

UNC CHARLOTTE

College of Liberal Arts and Sciences

Department of Mathematics and Statistics

9201 University City Blvd, Charlotte, NC 28223-0001

t/704.687.3878, f/704.687.6415

Time for a Change: Preparing for Common Core K-2 Mathematics Instruction

A Proposal

For

The Center for Teaching & Learning 2012-2013 Grants

Dr. Charlene Sheets

Abstract

The proposed project is a curriculum and professional development effort to prepare pre-service elementary education majors to teach the Common Core mathematics curriculum in K-2 classrooms. Common Core is a national initiative, currently adopted by 45 states (including North Carolina), to provide all educational stakeholders with a clear and consistent framework that brings together the common goals and best practices in education. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy." (CCSSI , 2010).

Towards this end, we will examine the effects of an innovative teacher preparation project designed to help our prospective elementary mathematics teachers develop effective strategies for implementing the Common Core standards for grades K-2. In particular, we will examine how the study participants learn to effectively use children’s literature as a springboard for teaching robust and relevant mathematics, which they will demonstrate through creating their own original mathematics lesson plans.

We, the faculty of UNC Charlotte, are committed to providing our education students rich experiences with Common Core mathematics. We seek to foster an environment that recognizes the benefits of Common Core. Both the College of Liberal Arts and Sciences and the College of Education at UNC Charlotte aspire to reach these goals.

Budget Request for SOTL Grant

Joint Proposal? Yes X No

Time for a Change: Preparing for Common Core K-2

Title of Project Mathematics Instruction

Duration of Project 10 months

Primary

Investigator(s) Dr. Charlene Sheets, Department of Mathematics and Statistics

Email Address(es) csheets@uncc.edu

UNC Charlotte SOTL

Grants Previously

Received (please names

Of projects, PIs, and dates) N/A

Allocate operating budget to Department of Mathematics and Statistics

<u>Account #</u>	<u>Award</u>	<u>January to June</u>
Faculty Stipend	Transferred directly from Academic Affairs to Grantee on May 15	\$3,850.00
911250	Graduate Student Salaries	\$0.00
911300	Special Pay (Faculty on UNCC payroll other than Grantee)	\$0.00
915000	Student Temporary Wages	\$0.00
915900	Non-student Temporary Wages Technical support	\$1000.00
920000	Honorarium (Individual(s) not with UNCC) Curriculum Consultant	\$2,500.00
921150	Participant Stipends	\$0.00
925000	Travel-Domestic	\$2,000.00
926000	Travel-Foreign	\$0.00
928000	Communication and/or Printing	\$1,200.00
930000	Supplies: Texas Instrument TI-10 Calculators	\$600.00
942000	Computing Equipment	\$0.00
944000	Educational Equipment: Children's Literature	\$1,800.00
951000	Other Current Services	\$0.00
Grand Total		\$12,950

Attachments:

1. Attach/provide a narrative that explains how the funds requested will be used.

Budget Narrative

1. A faculty stipend of \$3,850 shall be awarded to the project director, Dr. Charlene Sheets, for summer pay for her work efforts. During this time period she will be conducting qualitative analyses of student work samples, and preparing the original student-

constructed “Common Core K-2 literature-based instructional sequences” or “Common Core teaching module” for printing and dissemination.

2. Non-student temporary wages of \$1000 shall be awarded to Fabio Franco, an alumni of UNC Charlotte (who assisted Dr. Sheets during her recent STEM-supported curriculum development project, May 2011-August 2011) in the preparation of the “Common Core teaching module” for printing and dissemination.
3. An honorarium of \$2,500 shall be awarded to Dr. Volkan Sevim, Assistant Professor of Mathematics Education at Virginia Commonwealth University for his contributions to the data analysis, design of the conceptual framework and preparation of the “Common Core teaching module”. Dr. Sevim taught two sections of MAED 3222 at UNC Charlotte for a year in 2010-2011 and closely collaborated with Dr. Sheets in the design of this course. His expertise in the course content and his knowledge of the students in the elementary education program make his contribution critical.
4. Travel funds of \$2000 shall be allocated to defray costs associated with presentations made at regional and national conferences.
5. Printing funds of \$1,200 shall be allocated to defray costs associated with preparing the “Common Core teaching module”.
6. Funds of \$1,800 shall be allocated to purchase children’s literature used to develop the Common Core mathematical instructional sequences for 50 study participants.
7. Funds of \$600 shall be allocated to purchase a classroom set (n = 25) of Texas Instrument calculators for the elementary classroom.

