a written form at a level commensurate with that of students completing a master’s degree. | | | | |
| **Instrument 1** | Discussion boards and written assignments from MATH 585, Advanced Mathematical Thinking I. A score of 8 or higher on a 10-point multipart rubric will demonstrate students’ ability to read, interpret, and analyze research in mathematics education. We expect at least 75% of students to meet this learning outcome. | | | |
| **Based on your results, check whether the program met the goal Student Learning Outcome 5.** | | | **Met** | **Not Met** |
| **Program Student Learning Outcome 6:**  Students will be able to conduct research regarding secondary students’ mathematical thinking. | | | | |
| **Instrument 1** | | Capstone research projects from MATH 595, Advanced Mathematical Thinking II. A score of 8 or higher on a 10-point multipart rubric will demonstrate students’ ability to design and conduct research in mathematics education. We expect at least 75% of students to meet this learning outcome. | | |
| **Based on your results, check whether the program met the goal Student Learning Outcome 6.** | | | **Met** | **Not Met** |
| **Assessment Cycle Plan:** | | | | |
| Last year we did not assess Learning Outcomes 5 and 6 as the program was recently revised and at that time we had not taught MATH 585 and 595 yet.  This year we are assessing all learning outcomes and intend to do so next year with the same learning outcomes. We have slightly altered which class we pull the data from for Learning Outcomes 1 and 4, but the learning outcome is the same. LO1 now pulls data from MATH 501 and 511 (previously 501 and 515). LO4 now pulls data from MATH 503 and 512 (previously 511).  Rather than having rubrics for a specific class, we have renamed them to be rubrics for each learning outcome, and then the rubrics are used in all classes for the given learning outcome. These rubrics are attached at the end of this document after the curriculum map (they all were reformatted to be more cohesive with each other). | | | | |

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| **Program Student Learning Outcome 1** | | | | | | | |
| **Program Student Learning Outcome** | Students will be able to communicate mathematics in a written form at a level commensurate with that of students completing a master’s degree. | | | | | | |
| **Measurement Instrument 1** | Discussion boards, regularly assigned quizzes, and assessments from MATH 501, Introduction to Probability and Statistics I. | | | | | | |
| **Criteria for Student Success** | A score of 8 or higher on a 10-point multipart rubric (attached to end of this document) for each course will demonstrate students’ ability to communicate mathematically. We expect at least 75% of students to meet this learning outcome. | | | | | | |
| **Program Success Target for this Measurement** | | | 75% | | **Percent of Program Achieving Target** | 100% | |
| **Methods** | The artifacts from all enrolled students (n=13) that were used to assess this SLO were required discussion boards, regularly assigned quizzes, and assessments. | | | | | | |
| **Measurement Instrument 2** | Discussion boards, regularly assigned quizzes, and assessments from MATH 511, Algebra from an Advanced Perspective. | | | | | | |
| **Criteria for Student Success** | A score of 8 or higher on a 10-point multipart rubric (attached to end of this document) for each course will demonstrate students’ ability to communicate mathematically. We expect at least 75% of students to meet this learning outcome. | | | | | | |
| **Program Success Target for this Measurement** | | 75% | | **Percent of Program Achieving Target** | | 85.7% | |
| **Methods** | The artifacts from all enrolled students (n=7) that were used to assess this SLO were required discussion boards, regularly assigned quizzes, and assessments. | | | | | | |
| **Based on your results, highlight whether the program met the goal Student Learning Outcome 1.** | | | | | | **Met** | **Not Met** |
| **Results, Conclusion, and Plans for Next Assessment Cycle (Describe what worked, what didn’t, and plan going forward)** | | | | | | | |
| **Results**: These results are expected for this learning outcome.  **Conclusions**: The structure of MATH 501 was similar to what it was the previous year, with particular emphasis on students being able to provide statistically precise interpretations for given situations. The students who met the goal grew with respect to and demonstrated this ability regularly throughout the semester on discussion boards, quizzes, and assessments. In the past, students who did not meet the SLO either completed discussion boards sporadically, regularly engaged in bare minimum levels of interpretation, or both. MATH 511 used the same textbook as before. The main issues centered around the new Blackboard. The discussion board feature the new BB Ultra is inferior to the old BB interface, which we have relayed to relevant staff at WKU. The reason for this is that our discussions are intended to be multi-posts and detailed about working together to an answer, not just getting answers, and the structure is not conducive for discussion. Neverthless, 85.7% met the program success target for MATH 511.  **Plans for Next Assessment Cycle**: As indicated we now are getting data from MATH 501 and MATH 511 for this learning outcome. Both of these courses are core courses in the MA in the Mathematics Program, and they are offered once a year (511 in Falls and 501 in Springs). Both will be assessed again during the 2024-2025 academic year. | | | | | | | |

