Guidelines for the Mathematics Education Qualifying Exam for August 2020

Exam format: The exam will consist of two sections: One section for content from MTH 761 and one section for content from MTH 762. There will be two questions for you to answer for each section on the exam. The exam will likely be conducted in the Mac Computer Lab (Pearce 404) and the computers will be disconnected from the Internet. You will be given the exam on a USB memory drive and you will save your responses on that drive.

Exam grade: A grade of 70% or better on each part of the exam separately will be considered a passing score. In mathematics education, we build our arguments with words. In MTH 761 and MTH 762, we discussed how to form an argument in mathematics education (and how this might differ from a proof in mathematics). 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.

Exam Content: In MTH 761 and MTH 762, you read practitioner pieces, theoretical works, and empirical research studies utilizing qualitative, quantitative, and mixed methods research approaches. It is beyond human memory to recall all small details of each article and so this is not expected of you. In practice, mathematics education researchers routinely re-read relevant articles for such details. For the qualifying exam, however, you are expected to understand the main themes discussed in these courses and in the articles. We expect that you can compose well-reasoned arguments, based on these themes, that demonstrate your knowledge of the teaching and learning of mathematics. Furthermore, you should be able to critique research studies in mathematics education and determine the relevance of the results for the teaching and learning of mathematics.

MTH 761:
The following are some of the topics and readings with which you should be familiar. A general understanding of discussions from class is also expected.

National Standards and their Relevance to Teaching Collegiate Mathematics:

a. National Governors Association. (2010). Common core state standards - Mathematics. *Washington, DC*.
b. Barker, W., Bressoud, D., Epp, S., Ganter, S., Haver, B., & Pollatsek, H. (2004). *Undergraduate Programs and Courses in the Mathematical Sciences: CUPM Curriculum Guide, 2004*. Mathematical Association of America. 1529 Eighteenth Street NW, Washington, DC 20036-1358.
c. Zorn, P. (Ed.). (2015). *2015 CUPM Curriculum Guide to Majors in the Mathematical Sciences*. Mathematical Association of America.
d. TeachingWorks. (2019). High-Leverage Practices. University of Michigan.
e. TeachingWorks videos on "Doing", "Explaining", and "Modeling" (on Blackboard)

Eliciting Deep Mathematical Thinking:

a. Hughes-Hallet, D. (1999). Are we encouraging our students to think mathematically. In S.G. Krantz (Ed.)*, How to Teach Mathematics*, *2nd Edition*, 215-220.
b. Manouchehri, A., & Lapp, D. A. (2003). Unveiling student understanding: The role of questioning in instruction. *Mathematics Teacher*, *96*(8), 562-573.
c. Tall, D., & Vinner, S. (1981). Concept image and concept definition in mathematics with particular reference to limits and continuity. *Educational Studies in Mathematics*, *12*(2), 151-169.
d. Smith, J. C. (2006). A sense-making approach to proof: Strategies of students in traditional and problem-based number theory courses. *The Journal of Mathematical Behavior*, *25*(1), 73-90.
e. Wood, T. (1999). Creating a context for argument in mathematics class. *Journal for Research in Mathematics Education*, *30*(2), 171-191.

Various Styles of Active Learning:

a. Methods of College Teaching handout (from class)
b. Gerver, R. K., & Sgroi, R. J. (2003). Creating and using guided-discovery lessons. *The Mathematics Teacher*, *96*(1), 6.
c. Braun, B., Bremser, P., Duval, A. M., Lockwood, E., & White, D. (2017). What does active learning mean for mathematicians. *Notices of the AMS*, *64*(2), 124-129.
d. Fenton, W., Reynolds, B., Davidson, N., Baker, B., Berger, R., & Szpilka, A. (1995). Classroom strategies for cooperative learning. In E. Rogers, B. Reynolds, N. Davidson, & A. Thomas (Eds.), Cooperative learning in undergraduate mathematics: Issues that matter & strategies that work, 23-54.
e. Frantz, J., (1983). The Moore Method. The Forty-Acre Follies, Chapter 10.
f. Mahavier, W., (1998). What is the Moore Method?, The Legacy of R.L. Moore Project.
g. Marrongelle, K., & Rasmussen, C. (2008). Meeting new teaching challenges: Teaching strategies that mediate between all lecture and all student discovery. *Making the connection: Research and teaching in undergraduate mathematics education*, *73*, 167-177.

Assessment:

a. McCallum, W. (1999) Will this be on the test? In S.G. Krantz (Ed.)*, How to Teach Mathematics*, 2nd Edition, 233-240.
b. Reynolds, B., Thomas, A. & Milne, R. (1995). Designing assessment activities to encourage productive collaboration. In E. Rogers, B. Reynolds, N. Davidson, & A. Thomas (Eds.), Cooperative learning in undergraduate mathematics: Issues that matter & strategies that work, 55-70.
c. Projects and Writing to Learn Mathematics packet from Gold, B., Keith, S., Marion, W. (1999). Assessment practices in undergraduate mathematics, *AMC*, *10*(12).
d. Homework, Exams, and Grading packet from Gold, B., Keith, S., Marion, W. (1999). Assessment practices in undergraduate mathematics, *AMC*, *10*(12).
e. Assessing the Course as a Whole packet from Gold, B., Keith, S., Marion, W. (1999). Assessment practices in undergraduate mathematics, *AMC*, *10*(12).

You are also welcome to draw on any of your readings that you did for our class projects.

