M.S. Mathematics Education
Final Portfolio & Oral Exam Description

To be eligible to take the Comprehensive Examination, students must:

a) Have a cumulative grade point average of 3.0 or better across all courses completed in their program;

b) Have no more than 10 hours of required coursework remaining and anticipate completing this coursework within one calendar year; and

c) Be formally registered in MAT 603 graduate coursework at NAU at the time of the exam.

The Final Portfolio and Comprehensive Examination Committee shall consist of 3 members. The Committee and topics to be covered shall be selected by the student’s assigned departmental graduate advisor in the program, and approved by the Graduate Operations Committee. Where possible, the committee membership should be restricted to those faculty members from whom the student has completed or is in the process of completing coursework in their program.

A student will be tested over three courses, selected with the guidance of the student’s advisor and approved by both the advisor and the Graduate Operations Committee. One and only one of these three courses must be a Content Connections course. Note: If the oral exam includes courses that are currently in progress, then the exam may not take place until after the 12th week of instruction (after the 4th week of instruction in the summer). The co-chairs of the Committee shall be the committee members from the two selected non-Connections courses.

The M.S. Mathematics Education Final Portfolio will consist of a unique (not submitted as part of a previous course) body of work that documents and analyzes the ways in which a candidate applies key ideas from at least the two selected non-Connections courses to the candidate’s instructional practices. A brief description of which courses the candidate has selected for the Portfolio project, why the courses have been chosen, and how the courses will demonstrate evidence of application to practice shall be completed at the bottom of this form. Prior to facilitating the Portfolio project in the classroom, candidates are STRONGLY ENCOURAGED to submit lesson and/or unit sequence, as well as data collection and analysis plans to the committee members to ensure that the application of program ideas to instructional practices are properly demonstrated via this Portfolio project.

The M.S. Mathematics Education Comprehensive Oral Exam typically lasts 2 hours. Approximately one hour focuses conversation on the Final Portfolio project and the relationship between the ideas focused on in the project and other essential ideas from the M.S. Mathematics Education program and the broader mathematics education community. The other hour will focus on the Content Connections course so that the candidate can demonstrate deep understanding of the mathematical content from the chosen course and make connections between the many key pedagogical concepts learned and applied throughout the program.
A near-final draft of the M.S. Mathematics Education Final Portfolio must be submitted to the two appropriate members of the committee at least 6 weeks before the scheduled M.S. Mathematics Education Comprehensive Oral Exam date. M.S. Mathematics Education faculty will notify the candidate within at least 4 weeks of the scheduled exam date to determine if the candidate is prepared to successfully demonstrate evidence of program ideas to practice or whether the candidate should spend more time working on the Portfolio and should reschedule the Comprehensive Oral Exam. Additionally, candidates must schedule and hold a conference with their Content Connections instructor prior to 4 weeks of the scheduled exam date and successfully demonstrate they are prepared to discuss that course at their Exam. The Comprehensive Oral Exam may not occur until all committee members deem the Portfolio ready for defense.

At the end of the Comprehensive Oral Exam, a discussion of the Committee members shall occur, with a vote taken following the discussion. The committee members may vote to pass or fail. If a two-thirds majority is not obtained to pass, then the candidate fails the examination. The oral exam on the same set of course work may be retaken after a period of one month has passed. Should the candidate fail the comprehensive exam a second time, then enrollment in the program will be terminated. The Chair of the Oral Committee will promptly convey the result (pass/fail) of the exam to the Chair of the Graduate Operations Committee.