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| **Program Student Learning Outcome 2** | | | | | | | |
| **Program Student Learning Outcome** | Students will be able to write proofs of theorems in mathematics. | | | | | | |
| **Measurement Instrument 1** | Assessments from MATH 503, Introduction to Analysis. | | | | | | |
| **Criteria for Student Success** | A score of 8 or higher on a 10-point multipart rubric for problems given on assessments will indicate that students’ ability to write proofs. We expect at least 75% of students to meet this learning outcome. | | | | | | |
| **Program Success Target for this Measurement** | | | 75% | | **Percent of Program Achieving Target** | 90% | |
| **Methods** | The artifacts from all enrolled students (n=10) that were used to assess this SLO were required assessments. | | | | | | |
| **Measurement Instrument 2** | Assessments from MATH 515, Introduction to Number Theory. | | | | | | |
| **Criteria for Student Success** | A score of 8 or higher on a 10-point multipart rubric for problems given on assessments will indicate that students’ ability to write proofs. We expect at least 75% of students to meet this learning outcome. | | | | | | |
| **Program Success Target for this Measurement** | | 75% | | **Percent of Program Achieving Target** | | 100% | |
| **Methods** | The artifacts from all enrolled students (n=3) that were used to assess this SLO were required assessments. | | | | | | |
| **Based on your results, circle or highlight whether the program met the goal Student Learning Outcome 2.** | | | | | | **Met** | **Not Met** |
| **Results, Conclusion, and Plans for Next Assessment Cycle (Describe what worked, what didn’t, and plan going forward)** | | | | | | | |
| **Results**: These results were not suprising. Proof writing is typically one of the more difficult aspects of graduate mathematics, even for those with degrees in undergraduate mathematics. For both MATH 503 and MATH 515 not all students met the learning objective but both classes were well above the program success target.  **Conclusions**: MATH 503 is the most challenging course in the MA in Mathematics. Last assessment cycle we indicated we have had students leave the program because of this course. Thankfully, this iteration was much more successful and a higher proportion met the learning objective. We hired a new faculty member whose expertise in this area (both mathematically and pedagogically) was a large improvement to the course. He updated the instructional methodology, included technology, and recorded videos on an as needed basis for students. He also supplemented the course with two new textbooks. MATH 515 was taught for a second time ever this assessment cycle. As it only had 3 students, the discussions in the class could only be as back-and-forth as possible. The students did a great job in this course.  **Plans for Next Assessment Cycle**: Next assessment cycle, the instructor for MATH 503 will be the same. He plans to use the two next supplemental textbooks as the main textbooks for the course to support student learning. The instructor will also be the same for MATH 515. Both of these courses are core courses in the MA in the Mathematics Program, and they are offered once a year (503 in the Fall and 515 in the Spring). Both will be assessed again during the 2024-2025 academic year. | | | | | | | |

