Mathematics Curriculum Design and Analysis (Math 657 II)
Western Michigan University
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Course Overview

A useful framework for studying the school mathematics curriculum and its implications is to consider four different forms of the curriculum: an *ideal curriculum* as recommended in professional reports or specified by national or state standards; an *intended curriculum* as reflected in instructional materials; an *enacted curriculum* as actually taught; and an *attained curriculum* as indicated by student performance on classroom assessments, district-based tests, and standardized assessments.

The Math 657 I course focused primarily on the ideal and intended curricula during significant periods of school mathematics curriculum history. This course is designed to help doctoral students develop the knowledge, skills, and dispositions useful in the design, development, and analysis of school mathematics curriculum materials. A central feature will be a careful examination of contemporary intended curricula, both standard and innovative, from mathematical content, pedagogical design, and development perspectives. The enacted curriculum and attained curriculum will be the focus of a third course dealing with curriculum research and evaluation.

Course Goals

- Develop an understanding of important mathematical concepts, methods and habits of mind that are central to school mathematics and a critical understanding of how those ideas are developed in standard and innovative curriculum materials.
- Develop an understanding of the implications of theories of learning for the design of school mathematics curricula.
- Develop an understanding of the implications of calculator and computer technologies for the design of school mathematics curricula.
- Develop an understanding of the design perspectives and development approaches of recent comprehensive school mathematics curriculum development projects.
- Develop the ability to analyze curriculum materials in terms of content and pedagogical goals.
- Develop the ability to design instructional materials reflecting what is known about appropriate content, student learning, and use of technology.

Textbooks and Other Readings

Senk, S. L., & Thompson, D. R. (Eds.). (2003). *Standards-based school mathematics curricula: What are they? What do students learn?* Mahwah, NJ: Lawrence Erlbaum.

Steen, L. A. (Ed.). (1990). *On the shoulders of giants: New approaches to numeracy.* Washington, DC: National Academy Press.

Steen, L. A. (Ed.). (1990). *Reshaping school mathematics: A philosophy and framework for curriculum*. Washington, DC: National Academy Press.

Chapters from other books, reports and journal articles as assigned from the attached resource list. Other references in this list might prove helpful in preparing individual written assignments and completing assigned projects.

Course Assignments

There are several required components to this course. You are expected to fully complete each one.

1. *Reading Assignments*—Specific readings will be assigned for each session. You should come to class having read the assigned material thoroughly and thoughtfully. For *each* assigned reading, you are to develop two discussion questions. The questions should be sent to all course participants via email no later than Sunday evening prior to the Tuesday class. Active participation in class discussion of all readings is expected. Each student will be asked to lead discussion of assigned readings at some time during the semester.
2. *Projects*—Two projects as described below will be completed during the semester. The first project will be completed with the support of a classmate; the second will be completed individually.
    a. Curriculum Analysis—Analyze and prepare a written report and presentation of a content strand as developed across a grade band in a set of innovative curriculum materials. Analysis project due October 7.
    b. Curriculum Design—Design a lesson-by-lesson outline of an instructional unit focusing on an important topic in school or undergraduate mathematics and reflecting current thinking on key concepts, principles, techniques, and reasoning methods. Develop fully one of the lessons and corresponding teacher support materials that reflect what we know about student learning and use of calculator and computer technologies. Design project due November 29.
3. *Written assignments*—Throughout the course each student will prepare several written papers (varying in length). More specific guidance will be provided as we proceed through the semester.

Evaluation

Course grades will be based on individual written assignments, projects, and class participation. The components will be weighted as follows:

20% Contributions to class discussion related to readings and other assignments
25% Curriculum analysis project and presentation
25% Curriculum design project and presentation
30% Written assignments

Schedule

Week	Topic
1	Course Overview Comparative Analysis of a Sample of Conventional and Innovative Curriculum Materials with a Focus on Exponential Functions *Assignment:* 1. Read the chapters on "Patterns" and "Dimension" in the NRC publication *On the Shoulders of Giants*. 2. Select K-5, 6-8, and 9-12 series of Standards-based curriculum materials. Scan the materials for sightings of treatment of the themes of pattern and dimension. Note sample ideas or problems that illustrate these themes. 3. Read the chapter on "Content Analysis" in the NRC publication *On Evaluating Curricular Effectiveness*.
2	Introduction to Curriculum Analysis Perspectives and Methodologies *Assignment:* 1. Read the chapters on "Quantity" and "Uncertainty" in the NRC publication *On the Shoulders of Giants*. 2. Select K-5, 6-8, and 9-12 series of Standards-based curriculum materials. Scan the materials for sightings of treatment of the themes of quantity and uncertainty. Note sample ideas or problems that illustrate these themes. 3. Read the Introduction, Part I, and Appendix C of the AAAS Project 2061 report, *Middle-Grades Mathematics Textbooks: A Benchmarks-Based Evaluation*. (Available at www.project2061.org) Be prepared to discuss the findings in the case of the middle school mathematics curriculum materials you are assigned.
3	AAAS Curriculum Analysis—Middle School Mathematics *Assignment:* 1. Read the chapters on "Shape" and "Change" in the NRC publication *On the Shoulders of Giants*. 2. Select K-5, 6-8, and 9-12 series of Standards-based curriculum materials. Select series different from those you examined for the previous assignment. Scan the materials for sightings of treatment of the themes of shape and change. Note sample ideas or problems that illustrate these themes. 3. Read the AAAS Project 2061 *Algebra Textbooks Evaluation: Summary Report* and examine *Algebra Textbooks: A Standards-Based Evaluation*. (Available at www.project2061.org) Be prepared to discuss the findings in the case of the algebra mathematics curriculum materials you are assigned.

