

Mathematics Education Qualifying Exam August 2024

Instructions: The following questions constitute the Mathematics Education Qualifying Exam for August of 2024. The questions are separated into two sections; the first section is based on MTH 761 and the second section is based on MTH 762. You must answer all questions in both Section I and Section II. You must pass each section with a 70% score in order to pass the exam. In mathematics education, we build our arguments with words. While we will not be judging students' creative writing ability in the qualifying exam, we will judge your ability to form and express a coherent and reasoned argument about mathematics education using reasonable composition standards. You are expected to synthesize across the articles from class and the readings completed for your individual projects for the courses. You will then use them to build and argue your own points in addressing the qualifying exam questions. You have four hours to complete this exam. Remember to save your work frequently. Please type your responses directly into this document unless directed otherwise.

Section I: (Answer both questions)

1. Larsen (2013) and Larsen & Lockwood (2013) describe the use of guided reinvention as a means to develop conceptual understanding in students. In these particular cases, they explored using this technique to develop the concepts of group, isomorphism, and quotient groups.
 - a. Describe the general process and goals of guided reinvention providing some illustrations of how it is used.
 - b. For this part of the question, you will develop a lesson plan for teaching the **concept** of factorization as a means for solving equations using the construct of guided reinvention (Larsen, 2013; Dawkins, 2015). In MTH 761 when we developed lesson plans we used the format, **Launch-Explore-Summarize**, that incorporates teacher and student actions along with rationale for your pedagogical decisions. For this item, you will also use this format. Lesson plan sheets are provided and you should write neatly on these sheets (pencil is suggested in case you want to revise). If you need more sheets for any of the sections of your lesson, please ask and more will be provided. In the rationale column, please explain and cite any relevant research supporting your decisions. Be certain to provide both the questions you would ask students and possible responses you anticipate from them along with how you might respond. In addition, you will recall that Demir & Zengin (2023) found that the use of technology that allows for linked representations supported students in using multiple representations, making algebraic reasoning and generalization of mathematical observations more fluid. This is consistent with Kaput, Blanton, & Moreno's (2008) model for the development of symbolic meaning. It is important that your lesson expect students to link the concepts involved through multiple representations as they

develop a deep understanding. As we discussed in MTH 761, technology such as CAS is a key tool for doing this as Heid (1988) and others have shown over the last several decades and so appropriate use of CAS is encouraged. Be sure to also implement principles from Liljedahl's (2020) text, especially when using collaborative learning strategies in your lesson. Provide details on how you would form groups and orchestrate classroom discussion.

2. Now that you have developed a lesson plan, it is a good practice to reflect on it with respect to the research literature. Give your responses to the two questions that follow.

- a. A common mistake that students make when using factorization as a tool for solving equations is that they miss the connection to the Zero Factor Property. Consider a student trying to solve the equation, $2x^2 - 7x - 4 = 11$. Suppose they used the process below to arrive at the answers of $x=5$ or $x=15$. Discuss how your lesson preemptively attempted to address this error or how you would deal with the student response within the classroom discussion. Address connections to Kaput, Blanton, & Moreno's (2008) model for the development of symbolic meaning and feel free to reference any research you see fit for supporting your pedagogical decisions.

$$2x^2 - 7x - 4 = 11$$

$$(2x+1)(x-4) = 11$$

$$2x+1 = 11$$

$$x-4 = 11$$

$$2x = 10$$

$$x = 5$$

$$x = 15$$

- b. In MTH 761, we spent a significant amount of time looking at how to build a *thinking classroom* (Liljedahl, 2020). Discuss how your lesson from question 1 utilized the research shared by Liljedahl and others to foster thinking as opposed to mimicking. How would you arrange your classroom to encourage students to interact during your lesson in support of each other and how would you act as a facilitator? Please cite any relevant research in support of your approach to your lesson.

Section II: (Answer both questions)

The following are the questions for the MTH 762 portion of the exam. For both of these questions, we expect your response to be detailed and for you to use evidence from the literature to support your claims.

1. On the USB flash drive, you will find the Dibbs (2019) article, which we read and discussed in MTH 762. Please answer the following questions relating to this study:
 - a. This study uses qualitative research methods. Describe how one can determine this by reading this manuscript. In other words, what characteristics of the study are indicative of qualitative methodology?
 - b. Identify, name, and describe at least two strengths of this study's methods. Be sure to draw on what we learned about mathematics education research in class.
 - c. Identify, name, and describe at least one weakness of this study's methods. Be sure to draw on what we learned about mathematics education research in class.
 - d. Identify, name, and describe at least one strategy the author used to increase the trustworthiness of their **data collection**, again drawing on what we learned in class.
 - e. Identify, name, and describe at least one strategy the author used to increase the trustworthiness of their **data analysis**, again drawing on what we learned in class.
 - f. Discuss at least one finding that you think the author would not have uncovered had this study utilized quantitative research methods, rather than qualitative methods, to address their research questions.
2. Two types of manuscripts where the author(s) do not collect and report on **new** data are comprehensive literature reviews and meta-analyses. Please describe in detail what a comprehensive literature review is and what a meta-analysis is. In addition to your description, please also include a) why an author might choose to write each of these two types of manuscripts (comprehensive literature review and meta-analysis), b) the benefits of each of these manuscript types, and c) a drawback of each of these manuscript types. (An example of each type is included on the USB flash drive.)