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| **Program Student Learning Outcome 3** | | | | | |
| **Program Student Learning Outcome** | Students will demonstrate their capacity to use multiple strategies and appropriate technology to apply mathematics in problem solving situations and will justify their solutions with sound logic. | | | | |
| **Measurement Instrument 1** | Assessments from MATH 512, Geometry from an Advanced Perspective. | | | | |
| **Criteria for Student Success** | A score of 8 or higher on a 10-point multipart rubric for problems given on assessments will indicate that students’ capacity to use multiple strategies and appropriate technology to apply mathematics in problem solving situations. We expect at least 75% of students to meet this learning outcome. | | | | |
| **Program Success Target for this Measurement** | | 75% | **Percent of Program Achieving Target** | 80% | |
| **Methods** | The artifacts from all enrolled students (n=5) that were used to assess this SLO were required assessments. | | | | |
| **Based on your results, circle or highlight whether the program met the goal Student Learning Outcome 3.** | | | | **Met** | **Not Met** |
| **Results, Conclusion, and Plans for Next Assessment Cycle (Describe what worked, what didn’t, and plan going forward)** | | | | | |
| **Results**: These results are expected for this learning outcome.  **Conclusions**: We continued using the same textbook (after trying a different one a few years ago). We plan to continue to use the same textbook next year. We were very intentional in how technology was integrated into assignments and assessments. We will monitor student success on this learning outcome.  **Plans for Next Assessment Cycle**: MATH 512 is one of the core courses in the MA in the Mathematics Program, and it is offered once a year (every Spring). It will be assessed again during the 2024-2025 academic year. | | | | | |

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| **Program Student Learning Outcome 4** | | | | | | | |
| **Program Student Learning Outcome** | Students will demonstrate their capacity for collaboration in the mathematics classroom as a learner and as a teacher. | | | | | | |
| **Measurement Instrument 1** | Discussion boards from MATH 503, Introduction to Analysis. | | | | | | |
| **Criteria for Student Success** | A score of 8 or higher on a 10-point multipart rubric will demonstrate students’ ability to collaborate when working towards solutions to problems. We expect at least 75% of students to meet this learning outcome. | | | | | | |
| **Program Success Target for this Measurement** | | | 75% | | **Percent of Program Achieving Target** | 80% | |
| **Methods** | The artifacts from all enrolled students (n=10) that were used to assess this SLO were discussion boards. | | | | | | |
| **Measurement Instrument 2** | Discussion boards from MATH 512, Geometry from an Advanced Perspective. | | | | | | |
| **Criteria for Student Success** | A score of 8 or higher on a 10-point multipart rubric will demonstrate students’ ability to collaborate when working towards solutions to problems. We expect at least 75% of students to meet this learning outcome. | | | | | | |
| **Program Success Target for this Measurement** | | 75% | | **Percent of Program Achieving Target** | | 80% | |
| **Methods** | The artifacts from all enrolled students (n=5) that were used to assess this SLO were discussion boards. | | | | | | |
| **Based on your results, highlight whether the program met the goal Student Learning Outcome 4.** | | | | | | **Met** | **Not Met** |
| **Results, Conclusion, and Plans for Next Assessment Cycle (Describe what worked, what didn’t, and plan going forward)** | | | | | | | |
| **Results**: These results are expected as discussion in an online environment is approached differently by students. That said, the instructors of these classes had clear expectations of what constituted expected participation in discussions.  **Conclusions**: 80% of students in both classes met the program success target. This is not surprising as, despite the emphasis placed on the importance of discussing mathematics with classmates, sometimes students engage in a very surface-level way (e.g., “I got the same answer”). Research in mathematics indicates the importance of discussing with peers to develop understanding and we our best to emulate that in online environments. We don’t exepct all students to collaborate in the same way, but we are pleased that more than the success target did.  **Plans for Next Assessment Cycle**: As indicated we now are getting data from MATH 503 and MATH 512 for this learning outcome. Both of these classes are well suited to look at discussion boards and collaboration as the mathematics leads to multiple ways of thinking. Both of these courses are core courses in the MA in the Mathematics Program, and they are offered once a year (503 in the Fall and 512 in the Spring). Both will be assessed again during the 2024-2025 academic year. | | | | | | | |