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<th>Date</th>
<th>Task</th>
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| Semester before graduation                | • Submit graduation paperwork (nau.edu/GradCol/Student-Resources/graduation)  
Fall/winter graduation – submit by May 1  
Spring/summer graduation – submit by Dec 1  |
| By end of semester prior to semester of oral exam | • Select oral exam committee and submit oral exam approval paperwork to advisor. |
| Prior to implementation of instructional unit/sequence and at least 2 months prior to oral exam | • Submit, to committee co-chairs, brief description of selected courses, why courses have been chosen, and how selected courses will demonstrate evidence of application to practice.  
• Contact committee co-chairs to coordinate and schedule oral exam date and time. |
| Prior to implementation of instructional unit/sequence and at least 8 weeks prior to oral exam data | • STRONGLY ENCOURAGED to submit lesson and/or unit sequence, data collection/analysis plan, indication of data driven instructional decision making, etc. to co-chairs to ensure application of program ideas to instructional practice. |
| At least 6 weeks prior to oral exam       | • Submit near-final draft of the M.S. Mathematics Education Final Portfolio to committee co-chairs.  
• Participate in synchronous (face-to-face, online, or by phone) conversation with Connections Course committee member to discuss content preparation and demonstrate minimal threshold of |
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<tr>
<th>Schedule exit interview with Department of Mathematics &amp; Statistics Chair and complete online survey.</th>
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<td>4 weeks prior to oral exam</td>
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<td>Receive feedback from faculty members on portfolio and content preparedness. Indication of student readiness for oral exam or notification of need for significant revisions and/or content review will be given. In the case of significant revisions/review, the timeline and/or scheduled oral exam date may be modified to allow student time to address faculty concerns with content, scope and/or sequence of portfolio.</td>
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<td>2 week prior to oral exam</td>
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<td>Final draft of portfolio submitted to committee.</td>
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**Final Portfolio Guidelines.**
The goal of this assignment is to show what you have learned from completing this program in mathematics education and how you have incorporated your learning into your teaching. Completing this portfolio may also help you begin thinking about an AYA/Mathematics portfolio entry for national certification.

There are three sections to this project: (i) a discussion of the mathematical concept/content you chose and the instructional implications of that choice, (ii) a description of two especially pertinent pedagogy courses from this program along with descriptions of how these courses (and the program) have impacted the development and implementation (i.e. content and pedagogy) of a sample unit or series of lessons, and (iii) a reflection on the program, as a whole, as its impact on your experiences, expectations and applications of various themes regarding mathematics teaching and learning. Each section is described below.

Your portfolio should be prepared using standard 12-point Times New Roman font. Double spaced with one-inch margins. Use APA formatting for references and include a reference sheet at the end of your portfolio (but before the Appendices) for all cited sources. (For information on APA formatting, you can visit the Purdue Online Writing Lab at: https://owl.english.purdue.edu/owl/resource/560/01/).
For Section II of this portfolio, you will need to reference artifacts from your teaching (either those used or, if necessary, those you would use in a classroom setting). Artifacts include things like lesson plans, samples of student work, worksheets, project instructions/rubric, samples of student work, scores/data/data analysis summaries, and so on. The point is to choose a handful of items that best demonstrate your continued application of the "big ideas" from this program in your teaching of mathematics. Your artifacts will be part of the appendix of this portfolio. Label your artifacts by appendix item letter and refer to that appendix item directly in your narrative(s).

Section I – Content and Instruction (expected length: ~ 3-5 pages double spaced)

Directions: Choose a mathematical topic you wish to use as the focus of your portfolio. Ideally elements of this broader topic may be something you actually teach in one of your final two semesters in this program so that you can actually teach the content/concept and build your portfolio around your instructional experiences. Keep in mind that you will need to develop, discuss and utilize artifacts related to your chosen topic as part of the development of subsequent sections of this portfolio.

The topic should be something connected to your current and/or past classroom teaching assignment(s) and for which you will be able to sufficiently reflect upon and integrate MS Math Ed course content and philosophies. If you do not currently have a teaching assignment and/or are out of the classroom, you will need to choose a topic that you could teach.

The topic should also be something that is developed over the course of an extended period of time (e.g. a quarter or a semester rather than a single unit or lesson). While the balance of your portfolio may focus on a single strand within your topic, the discussion for this section should include a broad consideration of your content topic. A good way to think about your chosen topic is to think in terms of a CCSS strand rather than a single content topic and/or pedagogical approach (e.g. focus your discussion around the “Creating Equations” strand within the “Algebra” conceptual category rather than narrowing your focus to solving one-step equations using a pan balance). If your chosen strand crosses several grade levels, it may be helpful to focus your discussion around one grade level application of your strand.

