RUTGERS
Graduate School of Education

Learning and Teaching
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Rutgers, The State University of New Jersey

15:254:540:01 Introduction to Mathematics Education, 3 credits
Fall 2014
Mondays 4:50-7:30
Graduate School of Education, Room 30

Instructor: Carolyn A. Maher	carolyn.maher@gse.rutgers.edu
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Office Hours: by appointment	Prerequisites or other limitations: none
Mode of Instruction: ___ Lecture ___ Seminar __X_ Hybrid ___ Online ___ Other	Permission required: _X_ No __ Yes Non-matriculated students may get permission number from Marjory Palius at: marjory.palius@gse.rutgers.edu

Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentations: hhttps://ods.rutgers.edu/students/documentation-guidelines. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS web site at: https://ods.rutgers.edu/students/registration-form.

Course Catalogue Description

Introduction to Mathematics Education is designed to introduce students to the field of mathematics education through a variety of activities that blend in-person, on-campus sessions with interactions done asynchronously online through a course web site. The on-campus activities will include talks given by visiting scholars, class and project work in small groups on mathematical problem-solving tasks, video study, with consideration of elementary and secondary students might engage with those tasks as they build justifications to challenging, open-ended problems. The online course work will include reading assignments that introduce participants to theoretical perspectives on learning and research in math education, with guidelines for engaging in reflection and discussion of those readings and considerations of their relevance to teaching practices. Other online course work will include studying video clips of children engaged in math problem solving and talking about their mathematical ideas; through reflection and online discussion the videos will be connected to the readings and hands-on problem solving.

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Learning Goals

1. Students will gain introductory knowledge of the field of mathematics education with a focus on learning and teaching mathematics at the elementary and secondary level.
2. Students will learn about mathematical structures underlying strands of problem tasks from the counting/combinatorics strand of the 25+ years of longitudinal and cross-sectional research preserved at the Robert B. Davis Institute for Learning
3. Students will be introduced to research about how students engage with open-ended, challenging tasks as they build justifications of their solutions to problems
4. Students will learn about forms of students' mathematical reasoning through studying videos
5. Students will learn about research on learning and teaching through assigned readings and videos, and consider the relevance of this work to current teaching practices
6. Students will learn about the richness of representations through engaging in reflection and discussion of their own problem solving in conjunction with the problem solving of colleagues and of elementary/secondary students
7. Students will learn about the NCTM and Common Core State Standards and learn to recognize enactment of these standards through video study
8. Students will learn how to build a VMCAnalytic and create an Analytic that demonstrates their understanding of the implementation of Standards in elementary/secondary learning

Required texts:
All readings will be provided electronically

Grading policy:

Attendance - Students are required to attend all class sessions and participate regularly during online sessions. If special circumstances (religious observance, school open house, illness) require absence, students are responsible to inform the instructor beforehand and to make up all work. It is suggested that each student identify a partner who can assist when one is unable to attend class.

Class Participation – 35%
Online Participation – 30%
Analytic Project – 25%
Reflection/reaction papers 10%

Academic Integrity Policy:

Any violation of academic honesty is a serious offense and is therefore subject to an appropriate penalty. Refer to http://academicintegrity.rutgers.edu/integrity.shtml for a full explanation of policies.

Course Requirements

You are expected to be an active participant in the class through small group work in the classroom and though web-based discussions, projects, lectures and writing. Successful completion of the course requires that you engage in all activities and submit all assignments. You are required to:

1. Attend **all** on-campus sessions and lectures.

2. Actively participate in online discussions as you engage with assignments (readings and videos) and respond to guiding questions as posted on the eCompanion course web site. You are required to make at least one original posting and respond to at least two group member postings per week.

4. Be knowledgeable of all the assigned readings and video clip viewings.

5. Complete an *Individual Project* about the learning of a particular mathematical concept using *Video Mosaic* (www.videomosaic.org) resources to tell the story in a multimedia narrative called a VMCAnalytic. The topic needs to be approved by the instructor; more detail will follow.