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| **Program Student Learning Outcome 5** | | | | | |
| **Program Student Learning Outcome** | Students will be able to communicate about research in mathematics education in a written form at a level commensurate with that of students completing a master’s degree. | | | | |
| **Measurement Instrument 1** | Discussion boards and written assignments from MATH 585, Advanced Mathematical Thinking I. | | | | |
| **Criteria for Student Success** | A score of 8 or higher on a 10-point multipart rubric will demonstrate students’ ability to read, interpret, and analyze research in mathematics education. We expect at least 75% of students to meet this learning outcome. | | | | |
| **Program Success Target for this Measurement** | | 75% | **Percent of Program Achieving Target** | 100% | |
| **Methods** | The artifacts from all enrolled students (n=8) that were used to assess this SLO were required discussion boards and assignments. | | | | |
| **Based on your results, highlight whether the program met the goal Student Learning Outcome 5.** | | | | **Met** | **Not Met** |
| **Results, Conclusion, and Plans for Next Assessment Cycle (Describe what worked, what didn’t, and plan going forward)** | | | | | |
| **Results**: This was the first time that this learning outcome was assessed. These results are expected.  **Conclusions**: The students in this class produced high quality discussions and assignments demonstrating an ability to read, interpret, and analyze research in mathematics education. As this was the first time this learning outcome was assessed and the first time MATH 585 was taught we plan to implement the course in a similar way to see more data before seeing if changes need to be made. One exception is that the instructor plans to have more clear expectations when it comes to discussing mathematics (in addition to mathematics education). The latter was discussed well but better connections to mathematics content can be made.  **Plans for Next Assessment Cycle**: MATH 585 is one of two capstone courses in the MA in the Mathematics Program, and it is offered once a year (summers as our students are teachers and need some classes offered over the summer when they are not teaching). It will be assessed again next year. | | | | | |

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| **Program Student Learning Outcome 6** | | | | | |
| **Program Student Learning Outcome** | Students will be able to conduct research regarding secondary students’ mathematical thinking. | | | | |
| **Measurement Instrument 1** | Capstone research projects from MATH 595, Advanced Mathematical Thinking II. | | | | |
| **Criteria for Student Success** | A score of 8 or higher on a 10-point multipart rubric will demonstrate students’ ability to design and conduct research in mathematics education. We expect at least 75% of students to meet this learning outcome. | | | | |
| **Program Success Target for this Measurement** | | 75% | **Percent of Program Achieving Target** | 87.5% | |
| **Methods** | The artifacts from all enrolled students (n=8) that were used to assess this SLO was the required capstone project. | | | | |
| **Based on your results, highlight whether the program met the goal Student Learning Outcome 6.** | | | | **Met** | **Not Met** |
| **Results, Conclusion, and Plans for Next Assessment Cycle (Describe what worked, what didn’t, and plan going forward)** | | | | | |
| **Results**: This was the first time that this learning outcome was assessed. These results are expected. The only unexpected result is that a student needed to take an incomplete but they eventually passed.  **Conclusions**: The students in this class demonstrated an ability to design and conduct research in mathematics education. They all created a research proposal, interviewed high school students (with appropriate IRB approval), analyzed results, and wrote a final paper. The goal of this course is for them to see how designing and conducting research can enhance how they would approach teaching the mathematics that they are interviewing students on. As this was the first time this learning outcome was assessed and the first time MATH 595 was taught we plan to implement the course in a similar way to see more data before seeing if changes need to be made. One exception is that the instructor plans to have more clear expectations when it comes to discussing mathematics (in addition to mathematics education). The latter was discussed well but better connections to mathematics content can be made.  **Plans for Next Assessment Cycle**: MATH 595 is one of two capstone courses in the MA in the Mathematics Program, and it is offered once a year (every Fall). It will be assessed again in Fall 2024. | | | | | |

