

Integrating a Making Experience into Mathematics Teacher Preparation Coursework

Our research has documented prospective elementary teachers' learning of mathematics, pedagogy, and design through their Making experience and the coursework that informed it. Furthermore, we found that the development of their identities as teachers of mathematics was as central to their learning to teach mathematics as their learning of these three interrelated domains.

Looking across PMT's design experiences, features of a pedagogy in progress were implicated, such as the following: a commitment to an inquiry pedagogy informed by constructivist principles, centering student thinking, ensuring opportunities for mathematical reasoning, teaching through problem solving, designing tasks that afford multiple solution pathways and leverage students' funds of knowledge, and a realization of the power of tool-mediated, exploratory mathematical activity.

What follows are the Course Description, Goals, and Outline from a syllabus for a course in which the Making experience was implemented. We offer this example of a course in which the Making experience was implemented in order to provide prospective users of this curriculum with a vision of how such an experience can be integrated into a course that already exists. This course is a specialized content course with some attention given also to methods of teaching. The course met for 14 weeks and for 2.5 hours each week. We've highlighted text in the course description and goals where our research has shown that the Making experience played a role in supporting the teacher educator of this course to achieve those goals. The course outline includes "Design Plans" that refer explicitly to components of the experience.

Mathematics Education in the Elementary School

Course Description

In this course, we will explore what it means to learn and teach mathematics with understanding, and how we can help students from diverse cultural, racial, social, and linguistic backgrounds experience the joy of mathematical thinking. We will pay particular attention to how children think about mathematics and learn to use what we know about children's thinking to design and adapt instructional activities. We will consider students' home and community-based experiences and how we can leverage these experiences to teach mathematics. Finally, we will discuss the roles of students and teachers in the classroom, and how to foster an equitable classroom environment that encourages rich discussion of mathematics. We will specifically address issues of power, access, diversity, and relevance in learning and teaching mathematics.

Course Goals

- Explore mathematics as conceptual understanding, procedural fluency, problem solving, explanation and justification, and agency – in sum, develop mathematical power.
- Develop knowledge of children's mathematical thinking – how children think about mathematics and how they learn it.
- Learn how to recognize and create good problems and worthwhile tasks that engage students, build on students' thinking and experiences, leverage their home and community knowledge, and address important mathematics.
- Develop teaching practices of eliciting, interpreting, and responding to students' mathematical thinking.
- Learn how to establish a classroom environment that promotes equitable participation and provides opportunities for all students to work at a level of productive mathematical challenge.
- Develop teaching practices involved in conducting discussions of students' mathematical thinking.
- Develop new tools to support the teaching and learning of mathematics.

Course Outline

Week	Topic	Design Plans
1	<p>Working Together to Rethink Mathematics</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • Overview of the course, assignments, flow of class, and expectations • What is mathematics? • What do we believe about how children learn mathematics? • Setting norms for our professional and mathematical work together <p><i>Looking Ahead</i></p> <ul style="list-style-type: none"> • Introduce “Math Autobiography” assignment 	
2	<p>Learning Mathematics Through Problem Solving in Diverse Classrooms</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • Choosing good problems • Maintaining the cognitive demand of a problem <p><i>Due:</i></p> <ul style="list-style-type: none"> • Math Autobiography 	
3	<p>Children’s Informal Problem Solving Strategies and Early Number Sense</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • Eliciting and responding to children’s thinking <p><i>Looking Ahead:</i></p> <ul style="list-style-type: none"> • Introduce “Math Case Study” [3 Problem-Solving Interviews] • Hand out “Getting to Know You” interview. <p><i>Due:</i></p> <ul style="list-style-type: none"> • Select case-study student 	
4	<p>Children’s Thinking about Addition and Subtraction</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • Eliciting and responding to children’s thinking • Instructional Activity: Counting collections <p><i>Looking Ahead:</i></p> <ul style="list-style-type: none"> • Math Case Study: Discuss “Getting to Know You” interviews. Hand out Problem-Solving Interviews <p><i>Due:</i></p> <ul style="list-style-type: none"> • Write Up for “Getting to Know You” Interview for Math Case Study 	<p>Introduce “Making for Learning”_project; Coffee cup tutorial in Tinkercad</p>
5	<p>Children’s Thinking about Multiplication and Division</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • Eliciting and responding to children’s thinking <p><i>Looking Ahead:</i></p> <ul style="list-style-type: none"> • “Math Case Study”: Discuss Addition and Subtraction Interview results. • Discuss Multiplication and Division problems. <p><i>Due:</i></p> <ul style="list-style-type: none"> • Problem Solving Interview #1 	<p>Intro ticket: What design are you thinking about?</p> <p>Assign: Design Idea assignment</p>
6	<p>Base-10 and Place Value</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • Instructional activity: Choral Counting • The power of manipulatives 	<p>Design Idea Assignment Due</p> <p>Assign Project Rationale</p> <p>Design Time 1 (1 hr)</p>
7	<p>Children’s Thinking about Multi-Digit Operations (focus on multi-digit multiplication)</p>	<p>Design Time 2 (1 hr)</p>

	<p><i>Teaching:</i></p> <ul style="list-style-type: none"> • Positioning students competently • Setting and maintaining expectations for student participation 	
8	<p>Fractions – I: Children’s Thinking about Fractions: Informal understanding of partitioning and iterating</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • Problem Solving Lesson • “Math Case Study”: Go over guidelines for final write-ups. <p><i>Due:</i></p> <ul style="list-style-type: none"> • Project Rationale 	Design Time 3 (1 hr)
9	<p>Fractions – II: Children’s Thinking about Fraction Computation and Operations</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • The Two Norahs: Differently Constructed Learners • Review notes on 2nd PS interview <p><i>Due:</i></p> <ul style="list-style-type: none"> • Problem Solving Interview #2 	
10	<p>Children’s Algebraic Thinking</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • Relational and operational thinking • The big ideas of algebra • Instructional Activity: Problem Solving <p><i>Due:</i></p> <p>Final Write Up for “Math Case Study”</p>	In-class time to work on project interview tasks
11	<p>Children’s Thinking about Measurement</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • Adapting a textbook lesson to engage all learners in problem solving 	1-hr check-in about “Making for Learning” project. Submit interview tasks by the end of class.
12	<p>Children’s Geometric Thinking</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • The development of geometric thinking • Attributes and properties of shape 	
13	<p>Data & Statistics</p> <p><i>Teaching:</i></p> <ul style="list-style-type: none"> • Mathematics as a powerful and relevant tool for understanding and influencing real-world phenomena 	
14	<p>“Making for Learning” Project Presentation</p>	