1. Provide a short description of the instructional context of the course in which you will/could implement your instructional unit/sequence. What is the title and general content area/sequencing of the course? How is the course designed and organized? Provide a general description of the context, timing and instructional setting of this course. Are there extenuating/special circumstances that could help us understand your instructional context and its impact on the implementation of your portfolio?

2. Give a brief description of the mathematical strand you chose. This description should include a definition of the topics included in that strand within the context of secondary/college level mathematics and the grade level (if appropriate) that
you have chosen to focus on. To do this, find a single resource in mathematics education (e.g., the CCSS, a high school/college textbook, a research article, an article from a professional journal, or a reading from this course) to define the meaningfulness and application of the topic in grades 7-12 or at the college level. For example, why is differentiation studied at the secondary or college level? What application does it have and what role does it play in the curriculum at that level? Specifically discuss the content topics and applications that would be taught throughout a course sequence devoted to this topic. Reference your content source(s) (e.g. ACCRS-M, Common Core, textbook, etc.) in your narrative and include citations in your reference page.

3. Describe common difficulties encountered in learning and teaching the mathematical strand/topic you chose. What are some common student misconceptions related to your strand? What are implications for instruction and possible areas of difficulty when teaching this strand? Reference at least three professional sources of information and include citations in your reference page.

Section II – Connecting Content & Pedagogy  (expected length: ~ 15 - 25 pages double spaced, including figures, tables, etc but not including appendices)

Directions: Choose two mathematics education courses to serve as the pedagogical focus of your portfolio and give a brief description of why you chose these topics. These selected courses should reflect the skills you have developed as a mathematics teacher throughout the completion of this program. Then, develop an integrated discussion that incorporates the impact of your two chosen pedagogy courses on the planning, development and implementation of the content strand you have chosen for this portfolio. Discussions are often reinforced by including tables, charts, figures, screenshots, or other visual documentation that support the narrative and/or demonstrate pertinent aspects of planning, implementation, snippets of student work, assessment, etc. Within your appendices, provide 3 – 5 artifacts (e.g. lesson plans, student work, assessment data, projects, etc.) from your coursework and/or your classroom practice that highlight the various components of this section of your portfolio. Make explicit references and connections between your artifacts and your discussions (as indicated in the description of each component below).

Please note: Questions listed in each of these subsections are intended to guide your thinking and development of your narrative. DO NOT treat these guiding prompts as a list of questions to be answered; rather they can be used as resources around which to begin building your discussion.

1. Pedagogical Coursework – Choose two mathematics education courses that have particularly impacted your understanding and teaching of mathematics. For each mathematics education course you chose, give support from key literature on the importance of implementing tools and/or ideas in this area for improving student learning and instruction. Provide specific examples of the use of the pedagogical tools/approaches in your own instruction. How has your teaching changed as a
result of integration of each pedagogical tool/approach? Refer specifically to how some of the artifacts you have chosen for this portfolio highlight and demonstrate your use/application of these pedagogical tool(s). For example, if you chose technology as a course to focus on, you will need to support a discussion on general and specific applications of the technology in your teaching. Give support from key articles you read in class to justify your use of technology in support of effective instruction, student learning and authentic engagement with content. Finally, demonstrate your use and application of effective technology use through a discussion of your selected artifact(s).

Reference at least three sources of professional information for each of your chosen pedagogy courses. Include citations to these sources in your reference page. Make sure that your Portfolio uses clear headings to separate your rationale and support for each course and that you have focused on how ideas from the courses are being applied to your practice! Your discussion, along with support and background from each course, should be separated into two subheadings, one for each pedagogical course chosen and discussed.