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| **CURRICULUM MAP 049** | | | | | | | |
| **Program name:** | Master of Arts in Mathematics | | | | | | |
| **Department:** | Mathematics | | | | | | |
| **College:** | Ogden College of Science & Engineering | | | | | | |
| **Contact person:** | Nick Fortune | | | | | | |
| **Email:** | nicholas.fortune@wku.edu | | | | | | |
|  |  | **Learning Outcomes** | | | | | |
|  |  | **LO1** | **LO2** | **LO3** | **LO4** | **LO5** | **LO6** |
| Key: I = Introduced R = Reinforced / Developed M = Mastered  A = Assessed |  | Students will be able to communicate mathematics in a written form at a level commensurate with that of students completing a master’s degree. | Students will be able to write proofs of theorems in mathematics. | Students will demonstrate their capacity to use multiple strategies and appropriate technology to apply mathematics in problem solving situations and will justify their solutions with sound logic. | Students will demonstrate their capacity for collaboration in the mathematics classroom as a learner and as a teacher. | Students will be able to communicate about research in mathematics education in a written form at a level commensurate with that of students completing a master’s degree. | Students will be able to conduct research regarding secondary students’ mathematical thinking. |
| **Course** | **Course Title** |  |  |  |  |  |  |
| MATH 501 | Introduction to Probability and Statistics I | R/M/A |  | I/R | I/R |  |  |
| MATH 503 | Introduction to Analysis | I/R | R/M/A |  | R/M/A |  |  |
| MATH 511 | Algebra from an Advanced Perspective | I/R/M/A | I/R | I/R | I/R |  |  |
| MATH 512 | Geometry from an Advanced Perspective | I/R | I/R | R/M/A | R/M/A |  |  |
| MATH 515 | Number Theory | R/M | R/M/A | R/M | R/M |  |  |
| MATH 585 | Advanced Mathematical Thinking I |  |  |  |  | I/R/M/A | I/R |
| MATH 595 | Advanced Mathematical Thinking II |  |  |  |  |  | R/M/A |

**Learning Outcome 1 Rubric**

For this learning outcome, it is expected that you will engage substantially in discussion boards during this class and demonstrate evidence of conceptual understanding of the content on the midterm, final exam, and paper/project. As part of the MA in Mathematics program, it is expected that you will develop the ability to communicate mathematics in the written form as is expected for a master’s level student. As such, your written work (as compared to numerical answers) on these assessments will be analyzed according to the following rubric.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 10 | 8 | 5 | 2 | 0 |
| Surpasses Standard (Mastery plus Connections) | Meets Standard (Mastery) | Approaching Standard | Not Yet Approaching Standard | No Attempt |
| Explanations show mastery of content and deeper analysis/understanding of the content. Uses specific references to add to explanation. Makes connection to teaching of mathematics/statistics in a thoughtful way, considering student thinking and understanding. | Explanations show some analysis. Explanations show mastery and understanding of content. Minor or no connection to teaching of mathematics/statistics is made. | Explanations show some understanding of essential content, facts, but is lacking in greater analysis and evidence. | Explanations do not show understanding of basic content.  Explanations are incomplete or inaccurate. Answers show that mastery of the general content is missing. | Product does not address the assignment, is off topic, or was not submitted. |

**More explanation:**

1. A “0” means that the student either turned in an explanation that did not address the question/content or did not turn in an assignment at all.

2. A “2” means that a student provided explanations, but there was not enough evidence of understanding. This typically means that a student did not elaborate well enough or had some factual/procedural errors or major conceptual errors, which did not provide enough evidence or comprehension of the material.

3. A “5” means that a student has shown basic understanding of content and material. The base material is present and correct. A student who earns a “5” has an understanding of the concepts presented in class. To improve from “5” a student should include analysis or evaluation of the content. Elaborate beyond “How do you get this answer” toward “Why does this work?”

4. An “8” means that a student has mastered the content and is analyzing the content rather than just stating answers. An “8” typically means that a student is venturing into more abstract ideas and concepts and is attempting to relate them to their teaching of mathematics/statistics.

5. A “10” means that a student’s explanation is clear, directed, and evidence driven. Students who earn 10’s are writing with the content as their guide to create analytical responses. Students who earn a “10” show understanding of content and relate this understanding to the teaching of this content in their current or future mathematics/statistics classrooms (e.g., considers their future students’ thinking, including conceptions and misconceptions).

