

**Introduction to Mathematics Education**  
**15:254:540:01**  
**3 Credits**

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Phone Number: 848-932-0776	10 Seminary Place, Room 213
Office Hours: Wednesday 3:00-4:30 and by appointment	Prerequisites or other limitations: none
Mode of Instruction: <input type="checkbox"/> Lecture <input type="checkbox"/> Seminar <input checked="" type="checkbox"/> Hybrid <input type="checkbox"/> Online <input type="checkbox"/> Other	Permission required: <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes Non-matriculated students may get permission number from the instructor through email.

**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 VMCAAnalytic and create an Analytic that demonstrates their understanding of the implementation of Standards in elementary/secondary learning

**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.

## Course Requirements

You are expected to be an active participant in the class through small group work in the classroom and through 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](http://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 May 6. 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.

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 documentation: <https://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>

## Description of Activities: Course Outline and Assignments

Class sessions are held on campus in our regular classroom (GSE 211) 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.

<p><b>1/22/2014</b></p>	<p><b>Class Activities:</b> 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</p> <p><b>Reading Assignment:</b></p> <p>(1) Erlwanger, S. H. (1973). Benny’s Conception of Rules and Answers in IPI Mathematics. <i>The Journal of Children’s Mathematical Behavior</i> 1(2), 7-26.  (2) Skemp, R. R. (1976). Relational Understanding and Instrumental Understanding. <i>Mathematics teaching</i>, 77, 20-26.  (3) Combinatorics and Reasoning book (Maher, Powell &amp; Uptegrove, Eds.): Chapter 1: <i>The Longitudinal Study</i></p> <p><b>Video Assignment:</b></p> <p>(1) Shirts and Pants from PUP Math  (2) Stephanie and Dana working on the towers problem.  (3) Meredith removes the top cube.</p>
<p><b>1/29/2014</b></p>	<p><b>Class Activities:</b> 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</p> <p><b>Reading Assignment:</b></p> <p>(1) Maher, C. A., &amp; Martino, A. M. (1996). The development of the idea of mathematical proof: A 5-year case study. <i>Journal for Research in Mathematics Education</i>, 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.), <i>Teaching and learning proof across the K-16 curriculum</i> (pp. 120-132). New Jersey: Taylor Francis - Routledge.</p> <p><b>Video Assignment:</b></p> <p>(1) PUP Math Pizza (2 toppings, 4 toppings, 4 toppings w/halves)</p>
<p><b>2/5/2014</b></p>	<p><b>Class Activities:</b> Discuss heuristics and problem solving for early tasks in counting strand, and ideas from assigned readings.</p> <p><b>Reading Assignment:</b></p> <p>(1) Maher, C. A. &amp; Martino, A. (1998). “Brandon’s Proof and Isomorphism”. In C. A. Maher, <i>Can teachers help children make convincing arguments?</i> A</p>

	<p><i>glimpse into the process</i>. Rio de Janeiro, Brazil: Universidade Santa Ursula.</p> <p>(2) Greer, B., &amp; Harel, G. (1998). The role of isomorphisms in mathematical cognition. <i>The Journal of Mathematical Behavior</i>, 17(1), 5-24.</p> <p>(3) Vinner, S. (2013). The mathematics teacher: Between solving equations and the meaning of it all. <i>The Journal of Mathematical Behavior</i>, 32(3), 474-480.</p> <p><b>Video Assignment:</b></p> <p>(1) Brandon video</p>
<b>2/12/2014</b>	<p><b>Class Activities:</b> Guest Lecture by Dr. Shlomo Vinner, <i>Generalizations in everyday thought processes and in mathematical contexts</i>; Engage in exploration of binomial expansion; Ankur's challenge.</p> <p><b>Reading Assignment:</b></p> <p>(1) Klein, D. (2003). A brief history of American K-12 mathematics education in the 20th century. <i>Mathematical Cognition</i>, 175-225.</p> <p><b>Video Assignment:</b></p> <p>(1) Select Stephanie 8<sup>th</sup> grade interview videos</p>
<b>2/19/2014</b>	<p><b>Class Activities:</b> Guest Lecture by Dr. Gunnar Gjone, <i>Title TBD</i>; Continue working on Ankur's challenge; Introduction to VMCAntalytics.</p> <p><b>Reading Assignment:</b></p> <p>(1) Combinatorics and Reasoning book Chapter 8: <i>Responding to Ankur's Challenge: Co-construction of Argument Leading to Proof</i></p> <p>(2) Yackel, E. &amp; Hanna, G. (2003). Reasoning and proof. In J. Kilpatrick, G. W. Martin, and D. Schifter, (Eds.), <i>A Research Companion to Principles and Standards for School Mathematics</i> (pp. 227-236). Reston, VA: National Council of Teachers of Mathematics. House E.</p> <p><b>Video Assignment:</b></p> <p>(1) PUP- Math Romina's proof.</p>
<b>2/26/2014 ONLINE</b>	<p><b>Online Activities:</b> Construct a basic analytic, share with your group.</p> <p><b>Reading Assignment:</b></p> <p>(1) Agnew, G., Mills, C. M., &amp; Maher, C. A. (2010). VMCAntalytic: Developing a collaborative video analysis tool for education faculty and practicing educators. In R. H. Sprague, Jr. (Ed.), <i>Proceedings of the 43rd Annual Hawaii International Conference on System Sciences (HICCS-43): Abstracts and CD-ROM of Full Papers</i>. IEEE Computer Society, Conference Publishing Services: Los Alamitos, CA.</p> <p><b>Video Assignment:</b></p> <p>Watch two analytics: Brad Poprik and Diane Kovac</p>
<b>3/5/2014</b>	<p><b>Class Activities:</b> Share analytics, discuss grading rubric, work on Taxicab</p>