4	AAAS Curriculum Analysis—Algebra *Assignment:* 1. The Annotated Resource List for this course identifies several dissertations (Black (1986), Fischer (1997), Li (1999), Rock (1992), Stockdale (1985)) that focused on analysis of school mathematics textbooks from various perspectives. Select and examine one of the dissertations and prepare a report summarizing the conceptual framework, methodology, and findings. 2. Read *The TIMSS Curriculum Analysis: An Overview of an Integrated System of Curriculum Measurement*. Be prepared to discuss the TIMSS curriculum analysis methodology and compare it with that used by Project 2061.
5	TIMSS Curriculum Analysis *Assignment:* 1. Apply the AAAS Project 2061 curriculum-analysis procedure for algebra textbooks to evaluate one of the following two texts— *Algebra Connections,* College Preparatory Mathematics *Discovering Algebra,* Key Curriculum Press —in terms of your assigned NCTM Standard (and corresponding AAAS Benchmarks) and alignment between the assigned learning goal and the AAAS instructional criteria categories. Prepare a 5-page report summarizing your content and instructional analyses, including typical sightings. 2. For other perspectives on curriculum analysis, read and be prepared to discuss: Porter, A. C. (2002). "Measuring the Content of Instruction: Uses in Research and Practice." *Educational Researcher, 31*(7), 3-14. Dowling, P. (1996). "A Sociological Analysis of School Mathematics Texts." *Educational Studies in Mathematics 31*(4), 389-415. (Jodi, Karen, Lisa, Sandy) Herbel-Eisenmann, B. A., and D. Wagner. In the Middle of Nowhere: How a textbook can position the mathematics learner. (Dana, Diane, Nesrin, Todd—both papers) Herbel-Eisenmann, B. A. (2004). Examining the "voice" of a mathematics textbook: How does it construct the reader and portray mathematical knowledge? 3. For your curriculum analysis project, you are to analyze the geometry strand of innovative K-5, 6-8, or 9-12 curriculum materials in terms of specific learning goals and their alignment with intended instruction. Identify specific goals you plan to use and the curriculum you intend to analyze.

6	Other Approaches to, and Tools for, Analysis of Curriculum *Assignment:* 1. Work on your analysis of the geometry strand in your selected texts. Written and oral report due October 18. 2. Read Schmidt et al. (1997). *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education,* Executive Summary. 3. Read Cuoco, A., Goldenberg, E. P., & Mark, J. (1996). "Habits of Mind: An Organizing Principle for Mathematics Curricula." *Journal of Mathematical Behavior, 15,* 375-402. 4. Read Gravemeijer, K. P. (1994). "Educational Development and Development Research in Mathematics Education." *Journal of Research in Mathematics Education, 25*(5), 443-471.
7	Curriculum Design Perspectives I Guest speaker: Kenneth Ruthven, Cambridge University *Assignment:* 1. Finalize curriculum analysis project in the case of geometry; oral report to be accompanied by summarizing PowerPoint slides. 2. Read and be prepared to discuss the following articles: Battista, M., & Clements, D. (2000). Mathematics curriculum development as a scientific endeavor. In A. Kelly & R. Lesh (Eds.), *Handbook of research design in mathematics and science education* (pp. 737-760). Mahwah, NJ: Erlbaum. Brown, A. (1992). Design experiments: Theoretical and methodological challenges to creating complex interventions in classroom settings. *The Journal of Learning Sciences, 2*(2), 141-178. Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32*(1), 9-13.
8	Curriculum Analysis Reports—Geometry Curriculum Design Perspectives II and Design Experiments *Assignment:* 1. Read and be prepared to discuss *Reshaping School Mathematics: A Philosophy and Framework for Curriculum.* 2. Read and be prepared to discuss the following curriculum design papers: *Math Trailblazers* Mathematics Curriculum Design Principles and Development Perspectives — Catherine R. Kelso The K-6 *Everyday Mathematics* Curriculum: The University of Chicago School Mathematics Project —Max Bell and Andy Isaacs *Investigations in Number, Data, and Space* Curriculum Design and Development — Susan Jo Russell Goals, Theory, and Practice: Principles Behind the Design of *Math Workshop* — E. Paul Goldenberg and Nina Shteingold 3. Prepare a paper (≤ 5 pages) synthesizing design principles that are shared by two or more of these projects with respect to decisions on: • curriculum content, organization, and presentation • style(s) of instruction supported by the way the materials are structured