**Learning Outcome 2 Rubric**

For this learning outcome, it is expected that students demonstrate evidence of conceptual understanding of the content on assignments, midterm, and final exam. As part of the MA in Mathematics program, it is expected that you will develop the ability to communicate mathematics in the written form as is expected for a master’s level student. As such, your written work (as compared to numerical answers) on these assessments will be analyzed according to the following rubric.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 10 | 8 | 5 | 2 | 0 |
| Surpasses Standard (Mastery plus Connections) | Meets Standard (Mastery) | Approaching Standard | Not Yet Approaching Standard | No Attempt |
| Demonstrates complete understanding. A correct and complete proof is given. Some irrelevant information  may be included but does not affect the intended proof. | Demonstrates complete understanding. A correct approach to proving the theorem is attempted. Some statements may  be unjustified or improperly justified, but errors are minor and could be fixed given time to polish the proof. | Demonstrates understanding of theorem to be proved, but proof is incomplete or does not prove the intended result.  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. | Attempts the proof but demonstrates little or no understanding. | Product does not address the assignment, is off topic, or was not submitted. |

**More explanation:**

1. A “0” means that the student either turned in an explanation that did not address the question/content or did not turn in an assignment at all.

2. A “2” means that a student provided explanations, but there was not enough evidence of understanding. This typically means that a student did not elaborate well enough or had some factual/procedural errors or major conceptual errors, which did not provide enough evidence or comprehension of the material.

3. A “5” means that a student has shown basic understanding of content and material. The base material is present and correct. A student who earns a “5” has an understanding of the concepts presented in class. To improve from “5” a student should include analysis or evaluation of the content. Elaborate beyond “How do you get this answer” toward “Why does this work?”

4. An “8” means that a student has mastered the content and is analyzing the content rather than just stating answers. An “8” typically means that a student is venturing into more abstract ideas and concepts and is attempting to relate them to their teaching.

5. A “10” means that a student’s explanation is clear, directed, and evidence driven. Students who earn 10’s are writing with the content as their guide to create analytical responses. Students who earn a “10” show understanding of content and relate this understanding to the teaching of this content in their current or future math classrooms (e.g., considers their future students’ thinking, including conceptions and misconceptions).

**Learning Outcome 3 Rubric**

For this learning outcome, it is expected that students demonstrate evidence of conceptual understanding of the content on assignments, midterm, and final exam. As part of the MA in Mathematics program, it is expected that you will develop the ability to communicate mathematics in the written form as is expected for a master’s level student. As such, your written work (as compared to numerical answers) on these assessments will be analyzed according to the following rubric.

Table 1: Rubric for non-proof problems.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 10 | 8 | 5 | 2 | 0 |
| Surpasses Standard (Mastery plus Connections) | Meets Standard (Mastery) | Approaching Standard | Not Yet Approaching Standard | No Attempt |
| Demonstrates complete understanding and gives correct solution that is identified and includes work/explains thinking. | Demonstrates understanding, shows work/explains thinking, and has a correct solution that is not identified, or “units” are not included or demonstrates understanding, shows work/explains thinking, but gets a slightly wrong answer. | Demonstrates some understanding and gives incorrect solution but shows work and provides explanations/justify thoughts. | Attempts the problem but demonstrates little or no understanding **or** gives correct solution but shows no work and/or provides no answer to back up correct solution. | Product does not address the assignment, is off topic, or was not submitted. |

Table 2: Rubric for problems with proofs.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 10 | 8 | 5 | 2 | 0 |
| Surpasses Standard (Mastery plus Connections) | Meets Standard (Mastery) | Approaching Standard | Not Yet Approaching Standard | No Attempt |
| Demonstrates complete understanding. A correct and  complete proof is given. Some irrelevant information  may be included but does not affect the intended proof. | Demonstrates complete understanding. A correct approach to proving the theorem is attempted. Some statements may  be unjustified or improperly justified, but errors are minor and could be fixed given time to polish the proof. | Demonstrates understanding of theorem to be proved, but proof is incomplete or does not prove the intended result.  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. | Attempts the proof but demonstrates little or no understanding. | Product does not address the assignment, is off topic, or was not submitted. |

**More explanation:**

1. A “0” means that the student either turned in an explanation that did not address the question/content or did not turn in an assignment at all.