MTH 762:
The following are some of the topics and readings with which you should be familiar. A general understanding of how to critique studies and identify the strengths and weaknesses of articles is expected.

Overview of Mathematics Education Research:

a. Chapter 1 of textbook (McKnight et al., 2000)
b. Chapter 2 of textbook (McKnight et al., 2000)
c. Chapter 11 of textbook (McKnight et al., 2000)
d. Schoenfeld, A., (2001). Purposes and Methods of Research in Mathematics Education. In D. Holton (Ed.), *The Teaching and Learning of Mathematics at University Level: An ICMI Study*, 221-236.
e. Cai, J., Morris, A., Hohensee, C., Hwang, S., Robison, V., Cirillo, M., ... & Hiebert, J. (2019). Posing significant research questions. *Journal for Research in Mathematics Education*, *50*(*2*), 114-120.
f. Cai, J., Morris, A., Hohensee, C., Hwang, S., Robison, V., Cirillo, M., ... & Hiebert, J. (2019). Theoretical Framing as Justifying. *Journal for Research in Mathematics Education*, *50*(*3*), 218-224.
g. Cai, J., Morris, A., Hohensee, C., Hwang, S., Robison, V., Cirillo, M., ... & Hiebert, J. (2019). Choosing and Justifying Robust Methods for Educational Research. *Journal for Research in Mathematics Education*, *50*(*4*), 342-348.

Quantitative Research:

a. Chapter 3 of textbook (McKnight et al., 2000)
b. Chapter 4 of textbook (McKnight et al., 2000)
c. Chapter 5 of textbook (McKnight et al., 2000)
d. Rasmussen, C., Apkarian, N., Hagman, J. E., Johnson, E., Larsen, S., & Bressoud, D. (2019). Characteristics of Precalculus Through Calculus 2 Programs: Insights From a National Census Survey. *Journal for Research in Mathematics Education*, *50*(*1*), 98-112.
e. Sherman, M. F., Walkington, C., & Howell, E. (2016). A Comparison of Symbol-Precedence View in Investigative and Conventional Textbooks Used in Algebra Courses. *Journal for Research in Mathematics Education*, *47*(*2*), 134-146.
f. Hiebert, J., Stigler, J. W., & Manaster, A. B. (1999). Mathematical features of lessons in the TIMSS Video Study. *ZDM*, *31*(*6*), 196-201.
g. Rodriguez, M. (2019). Impact of Implementing Graphing Calculators on College Algebra Students' Performance, Satisfaction, and Motivation. *International Journal of Learning, Teaching and Educational Research*, *18*(*6*), 96-109.

Qualitative Research:

a. Chapter 6 of textbook (McKnight et al., 2000)
b. Chapter 7 of textbook (McKnight et al., 2000)
c. Chapter 8 of textbook (McKnight et al., 2000)
d. Lockwood, E., & Purdy, B. (2019). Two Undergraduate Students' Reinvention of the Multiplication Principle. *Journal for Research in Mathematics Education*, *50*(*3*), 225-267.

e. Jett, C. C. (2019). Mathematical Persistence Among Four African American Male Graduate Students: A Critical Race Analysis of Their Experiences. *Journal for Research in Mathematics Education*, *50*(*3*), 311-340.
f. Dibbs, R. (2019). Forged in failure: engagement patterns for successful students repeating calculus. *Educational Studies in Mathematics*, *101*(*1*), 35-50.
g. Iannone, P., & Miller, D. (2019). Guided notes for university mathematics and their impact on students' note-taking behaviour. *Educational Studies in Mathematics*, 1-18.

Mixed Methods Research:

a. Leech, N. L., & Onwuegbuzie, A. J. (2009). A typology of mixed methods research designs. *Quality & Quantity*, *43*(*2*), 265-275.
b. Mejía-Ramos, J. P., & Weber, K. (2019). Mathematics Majors' Diagram Usage When Writing Proofs in Calculus. *Journal for Research in Mathematics Education*, *50*(*5*), 478-488.
c. Gresham, G. (2018). Preservice to inservice: Does mathematics anxiety change with teaching experience? *Journal of Teacher Education*, *69*(*1*), 90-107.
d. Worthley, M. R., Gloeckner, G. W., & Kennedy, P. A. (2016). A mixed-methods explanatory study of the failure rate for freshman STEM calculus students. *PRIMUS*, *26*(*2*), 125-142.
e. Cifarelli, V., Goodson-Espy, T., & Chae, J. L. (2010). Associations of students' beliefs with self-regulated problem solving in college algebra. *Journal of Advanced Academics*, *21*(*2*), 204-232.

Teaching Experiments and Evaluation:

a. Chapter 9 of textbook (McKnight et al., 2000)
b. Chapter 10 of textbook (McKnight et al., 2000)
c. Hiebert, J., Morris, A. K., Berk, D., & Jansen, A. (2007). Preparing teachers to learn from teaching. *Journal of Teacher Education*, *58*(*1*), 47-61.
d. Berk, D., & Hiebert, J. (2009). Improving the mathematics preparation of elementary teachers, one lesson at a time. *Teachers and Teaching: theory and practice*, *15*(*3*), 337-356.
e. Fernandez, C. (2002). Learning from Japanese approaches to professional development: The case of lesson study. *Journal of Teacher Education*, *53*(*5*), 393-405.

You are also welcome to draw on any of your readings that you did for our class projects.