University of Texas at El Paso
College of Education
Department of Teacher Education

MTED 5322 (14315) Pedagogy and Content Knowledge in Teaching Mathematics: Fostering Geometric Reasoning
Fall 2011

Class meeting time: R 5:30 p.m. – 8:20 p.m.
Class meeting place: College of Education, EDUC 402

Professor: Dr. David Carrejo
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Office Hours: M 1:30 p.m. – 4:00 p.m., R 1:30 – 4:00 p.m., F 9:00 a.m. – 11:00 a.m., or by appointment

This syllabus is subject to change as needed. Any changes to the syllabus will be announced in class.

No cellular phones or beepers are permitted in class.
If you have or suspect a disability and need accommodations you should contact Disabled Student Services (DSSO) at 747- 5148 or at dss@utep.edu or come by Room 106 Union East Building.

Required Texts

- Addington, S., & Dennis, D. (2006). *Measuring the World: Mathematics for Elementary and Middle School Teachers.* Published by the authors. Available: Chapters will be provided on the course website via Blackboard

- Hohenwarter , M., Borcherds, M., & Kreis, Y. (2010). *Geogebra: Dynamic Software for Everyone* [v. 3.2]. Available: www.geogebra.org. This is free, open-source software for both Mac and Windows.

- Other required readings will be available through Academic Search Complete (EBSCO) and electronic journals which are accessible through the UTEP library website. This is a free service for UTEP students. Other readings will be available online, open-source, or will be provided by me. A bibliography of required readings is provided at the end of this syllabus.

- We will also be accessing the following websites for course materials. This list is not inclusive.

    - NCTM Illuminations: www.illuminations.nctm.org
    - History of Mathematics: www.quadrivium.info
    - Early Algebra: www.ase.tufts.edu/education/earlyalgebra/default.asp

Texas Math Standards and National Standards

- All TEKS, Texas Essential Knowledge and Skills, for all grades and subjects can be found at this website: http://www.tea.state.tx.us/index2.aspx?id=6148

- National Council of Teachers of Mathematics (2000). *Principals and Standards for School Mathematics*: http://standards.nctm.org/

- Curriculum Focal Points: http://www.nctm.org/focalpoints.aspx

Assessment

- State of Texas Assessments of Academic Readiness (STAAR™) Resources: http://www.tea.state.tx.us/student.assessment/staar/

English Language Proficiency Standards

This course integrates English Language Proficiency Standards for English Language Learners (ELLs) in order to provide strategies for language acquisition and academic success in all content areas for students at different levels (beginning, intermediate, advanced, and advanced high) in the domains of listening, speaking, reading and writing.

- ELP Standards: http://ritter.tea.state.tx.us/rules/tac/chapter074/ch074a.html#74.4

Policy on Academic Dishonesty

The University of Texas at El Paso prides itself on its standards of academic excellence. In all matters of intellectual pursuit, UTEP faculty and students must strive to achieve based on the quality of work produced by their individual. In the classroom and in all other academic activities, students are expected to uphold the highest standards of academic integrity. Any form of scholastic dishonesty is an affront to the pursuit of knowledge and jeopardizes the quality of the degree awarded to all graduates of UTEP. It is imperative, therefore, that all faculty, insist on adherence to these standards.

Any student who commits an act of scholastic dishonesty is subject to discipline. Scholastic dishonesty includes, but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are not attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts. Proven violations of the detailed regulations, as printed in the Handbook of Operating Procedures (HOP) and available in the Office of the Dean of Students, may result in sanctions ranging from disciplinary probation, to failing grades on the work in question, to failing grades in the course, to suspension or dismissal among others.

Course Framework

Students enrolled in this course are offered a research-based and multi-faceted look at issues regarding the learning and teaching of geometry in the K-12 curriculum. The course will focus on the development of geometric reasoning through the mathematics of "space" -- spatial reasoning, measure, estimation, dimension, form (shape), and proof. A key objective of the course is for students to understand and appreciate how geometry is integrated into other mathematical domains such as numeracy and algebra.

Based on scholarly work, the course is organized around four major themes: 1) the nature of geometry as a domain of mathematics (including historical perspectives), 2) a constructivist-based analysis of math students' geometric reasoning and learning, 3) the role of technology and mathematical modeling in fostering geometric reasoning, and 4) the nature and role of geometric proof across grade levels.

Our driving questions include:

- **What are the most powerful geometric concepts, ideas, and methods (including modeling techniques) that are accessible to learners?**

  To try and answer this question about learning, you will be reading and analyzing relevant literature. It is imperative that we understand what has been researched and what methods of research have been used regarding student learning in geometry.

- **How can we link theory and practice in the teaching and learning of geometry across the K-12 mathematics curricula?**

  We will explore **pedagogical content ideas and methods** when teaching geometry topics. Our understanding of these ideas and methods will be relevant for several grade levels in K-12.