2. A “2” means that a student provided explanations, but there was not enough evidence of understanding. This typically means that a student did not elaborate well enough or had some factual/procedural errors or major conceptual errors, which did not provide enough evidence or comprehension of the material.

3. A “5” means that a student has shown basic understanding of content and material. The base material is present and correct. A student who earns a “5” has an understanding of the concepts presented in class. To improve from “5” a student should include analysis or evaluation of the content. Elaborate beyond “How do you get this answer” toward “Why does this work?”

4. An “8” means that a student has mastered the content and is analyzing the content rather than just stating answers. An “8” typically means that a student is venturing into more abstract ideas and concepts and is attempting to relate them to their teaching.

5. A “10” means that a student’s explanation is clear, directed, and evidence driven. Students who earn 10’s are writing with the content as their guide to create analytical responses. Students who earn a “10” show understanding of content and relate this understanding to the teaching of this content in their current or future math classrooms (e.g., considers their future students’ thinking, including conceptions and misconceptions).

**Learning Outcome 4 Rubric**

For this learning outcome, it is expected that you will engage substantially in discussion boards related to the mathematics content. These discussion boards will demonstrate your capacity for collaboration as a learner and a teacher. As part of the MA in Mathematics program, it is expected that you will develop the ability to communicate mathematics in the written form as is expected for a master’s level student. As such, your written work (as compared to numerical answers) on these assessments will be analyzed according to the following rubric.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 10 | 8 | 5 | 2 | 0 |
| Surpasses Standard (Mastery plus Connections) | Meets Standard (Mastery) | Approaching Standard | Not Yet Approaching Standard | No Attempt |
| Explanations show mastery of content and deeper analysis/understanding of the content. Uses specific references to add to explanation. Makes connection to teaching of mathematics/statistics in a thoughtful way, considering student thinking and understanding. | Explanations show some analysis. Explanations show mastery and understanding of content. Minor or no connection to teaching of mathematics/statistics is made. | Explanations show some understanding of essential content, facts, but is lacking in greater analysis and evidence. | Explanations do not show understanding of basic content. Explanations are incomplete or inaccurate. Answers show that mastery of the general content is missing. | Product does not address the assignment, is off topic, or was not submitted. |

**More explanation:**

1. A “0” means that the student either turned in an explanation that did not address the question/content or did not turn in an assignment at all.

2. A “2” means that a student provided explanations, but there was not enough evidence of understanding. This typically means that a student did not elaborate well enough or had some factual/procedural errors or major conceptual errors, which did not provide enough evidence or comprehension of the material.

3. A “5” means that a student has shown basic understanding of content and material. The base material is present and correct. A student who earns a “5” has an understanding of the concepts presented in class. To improve from “5” a student should include analysis or evaluation of the content. Elaborate beyond “How do you get this answer” toward “Why does this work?”

4. An “8” means that a student has mastered the content and is analyzing the content rather than just stating answers. An “8” typically means that a student is venturing into more abstract ideas and concepts and is attempting to relate them to their teaching.

5. A “10” means that a student’s explanation is clear, directed, and evidence driven. Students who earn 10’s are writing with the content as their guide to create analytical responses. Students who earn a “10” show understanding of content and relate this understanding to the teaching of this content in their current or future math classrooms (e.g., considers their future students’ thinking, including conceptions and misconceptions).

