M.S. Mathematics Education
Final Portfolio & Oral Examination Instructions & Guidelines

The culmination of the M.S. in Mathematics Education degree consists of a final portfolio and an oral exam. These assignments require and allow candidates the opportunity to demonstrate that they have retained the knowledge they have gained throughout the degree program and that they apply core ideas from the program into their professional teaching practice.

To be eligible to take the Comprehensive Examination, candidates 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 in the current semester or session; and

c) Be formally registered in graduate coursework at NAU at the time of the exam. (In addition to any outstanding classes/credits, candidates admitted after Fall 2014 are required to take MAT 603 during the semester they will submit their portfolio and take their oral exam. Candidates admitted prior to Fall 2014 are strongly encouraged, though not required, to enroll in MAT 603 during the semester of their exam.)

A candidate will be tested over three courses, selected with the guidance of the candidate's advisor and approved by both the advisor and the Graduate Operations Committee. Two of the courses selected should be from the non-*Connections* pedagogical/methodological courses (e.g. MAT 500, 501, 502, 508, 509, 510, 600, 601, 602) and one course should be selected from the *Content Connections* courses (e.g. MAT 504, 505, 506, 507). 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 Final Portfolio and Comprehensive Examination Committee shall consist of 3 members. Where possible, the committee membership should be restricted to those faculty members from whom the candidate has completed or is in the process of completing coursework in his/her program. The co-Chairs of the Committee are the instructors of the two selected pedagogy courses. The M.S. Mathematics Education Final Portfolio and Comprehensive Oral Examination Approval Form should be submitted by the candidate and his/her advisor AT LEAST 3 MONTHS before the date the exam is being requested in order to leave adequate time to complete the portfolio and study for the exam.

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. Selection of the two non-*Connections* courses should be based on interest and alignment with current classroom practice. The portfolio provides the candidate with a chance to demonstrate their knowledge, synthesis, and application of non-*Connections* coursework as part of their own mathematics instruction. *Please note*: While

the two non-*Connections* courses must closely align with classroom practice within the scope of this portfolio, the *Content Connections* course chosen for the oral examination does not necessarily need to align with the content of the portfolio nor with the content classes currently being taught by the candidate.

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.

Prior to facilitating the Portfolio project in the classroom, candidates are required to discuss instructional plans and connecting program ideas to instructional practice with a specific focus on the two chosen non-*Connections* courses for this Portfolio project. 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. Furthermore, an 'interview' must be scheduled with the *Content Connections* course instructor/committee member to further ensure that candidates appear to be sufficiently prepared for the mathematics content component of the Comprehensive Oral Exam. M.S. Mathematics Education faculty will discuss candidate preparedness and notify the candidate within at least 4 weeks of the scheduled exam date to determine if the candidate is prepared to successfully engage in the content portion of their Portfolio defense. The Comprehensive Oral Exam may not occur until all committee members deem the candidate ready for defense. Please refer to the following timeline for targeted task deadlines. Failure to submit plans and drafts at the appropriate time may result in a delay in taking the oral examination.

Date	Task
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 within the first 4 weeks of the semester	• Participate in a synchronous (face-to-face, online, or by phone) conversation with one (or both) of your committee co-chairs (i.e. instructors of pedagogy courses selected for exam) to discuss instructional plans for lesson sequence and/or unit and demonstrate initial plans for connecting program ideas to instructional 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 understanding of content to be covered during oral exam.
4 weeks prior to oral exam	• Receive feedback from faculty members on portfolio and content preparedness. Indication of candidate 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 candidate time to address faculty concerns with content, scope and/or sequence of portfolio.
2 week prior to oral exam	• Final draft of portfolio submitted to committee. • Complete Department of Mathematics & Statistics online Graduation Questionnaire - http://cefns.nau.edu/math/grad-survey/ • (optional) If desired, you may also schedule an exit interview with the department chair by emailing Melinda.Miller@nau.edu

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 Co-Chairs of the Committee will promptly convey the result (pass/fail) of the exam to the Chair of the Graduate Operations Committee.

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.