6. Complete a *reflection paper* about your work in this course to include online discussions about videos and readings, guest speakers and project work. This will be the final assignment and due on December 15. You should reflect on your knowledge of the mathematics, research on how students learn, and implications for teaching with regard to NCTM and Common Core Standards. You may review your postings on the course web site and notes from problem solving and sharing of solutions as you develop your reflective assessment.

7. Complete all pre- and post-assessments.

Summary of Requirements

Class Participation – 35%
Online Participation – 30%
Analytic Project – 25%
Reflection/reaction papers - 10%

Description of Activities: Course Outline and Assignments

Class sessions are held on campus in our regular classroom (GSE 030) except when indicated as ONLINE in the following outline of activities. Every week includes online discussions in addition to activities conducted in a face-to-face setting.

Week	**Topics to be covered**	**Assignment & Readings**
Week 1: 9/8/2014	**Class Activities:** Introduction to the course and eCollege; Engage in task for building towers 5/4/3/n-tall; Extend problem solving to "Guess My Tower" task; Discuss heuristics and problem solving for early tasks in counting strand; Review syllabus and discuss course requirements	**Reading Assignment:** **(**1**)** Erlwanger, S. H. (1973). Benny's Conception of Rules and Answers in IPI Mathematics. *The Journal of Children's Mathematical Behavior* 1(2), 7-26. **(**2**)** Skemp, R. R. (1976). Relational Understanding and Instrumental Understanding. *Mathematics teaching*, 77, 20-26. **(**3**)** Combinatorics and Reasoning book (Maher, Powell

		& Uptegrove, Eds.): Chapter 1: *The Longitudinal Study* **Video Assignment:** (1) Shirts and Pants from PUP Math (2) Stephanie and Dana working on the towers problem. (3) Meredith removes the top cube.
Week 2: 9/15/2014 **LIBRARY SESSION**	**NOTE: THIS CLASS WILL BE HELD AT ALEXANDER LIBRARY ON THE FOURTH FLOOR ROOM 413** **Class Activities:** Explore the Video Mosaic online library, get familiar with the VMCAnalytic tool. Construct a mini-analytic with classmates based on the videos from the previous week	**Reading Assignment:** (1) Agnew et. al (2011)
Week 3: 9/22/2014	**Class Activities:** Engage in a pizza problem task: pizzas with halves, selecting from 4 toppings; pizzas, selecting from 4 toppings; pizzas, selecting from n-toppings. Share how solutions were found and examine representations used in problem solving; Consider whether justifications offered are convincing and why / why not	**Reading Assignment:** (1) Maher, C. A., & Martino, A. M. (1996). The development of the idea of mathematical proof: A 5-year case study. *Journal for Research in Mathematics Education*, 194-214. (2) Maher, C. A. (2009). Children's reasoning: Discovering the idea of mathematical proof. In M. Blanton, D. Stylianou and E. Knuth (Eds.), *Teaching and learning proof across the K-16 curriculum* (pp. 120-132). New Jersey: Taylor Francis - Routledge. **Video Assignment:** (1) PUP Math Pizza (2 toppings, 4 toppings, 4 toppings w/halves)