**Learning Outcome 5 Rubric**

For this learning outcome, it is expected that you will engage substantially in discussion boards during this class and demonstrate evidence of understanding of the content on the midterm, final exam, and paper/project. As part of the MA in Mathematics program, it is expected that you will develop the ability to read, interpret, and analyze research in mathematics education as is expected for a master’s level student. As such, your written work on these assessments will be analyzed according to the following rubric.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 10 | 8 | 5 | 2 | 0 |
| Surpasses Standard (Mastery plus Connections) | Meets Standard (Mastery) | Approaching Standard | Not Yet Approaching Standard | No Attempt |
| Discussions and assignments show mastery of the ability to read, interpret, and analyze research in mathematics education. Makes connection to teaching of mathematics/statistics in a thoughtful way, considering student thinking and understanding. | Discussions and assignments show the ability to read, interpret, and analyze research in mathematics education. Makes some connection to teaching of mathematics/statistics in a thoughtful way, considering student thinking and understanding. | Discussions and assignments show some ability to read, interpret, and analyze research in mathematics education. Makes no connection to teaching. | Discussions and assignments do not show ability to read, interpret, and analyze research in mathematics education. Makes no connection to teaching. | Did not show ability to read, interpret, or analyze research in mathematics education. Makes no connection to teaching. |

**More explanation:**

1. A “0” means that the student either turned in assignments that did not address the objective or did not turn in an assignment at all.

2. A “2” means that a student provided assignments, but there was not enough demonstration of the ability to read, interpret, and analyze research in mathematics education. This typically means that a student did not elaborate well enough or had some major misunderstandings.

3. A “5” means that a student has shown basic ability to read, interpret, and analyze research in mathematics education. A student who earns a “5” has an understanding what mathematics education research is but could improve by including analysis or evaluation of the content. Elaborate beyond “How did this research happen” toward “What does this mean?”

4. An “8” means that a student has demonstrated the ability to read, interpret, and analyze research in mathematics education. An “8” typically means that a student is venturing into more theoretically grounded ideas and concepts and is attempting to relate them to their teaching.

5. A “10” means that a student has demonstrated the exemplary ability to read, interpret, and analyze mathematics education research. Students who earn a “10” demonstrate a strong understanding of literature in mathematics education. Students who earn a “10” show understanding of content and relate this understanding to the teaching of this content in their current or future math classrooms (e.g., considers their future students’ thinking, including conceptions and misconceptions).

**Learning Outcome 6 Rubric**

For this learning outcome, it is expected that you will demonstrate evidence of understanding on assignments and a final project. As part of the MA in Mathematics program, it is expected that you will develop the ability to design and conduct research on mathematics education as is expected for a master’s level student. As such, your written work on these assessments will be analyzed according to the following rubric.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 10 | 8 | 5 | 2 | 0 |
| Surpasses Standard (Mastery plus Connections) | Meets Standard (Mastery) | Approaching Standard | Not Yet Approaching Standard | No Attempt |
| Capstone project demonstrates the exemplary ability to design and conduct mathematics education research. Makes connection to teaching of mathematics/statistics in a thoughtful way, considering student thinking and understanding. | Capstone project demonstrates the ability to design and conduct mathematics education research. Makes some connection to teaching of mathematics/statistics in a thoughtful way, considering student thinking and understanding. | Capstone project demonstrates some ability to design and conduct mathematics education research. Makes no connection to teaching. | Capstone project does not demonstrate ability to design and conduct mathematics education research. Makes no connection to teaching. | Capstone project does not address the assignment, is off topic, or was not submitted. |

**More explanation:**

1. A “0” means that the student either turned in a project that did not address the objective or did not turn in an assignment at all.

2. A “2” means that a student provided a project, but there was not enough demonstrate of the ability to design and conduct mathematics education research. This typically means that a student did not elaborate well enough or had some major misunderstandings.

3. A “5” means that a student has shown basic ability to design and conduct mathematics education research. A student who earns a “5” has an understanding of what mathematics education research is but could improve by including more analysis or evaluation.

4. An “8” means that a student has demonstrated the ability to design and conduct mathematics education research. An “8” typically means that a student is venturing into more theoretically grounded ideas and concepts and is attempting to relate them to their teaching.

5. A “10” means that a student has demonstrated the exemplary ability to design and conduct mathematics education research. Students who earn a “10” demonstrate a strong understanding of literature in mathematics education and the ability to design their own study that builds on that research. Students who earn a “10” relate this understanding to the teaching of this content in their current or future math classrooms (e.g., considers their future students’ thinking, including conceptions and misconceptions).