The **big idea of this portfolio** is to select a topic that can be taught over the course of several days or as part of a single unit; reflect upon the main concepts, skills, and knowledge from your two selected pedagogy courses; and demonstrate how you have implemented those skills and knowledge as part of teaching your selected content/topic.

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 the two pedagogy courses you have selected 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, assessment 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 the topic selected is something you actually teach in one of your final two semesters in this program so that you can 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. The topic should also be something that is developed over the course of an extended period of time (e.g. several lessons or a unit, rather than a single lesson or activity). 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 content strand rather than a single content topic and/or pedagogical approach (e.g. focus your discussion around "Creating Equations" rather than narrowing your focus to "solving one-step equations using a pan balance").

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? How does your chosen topic fit into the scope/sequence of your course? 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., your state standards, 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) 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.

<u>Section II – Connecting Content & Pedagogy</u> (expected length: ~ 8 - 12 pages double spaced, including figures, tables, etc but not including appendices)

Directions: Choose two non-Connections courses to serve as the pedagogical focus of your portfolio These selected courses should reflect the skills you have developed as a mathematics teacher throughout the completion of this program. Develop an integrated discussion that summarizes the main philosophical and pedagogical tenets of each course and 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).

<u>Please note:</u> 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 (a section for making general/theoretical connections between your instruction and your chosen non- *Connections* courses):

   Choose two non-*Connections* courses that have particularly impacted your understanding and teaching of mathematics. For each course you choose, develop a general discussion of the key concepts, skills, and knowledge from the course along with connections to the impact of effective instruction on the student learning experience. Reference at least three sources of professional information (e.g. course readings, online resources, research articles, etc.) for each of your chosen pedagogy courses. Include citations to these sources in your reference page.

2. Structured Learning Experiences (a section for making specific/practical connections between your instructional sequence/unit and your chosen non-*Connections* courses):

   Describe the instructional sequence you have developed to teach your concept. Discuss the impact of the pedagogical concepts, skills, and knowledge from your two chosen pedagogy courses on your planning, instruction, and assessment. How are these plans similar to and/or different from what you may have done prior to completing this MS Math Education program? 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. Refer specifically to how some of the artifacts you have chosen for this portfolio highlight and demonstrate your use/application of these pedagogical concepts, skills, knowledge. 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).

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 entire MS Math Ed program (not just as it relates to your two chosen non-Connections courses). 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 and how they've impacted your own skills, concepts, and knowledge as a professional.

*Please note: For this section, develop a narrative that addresses **each** of the guiding questions below. Be sure to focus both on personal reflections based on your experiences in this program as well as more theoretical reflections based on the impact of shifting toward a more reform-oriented approach to teaching/learning mathematics.*

1. 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?

2. What are your beliefs regarding teaching and learning mathematics? How do students learn? What is the role of the teacher in learning? The student? What is the role of assessment? Curriculum? Technology? Curricular standards? In what ways are curriculum, assessment, instruction, standards, and student engagement all linked to promote effective learning environments?

3. 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? What elements of this program have been most influential in impacting your thinking about mathematics teaching and learning.

4. How does the portfolio reflect your professional development over the course of the program? What final lessons have you learned?

Final Comments on Oral Examination Preparation

Your oral examination will include a 45-60 minute question/answer period related to your *Content Connections* and a 45-60 minute question/answer period related to your portfolio and other non-*Connections* courses. During the latter we will discuss the implementation of your portfolio and the connections between your instruction and your chosen coursework. In addition to the material covered in your portfolio, we may ask a few questions (similar to those listed below) about the MS Math Ed program as a whole.

1. Problem solving vs solving problems. Be able to define, distinguish, and make connections between a shift toward a problem-solving based approach and its impact on student engagement, curriculum, assessment, equity, etc.
2. Be able to discuss the connections between curriculum, instruction, and assessment. How does a shift in one necessitate a shift in the others?
3. The impact of technology integration on instruction, curriculum, and assessment.
4. Discuss, in general terms, today's reform efforts in the context of the historical evolution of mathematics education over the last 100+ years.
5. Reflect on your development as a teacher. Where were you when you first started the program and where are you now? How have your actions changed? How have your thoughts about teaching/learning changed? What are your next steps as a professional and life-long learner?
6. 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?