	<p>problem.</p> <p><b>Reading Assignment:</b></p> <p>(1) Davis, R. B. (1992). Understanding ‘understanding’. <i>The Journal of Mathematical Behavior</i>, 11, 225-241.</p> <p>(2) Steffe, L. P., &amp; Kieren, T. (1994). Radical constructivism and mathematics education. <i>Journal for research in mathematics education</i>, 25(6), 711-733.</p> <p><b>Video Assignment:</b></p> <p>(1) Watch fellow student analytics, provide feedback based on rubric.</p>
3/12/2014 ONLINE	<p><b>Online Activities:</b> Work on your analytics.</p> <p><b>Reading Assignment:</b></p> <p>(1) Schoenfeld, A. H. (1983). Beyond the purely cognitive: Belief systems, social cognitions, and metacognitions as driving forces in intellectual performance. <i>Cognitive science</i>, 7(4), 329-363.</p> <p>(2) Read Common Core Standards and tie your video to the standards</p>
3/26/2014	<p><b>Class Activities:</b> Analytic discussion; Sharing of Taxicab solutions.</p> <p><b>Reading Assignment:</b></p> <p>(1) Tall, D., &amp; Vinner, S. (1981). Concept image and concept definition in mathematics with particular reference to limits and continuity. <i>Educational studies in mathematics</i>, 12(2), 151-169.</p> <p>(2) Combinatorics and Reasoning book (Maher, Powell &amp; Uptegrove, Eds.):</p> <ul style="list-style-type: none"> <li>- Chapter 12: <i>Representations and Standard Notation</i></li> <li>- Chapter 13: <i>So Let's Prove It!</i></li> </ul> <p><b>Video Assignment:</b></p> <p>(1) Taxicab videos</p>
4/2/2014	<p><b>Class Activities:</b> Exploration of Pascal’s Triangle; Investigation of meaning behind symbolic notation – Why does the addition rule work? Discussion of readings.</p> <p><b>Reading Assignment:</b></p> <p>(1) Cobb, P., &amp; Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. <i>Educational psychologist</i>, 31(3-4), 175-190.</p> <p><b>Video Assignment:</b></p> <ul style="list-style-type: none"> <li>(1) Night session</li> <li>(2) Muteb Alqahtani’s analytic</li> </ul>
4/9/2014	<p><b>Class Activities:</b> World Series problem</p> <p><b>Reading Assignment:</b></p>

	<p>(1) Francisco, J. M., &amp; Maher, C. A. (2005). Conditions for promoting reasoning in problem solving: Insights from a longitudinal study. <i>The Journal of Mathematical Behavior</i>, 24(3), 361-372.</p> <p><b>Video Assignment:</b></p> <p>(1) Romina's Story</p>
<b>4/16/2014 ONLINE</b>	<p><b>Online Activities:</b> Problem of Points; Work on analytics</p> <p><b>Reading Assignment:</b></p> <p>(1) Pascal and Fermat letters</p> <p>(2) Francisco, J. M. (2013). Learning in collaborative settings: students building on each other's ideas to promote their mathematical understanding. <i>Educational Studies in Mathematics</i>, 82(3), 417-438.</p> <p><b>Video Assignment:</b></p> <p>(1) Kenilworth students reflecting</p> <p>(2) World Series videos</p>
<b>4/23/2014</b>	<p><b>Class Activities:</b> Short presentation (10 minutes to present another 5 minutes for questions) of analytic from project.</p>
<b>4/30/2014</b>	<p><b>Class Activities:</b> Short presentation (10 minutes to present another 5 minutes for questions) of analytic from project.</p> <p><b>Reflection paper due by May 6.</b></p>
<b>5/6/2014</b>	<p><b>Reflection Paper Assignment Due</b></p>

### Grading and Activities

**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%

### Required Readings

Agnew, G., Mills, C. M., & Maher, C. A. (2010). VMCAAnalytic: 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.
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- 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.

**Academic Integrity**

You are responsible for knowledge of and will be held accountable to the Academic Integrity at Rutgers policy found at <http://academicintegrity.rutgers.edu>

Make sure that you provide proper citations for all materials that you use in your project work.