Week 4: 9/29/2014	**Class Activities:** Discuss heuristics and problem solving for early tasks in counting strand, and ideas from assigned readings.	**Reading Assignment:** (1) Maher, C. A. & Martino, A. (1998). "Brandon's Proof and Isomorphism". In C. A. Maher, *Can teachers help children make convincing arguments? A glimpse into the process.* Rio de Janeiro, Brazil: Universidade Santa Ursula. (2) Greer, B., & Harel, G. (1998). The role of isomorphisms in mathematical cognition. *The Journal of Mathematical Behavior*, *17*(1), 5-24. (3) Vinner, S. (2013). The mathematics teacher: Between solving equations and the meaning of it all. *The Journal of Mathematical Behavior*, *32*(3), 474-480. **Video Assignment:** (1) Brandon video
Week 5: 10/6/2014 **ONLINE SESSION**	**Online Activities:** Work on Ankur's challenge online using the VMT software with your group.	**Reading Assignment:** (1) Combinatorics and Reasoning book Chapter 8: *Responding to Ankur's Challenge: Co-construction of Argument Leading to Proof* (2) Yackel, E. & Hanna, G. (2003). Reasoning and proof. In J. Kilpatrick, G. W. Martin, and D. Schifter, (Eds.), *A Research Companion to Principles and Standards for School Mathematics* (pp. 227-236). Reston, VA: National Council of Teachers of Mathematics. House E. **Video Assignment:** (1) PUP- Math Romina's proof.

Week 6: 10/13/2014	**Class Activities:** Discuss solutions to Ankur's challenge, work on Taxicab problem.	**Reading Assignment:** (1) Davis, R. B. (1992). Understanding 'understanding'. *The Journal of Mathematical Behavior*, *11*, 225-241. (2) Steffe, L. P., & Kieren, T. (1994). Radical constructivism and mathematics education. *Journal for research in mathematics education*, *25*(6), 711-733. **Video Assignment:** (1) Taxicab clips
Week 7: 10/20/2014	**Class Activities:** Discuss Taxicab problem, work on World Series problem	**Reading Assignment:** (1) Schoenfeld, A. H. (1983). Beyond the purely cognitive: Belief systems, social cognitions, and metacognitions as driving forces in intellectual performance. *Cognitive science*, *7*(4), 329-363. (2) Read Common Core Standards and tie your video to the standards
Week 8: 10/27/2014 ONLINE	**Online Activities:** Construct a basic analytic, share with your group.	**Assignment:** Work on your analytic
Week 9: 11/3/2014	**Class Activities:** Analytic discussion; Sharing of World Series solutions.	**Reading Assignment:** (1) 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. (2) Combinatorics and Reasoning book (Maher, Powell & Uptegrove, Eds.): - Chapter 12: *Representations and Standard Notation*

		- Chapter 13: *So Let's Prove It!* **Video Assignment:** (1) World Series video
Week 10: 11/10/2014	**Class Activities:** Exploration of Pascal's Triangle; Investigation of meaning behind symbolic notation – Why does the addition rule work? Discussion of readings.	**Reading Assignment:** (1) Cobb, P., & Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational psychologist*, *31*(3-4), 175-190. **Video Assignment:** (1) Night session
Week 11: 11/17/2014	**Class Activities:** Problem of points; Work on analytics (1)	**Reading Assignment:** (1) Francisco, J. M., & Maher, C. A. (2005). Conditions for promoting reasoning in problem solving: Insights from a longitudinal study. *The Journal of Mathematical Behavior*, *24*(3), 361-372. **Video Assignment:** (1) Romina's Story Kenilworth students reflecting
Week 12: 11/24/2014 ONLINE	**Online Activities:** Work on your analytic	**Assignment:** Work on final project
Week 13: 12/1/2014	**Class Activities:** Short presentation (10 minutes, 5 minutes for questions) of analytic from project.	
Week 14: 12/8/2014	**Class Activities:** Short presentation (10 minutes, 5 minutes for questions) of analytic from project.	**Complete the online post-assessments by December 12. Reflection paper due by December 15.**
Week 15: 12/15/2014		**Reflection Paper Assignment Due**

Required Readings

Agnew, G., Mills, C. M., & Maher, C. A. (2010). VMCAnalytic: Developing a collaborative video analysis tool for education faculty and practicing educators. In R. H. Sprague, Jr. (Ed.), *Proceedings of the 43rd Annual Hawaii International Conference on System Sciences (HICCS-43): Abstracts and CD-ROM of Full Papers*. IEEE Computer Society, Conference Publishing Services: Los Alamitos, CA.