2. Instructional development - Develop an integrated discussion that incorporates the impact of your two chosen pedagogy courses on the planning, development and implementation of the content strand you have chosen for this portfolio. Whether this is a content strand that you taught in the past, are in the middle of teaching, or will teach in the future, how do the content and pedagogical implications of your two chosen pedagogy courses inform your teaching and the development of student learning experiences. How are these plans similar to and/or different from what you may have done prior to completing this MS Math Education program?

Describe the instructional sequence you have developed to teach your content area over an extended period of time (e.g. several months, a semester or a school year). How do your structured learning experiences build on and develop students’ conceptual understanding of your topic? More than a listing or series of activities, this discussion should focus on “big idea” instructional approaches, in terms of content and pedagogy, that provide students with a variety of learning experiences that enhance their ability to think and reason mathematically, engage in content in authentic ways, and demonstrate understanding through a variety of avenues. Throughout the narrative, provide several examples that demonstrate a deep understanding of pedagogical decision making (especially as it relates to the two pedagogy courses developed above) that promoted the development of content and authentic student learning experiences. Use selected artifacts to support and demonstrate the main ideas from this discussion.

3. Data driven instructional decision making – In data driven instruction, we consider assessment throughout the entire instructional process (i.e., in planning, implementation, and reflection). We begin the planning process by considering what we want students to learn and how they can show what they have learned, which
drives our learning objectives, instructional decisions, and planned assessment. During implementation of a lesson, we continue to consider assessment as we make “in the moment” decisions. That is, how will a spontaneous instructional decision change what students are learning and how we assess this learning? Did the planned assessment provide enough opportunities for students to show their knowledge and skills? After a lesson, we use assessment to analyze and reflect on the effectiveness of teaching strategies for our current students and future practice. Describe how assessment has been or will be used in each stage of your instruction. That is, how to you use thoughts about assessment to plan instruction? How do you decide what to assess and when to assess it? And how does the collection and analysis of quantitative, qualitative and reflective assessment data play a role in the development of instructional sequencing and planning? Provide several examples that demonstrate how the use of data from various assessments was used (or could be used) to inform instructional next-steps. Use selected artifacts to support and demonstrate the main ideas from this discussion.

Section III – Conclusions (expected length: ~ 3 - 5 pages double spaced)

Directions: Reflect on the common themes, experiences and applications of mathematics teaching and learning in which you have engaged throughout the MS Math Ed program. Specifically, think about the interplay and interrelationships between teaching, learning, assessment, and curriculum. Subthemes of equity, problem solving, engagement, and technology naturally emerge when considering the impact of shifts to one element of the instructional paradigm on another element. In this concluding discussion, develop your understanding of the “big picture” ideas of the MS Math Education program in a holistic light.

Please note: Questions listed in each of these subsections are intended to guide your thinking and development of your narrative. DO NOT treat these guiding prompts as a list of questions to be answered; rather they can be used as resources around which to begin building your discussion.

1. Reflect on what you learned from analyzing reform oriented mathematics teaching and authentic student learning and engagement (as part of this portfolio and as part of individual courses in this program).
   a. How have your ideas about mathematics content and the connections between higher level math and secondary mathematics instruction grown and developed throughout this program? In what ways has your understanding of geometry, algebra, probability & statistics and calculus been promoted through your content coursework? In what ways have you developed curricular, content and problem solving connections between your coursework in this program and your teaching?
M.S. Mathematics Education
Final Portfolio & Oral Exam Description

c. What does exemplary mathematics teaching look like? What role do guiding documents like the NCTM Process Standards or Common Core Standards of Mathematical Practice play in defining and implementing effective mathematics instruction?

d. How are the “big ideas” of this program integrated within and between courses to promote development of your understanding of effective teaching and learning? What are some of the themes that you have seen implemented, developed and supported across courses within this program? How have these “big ideas” been developed and applied, both within the program and with respect to your own instruction?

2. What elements of this program have been most influential in impacting your thinking about mathematics teaching and learning? About mathematics content? In what ways were they influential? How does the portfolio reflect your professional development over the course of the program? What final lessons have you learned?