We will also reflect upon our own experiences and beliefs about mathematics. We will look at mathematics as a discipline, and, based on the presented research literature, compare more traditional ideas about what it means to 'know' and 'do' mathematics to the vision of mathematics advocated by the reform movements as well as what it means to 'know' and 'do' mathematics relying on constructivist principles on learning and teaching.

Course Objectives

Upon completion of the course, students will be better prepared to:

- Identify what makes a 'good mathematical task', and how can a good task support students' learning
- Understand how children make sense of key geometric concepts
- Understand how tools (including manipulatives, calculators, and other technology) assist children in their thinking and problem solving
- Identify their role as teacher in a math classroom
- Design mathematics lessons based upon constructivist principles of learning and teaching
- Design instruction based on what they learn from their students

Course Requirements

- It is expected that students will attend **all classes** and actively participate in working on projects and class discussions. Students are expected to prepare for each class session. **Lateness to class is strongly discouraged. With the emphasis on collegiality it is important that all group members be in class to contribute to the group's effort in developing an understanding of what it means to teach mathematics effectively**.
- Assignments are due on the specified dates. **Late assignments will not be accepted**.
- The schedule of topics and reading assignments may change over the course of the semester. **Any changes to the syllabus will be announced in class. Every student is responsible for these changes whether or not the student is present in class.**
- **Type or word-process all written assignments**. All assignments should be double spaced with a 12 point font. Number your pages, preferably using a header or footer. Correct grammar and spelling are expected. Further guidelines for the final project will be provided in class.
- **Homework should be turned in as hard copy.** Given the nature of the mathematics problems, the traditional paper and pencil method of completing the assignments is preferred, including any graphs, charts, or tables. Geometric constructions should also be completed by paper and pencil unless otherwise specified.

Attendance Policy

There will be a student sign-in sheet at the beginning of each class. If a student misses a session, it is the responsibility **of the student** for knowing and completing all work required. **Each attendance will count towards the final grade. Two tardies (including early leaves) will count as one absence. More than two absences may result in a student earning one-letter grade lower in the course.**

Course Assignments

1. *Presentations on Required Readings*

   Working in pairs, students will be required to create a brief presentation (PowerPoint) for select articles, papers, or chapter(s) you are assigned for a given week. Each pair of students will present/lead the discussion per week. Each presentation should highlight key points in the reading(s) and you are expected to generate discussion questions as well as an activity/experiment for the class. Guidelines for presentations and presentation rubric will be provided in class. All presentation materials will be turned in on the day of the presentation so they can be made available to the class via Blackboard.

2. *Homework (problem-based activities)*

   During this course you will work on inquiry-based activities (labs) provided in the textbook and provided by me. You will be assigned homework problems based on these activities. The homework assignments and due dates will be announced in class; typically, the homework will be due the following class day. All homework assignments will be posted on Blackboard. Given the nature of the assignments, I prefer that you turn in your homework assignments in hard-copy format. In some cases, electronic format will be necessary.

3. *Final Project (2 parts)*

   The focus of the final project is to build a learning trajectory for students at a particular grade level and to understand how theories of learning influence curriculum. Specifically, you want to focus on how to *bridge research and practice*.

Part I: Lesson Plans

I require that you construct a sequence of lessons (**minimum of three**) in geometry. Topics will receive final approval from me. The completed sequence must involve either a technology (computer) component and/or two "hands-on" components. A lesson plan guide and a unit guide will be provided in class.

Part II: Thought Paper

You will be responsible for writing a **minimum 10 page** "white" paper supporting your lesson design (i.e. a paper that justifies why you believe the lessons you've designed are important and how they are based on a sound understanding of constructivist-based teaching). Include an introduction section that introduces the content and the significance of the learning trajectory (i.e. why it is important for students to learn this topic or topics and why they should learn it the way you've designed your lessons). Include a theoretical framework that focuses on student/teacher learning for your given topic (**a minimum of 3 solid references** from peer-reviewed journals or edited books). Further details about the project will be given in class along with continuing guidance from me.

You will submit your project electronically **on Thursday, December 8,** by 12:00 midnight, MST, the final exam day. All materials related to the final project **must be** submitted on that day.

Grades

In this course all grades are important, but some assignments take more time and thought so therefore some may have a different weight.