9	Design and Development Perspectives of Standards-based Elementary School Mathematics Curricula, the case of: *Everyday Mathematics* *Investigations in Number, Data, and Space* *Math Trailblazers* *Math Workshop* *Assignment:* 1. Read and be prepared to discuss the following curriculum design papers: Designing the *Connected Mathematics* Curriculum — Glenda Lappan Realistic Mathematics Education: The Foundation for *Mathematics in Context* — David C. Webb and Margaret R. Meyer The Design and Development of the *MathScape: Seeing and Thinking Mathematically in the Middle Grades* Curriculum — Glenn Kleiman, Emily Fagan, Susan Janssen, Amy Brodesky, and Dan Tobin Middle Grades *MATH Thematics*: The STEM Project —Rick Billstein and Jim Williamson 2. Prepare a paper (≤ 5 pages) synthesizing design principles that are shared by two or more of these projects with respect to decisions on: • curriculum content, organization, and presentation • style(s) of instruction supported by the way the materials are structured • incorporation of technology 3. Identify topic and grade level for your curriculum design project.
10	Design and Development Perspectives of Standards-based Middle School Mathematics Curricula, the case of: *Connected Mathematics* *Mathematics in Context* *MathScape* *MathThematics* *Assignment:* 1. Read and be prepared to discuss the paper, "Curriculum Development Research: Toward a Framework for 'Research-Based Curricula'" by Douglas Clements. 2. Read and be prepared to discuss the following curriculum design papers: The ARISE Project—*Mathematics: Modeling Our World* — Sol Garfunkle Designing and Developing the *Interactive Mathematics Program* — Sherry Fraser Design Principles and Development Process for *MATH Connections* — William P. Berlinghoff 3. Work on your curriculum design project, checking with me for clarification and feedback as needed.

11	Design and Development Perspectives of Standards-based High School Mathematics Curricula, the case of: *Mathematics: Modeling Our World* *Interactive Mathematics Program* *Math Connections* *Assignment:* 1. Read and be prepared to discuss: Heid, M. K. (1997). The technological revolution and the reform of school mathematics. *American Journal of Education, 106*(1), 5-61. 2. Working in pairs, examine *Tinker Plots* or one of the suite of computing tools being developed by the Core-Plus Mathematics Project. Prepare a response to the following questions: a. What can the tool you are examining offer to the teaching and learning of mathematical reasoning and problem solving? Prepare a demonstration of some key capabilities that illustrate your ideas. b. What do you see as the most significant implications of the tool for the design of curriculum? 3. Continue work on your curriculum design project.
12	Perspectives on Curriculum Design and Development The "Functional Mathematics" Curriculum and Curriculum Design Considerations Guest Speaker: Hugh Burkhardt, Shell Centre *Assignment:* 1. Read and be prepared to discuss the following curriculum design papers: Philosophies and Design Principles for the Systemic Initiative for Montana Mathematics and Sciences (SIMMS) —Johnny W. Lott, James Hirstein, and Gary Bauer Design Principles of the UCSMP Secondary Curriculum— Zalman Usiskin 2. Continue work on your curriculum design project.

13	Design and Development Perspectives of Standards-based High School Mathematics Curricula, the case of: *SIMMS: Integrated Mathematics* *UCSMP Secondary Component* Technology and Curriculum Design Student demonstration and discussion of new or emerging computing tools for school mathematics *Assignment:* 1. Read and be prepared to discuss Boaler, J. (2002). Learning from teaching: Exploring the relationship between reform curriculum and equity. 2. Read and be prepared to discuss the following curriculum design papers: Design and Development of the Core-Plus Mathematics Curriculum — James Fey and Christian Hirsch Towards a Curriculum Design Based on Mathematical Thinking (Math Themes) — Al Cuoco 3. Continue work on your curriculum design project.
14	Design and Development Perspectives of Standards-based High School Mathematics Curricula, the case of: *Core-Plus Mathematics* *Math Themes* Equity and Curriculum Design *Assignment:* 1. Prepare a paper (≤ 8 pages) summarizing similarities and differences in design principles among the 7 comprehensive high school mathematics projects with respect to decisions on: • curriculum content, organization, and presentation • style(s) of instruction supported by the way the materials are structured • incorporation of technology • approaches to issues of access and equity 2. Complete your curriculum design project and prepare a 15-minute presentation that describes your project, the design principles you drew on, and the dilemmas and challenges you faced in crafting the sample curriculum materials.
15	Presentations on Curriculum Design Projects