Ball, D. L. & Bass, H. (2003). Making mathematics reasonable in school. In J. Kilpatrick, G. W. Martin, and D. Schifter, (Eds.), *A Research Companion to Principles and Standards for School Mathematics* (pp. 27-44). Reston, VA: National Council of Teachers of Mathematics.

Cobb, P., & Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational psychologist*, *31*(3-4), 175-190.

Davis, R. B. (1992). Understanding 'understanding' (1992). *The Journal of Mathematical Behavior, 11*, 225-241

Erlwanger, S. H. (1973). Benny's Conception of Rules and Answers in IPI Mathematics. *The Journal of Children's Mathematical Behavior* 1(2), 7-26.

Francisco, J. M., & Maher, C. A. (2005). Conditions for promoting reasoning in problem solving: Insights from a longitudinal study. *The Journal of Mathematical Behavior*, *24*(3), 361-372.

Greer, B., & Harel, G. (1998). The role of isomorphisms in mathematical cognition. *The Journal of Mathematical Behavior*, *17*(1), 5-24.

Lampert, M. & Cobb, P. (2003). Communication and language. In J. Kilpatrick, G. W. Martin, and D. Schifter, (Eds.), *A Research Companion to Principles and Standards for School Mathematics* (pp. 327-249). Reston, VA: National Council of Teachers of Mathematics.

Klein, D. (2003). A brief history of American K-12 mathematics education in the 20th century. *Mathematical Cognition*, 175-225.

Ma, L. (1999) *Knowing and Teaching Elementary Mathematics*. [Ch. 4, Exploring new knowledge: The relationship between perimeter and area. and/or Ch. 5, Teachers' subject matter knowledge: profound understanding of fundamental mathematics.] Lawrence Erlbaum: Mahwah, NJ.

Maher, C. A. (2009). Children's reasoning: Discovering the idea of mathematical proof. In M. Blanton, D. Stylianou and E. Knuth (Eds.), *Teaching and learning proof across the K-16 curriculum* (pp. 120-132). New Jersey: Taylor Francis - Routledge.

Maher, C. A. & Martino, A. (1998). "Brandon's Proof and Isomorphism". In C. A. Maher, *Can teachers help children make convincing arguments? A glimpse into the process.* Rio de Janeiro, Brazil: Universidade Santa Ursula.

Maher, C. A. & Speiser, R. (1997). How far can you go with block towers? Stephanie's Intellectual Development. *The Journal of Mathematical Behavior, 16*(2), 125-132.

Maher, C. A. & Weber, K. (2010). Representation Systems and Constructing Conceptual Understanding. Special Issue of the *Mediterranean Journal for Research in Mathematics Education 9*(1), 91-106.

Schoenfeld, A. H. (1983). Beyond the purely cognitive: Belief systems, social cognitions, and metacognitions as driving forces in intellectual performance. *Cognitive science*, *7*(4), 329-363.

Skemp, R. R. (1976). Relational Understanding and Instrumental Understanding. *Mathematics teaching*, 77, 20-26.

Steffe, L. P., & Kieren, T. (1994). Radical constructivism and mathematics education. *Journal for research in mathematics education*, *25*(6), 711-733.

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.

Vinner, S. (2013). The mathematics teacher: Between solving equations and the meaning of it all. *The Journal of Mathematical Behavior*, *32*(3), 474-480.

Yackel, E. & Hanna, G. (2003). Reasoning and proof. In J. Kilpatrick, G. W. Martin, and D. Schifter, (Eds.), *A Research Companion to Principles and Standards for School Mathematics* (pp. 227-236). Reston, VA: National Council of Teachers of Mathematics.

Selected chapters from:

Maher, C. A., Powell, A. B. & Uptegrove, E. (Eds.), (2010). *Combinatorics and reasoning: Representing, justifying and building isomorphisms.* Springer Publishers.