- **Class Attendance** 15%
- **Presentations on Readings** 20%
- **Homework Assignments** 25%
- **Final Project** 40%

Grade Distribution:	**Grade**	**%**
	A	**93-100**
	B	**85-92**
	C	**75-84**
	D	**65-74**
	F	**0-64**

General calendar – *Topics, assigned readings, and due dates are subject to change.*

DATE	TOPIC	ACTIVITY FOCUS	READING FOCUS
August 25	1) Introduction to course 2) Review of syllabus 3) Introduction to Blackboard and UTEP library databases	1) Perspectives on geometry 2) Van Hiele's Levels & Piaget 3) Introduction to measurement and estimation	
September 1	Classification and sorting	1) Patterns 2) Students working with "data" 3) Logic	*Papic et al. (2011)*
September 8	1) Measure 2) Spatial reasoning	1) More on logic 2) Informal and standard concepts of "angle"	**Student presentations begin** *A&D, Chapter 6, section 3* *Clements & Burns (2000)* *Munier & Merle (2009)*
September 15	1) Measure 2) Spatial reasoning	1) Concepts of area 2) Some fractal geometry	*A&D, Chapter 1, section 2* *Bonotto (2003)* **Homework 1 due**
September 22	1) Measure 2) Spatial reasoning	1) 2D-3D orientation 2) Volume	*Batista & Clements(1996)*
September 29	Polygons	Properties Polygons and area, length, and perimeter	*A&D, Chapter 1, section 3* *Barrett & Clements(2003)* **Homework 2 due**
October 6	Polygons	Geometric constructions	*Brakke website on constructions* *Intro to Geogebra*
October 13	Symmetry	1) Reflections, rotations, translations 2) More on fractal geometry	*Jacobson & Lehrer (2000)* **Homework 3 due**
October 20	Similarity	Ratio and proportion and scale	*A&D, Chapter 5, section 3* *Lehrer et al. (2003)*
October 27	Analytic geometry	1) The number line 2) The coordinate plane	*A&D, Chapter 4, section 3* *Saxe et al. (2010)* **Homework 4 due**
November 3	Analytic geometry	Descarte's Geometry Geogebra	*Dennis (1997)*
November 10	Analytic geometry	Mathematical modeling Geogebra	*Jackiw (2010)* **Homework 5 due**
November 17	Proof and justification	Mathematical modeling	*McCrone & Martin (2009)*
November 24	*THANKSGIVING DAY – NO CLASS*		
December 1	**Last day of regular classes** Non-Euclidean geometry	Lenart Spheres	**Homework 6 due**
December 8	**Final exam day**		**Final projects due**

Bibliography

- *September 1*

Papic, M.M., Mulligan, J.T., & Mitchelmore, M.C. (2011). Assessing the development of preschoolers' mathematical patterning. *Journal for Research in Mathematics Education, 42*(3), 237-268.

- *September 8*

Clements, D.H., & Burns, B.A. (2000). Students' development of strategies for turn and angle measure. *Educational Studies in Mathematics, 41*(1), 31-45

Munier, V., & Merle, H. (2009). Interdisciplinary mathematics-physics approaches to teaching the concept of angle in elementary school. *International Journal of Science Education, 31*(14), 1857-1895.

- *September 15*

Bonotto, C. (2003). About students' understanding and learning the concept of surface area. In D.H. Clements & G. Bright (Eds.), *Learning and Teaching Measurement: 2003 Yearbook* (pp. 157-168). Reston, VA: National Council of Teachers of Mathematics.

- *September 22*

Batista, M.T., & Clements, D.H. (1996). Students' understanding of three-dimensional rectangular arrays of cubes. *Journal for Research in Mathematics Education, 27*(3), 258-292.

- *September 29*

Barrett, J.E., & Clements, D.H. (2003). Quantifying path length: Fourth-grade children's developing abstractions for linear measurement. *Cognition and Instruction, 21*(4), 475-520.

- *October 13*

Jacobson, C., & Lehrer, R. (2000). Teacher appropriation and student learning of geometry through design. *Journal for Research in Mathematics Education, 31*(1), 71-88.

- *October 20*

Lehrer, R., Strom, D., & Confrey, J. (2002). Grounding metaphors and inscriptional resonance: Children's emerging understanding of mathematical similarity. *Cognition and Instruction, 30*(3), 359-398.

- *October 27*

Saxe, G.B., Earnest, D., Sitabkhan, Y., Haldar, L.C., Lewis, K.E., & Zheng, Y. (2010). Supporting generative thinking about the integer number line in elementary mathematics. *Cognition and Instruction, 28*(4), 433-474.

- *November 3*

Dennis, D. (1997) Rene Descartes' curve-drawing devices: Experiments in the relations between mechanical motion and symbolic language. *Mathematics Magazine, 70*(3), 163-174. Available: http://www.quadrivium.info/MathHistoryIndex.html

- *November 10*

Jackiw, N. (2010). Linking algebra and geometry: The dynamic geometry perspective. In Z. Usiskin, K. Andersen, & N. Zotto (Eds.), *Future Curricular Trends in School Algebra and Geometry* (pp. 231-241). Charlotte, NC: Information Age Publishing.

- *November 17*

Soucy McCrone, S.M., & Martin, T.S. (2009). Formal proof in high school geometry: Student perceptions of structure, validity, and purpose. In D.A. Stylianou, M.L. Blanton, & E.J. Knuth (Eds.), *Teaching and Learning Proof Across the Grades: A K-16 Perspective* (pp. 204-221). New York, NY: Routledge.