Has funding for the project been requested from other sources? ___Yes ___X___No If yes, list sources.



Office of the Dean

9201 University City Boulevard, Charlotte, NC 28223-0001
t/ 704-687-0088 f/ 704-687-0089 <http://clas.uncc.edu>

November 6, 2012

SOTL Grants Committee
Center for Teaching & Learning
ctl@uncc.edu

Dear Committee Members:

I am writing in support of the SOTL proposal, "Time for a Change: Preparing for Common Core K-2 Mathematics Instruction" submitted by Dr. Charlene Sheets of the Department of Mathematics and Statistics. This endeavor seeks to improve the training of future elementary school teachers to teach Common Core mathematics in American schools in Kindergarten through second grade. Students in a mathematics methods course will participate in an innovative curriculum and professional development project. This unique program is based upon the utilization of children's literature to create mathematics lesson plans, thus engaging undergraduate students in the development of original work products which will be shared at local, state, and national professional conferences.

Dr. Sheets' project is consistent with a number of the objectives in our CLAS strategic plan, including educating students in the tradition of the liberal arts and working with the College of Education to provide content coursework for teacher education. Improving the mathematics proficiency of our nation's students is more important than ever. It is, therefore, my pleasure to recommend the proposal for your consideration.

Please let me know if you require further information. Thank you.

Sincerely yours,

Nancy A. Gutierrez, Dean
College of Liberal Arts and Sciences

Project Narrative

Specific Aims

As it stands now, in the United States, your address determines the quality of public school instruction you will experience. In the United States, we do not have a national curriculum. The discrepancies between the have's and the have not's are wide! Many educators agree that it is time for a change (Ball and Bass, 2000; Carpenter and Lehrer, 1999; Ma, 1999; NCTM, 1991; Stigler and Hiebert, 1999). Toward this end, we would like to examine the effects of an innovative pre-service elementary mathematics teacher preparation program and develop a coherent mathematics education research agenda (Sheets and Cifarelli, 2011; Sheets and Sevim, 2011) to support beginning teachers who will be teaching the Common Core mathematics curriculum in Kindergarten through second grade.

Purpose

The purpose of this curriculum and professional development project is to elaborate upon ways that pre-service elementary education majors in one mathematics methods course at UNC Charlotte demonstrate the ability to develop viable strategies for implementing the eight standards for mathematical practice for teaching Common Core mathematics in grades K-2 (See Appendix A). Toward this end, we will assess the extent to which these pre-service teachers learn to recognize and embed Common Core mathematical tasks in the construction of their own original "literature-based mathematics lesson plans" for K-2 mathematics classes. We seek to develop a Common Core curriculum framework that supports student movement toward integration of mathematical pedagogical knowledge learned from others to personal experience and reflection.

Objectives

1. Based on research that helps us conceptualize teaching and learning mathematics to pre-service elementary teachers, this study seeks to identify and enhance the set of ten most effective original Common Core literature-based mathematics lesson plans for grades K-2 that will be developed by 50 pre-service UNC Charlotte elementary education majors in two sections of mathematics methods course MAED 3222.
2. The study also seeks to develop (from the set of ten most effective original lesson plans for grades K-2 developed by 50 pre-service elementary education majors in two mathematics methods courses) a learning/teaching module to be (a) incorporated into the

theory and practice of MAED 3222 at UNC Charlotte and (b) disseminated at local, state, and national levels through a variety of workshops and conference presentations.

3. Building upon the work of Knefelkamp (2000), Perry (1970), Ball and Bass (2000), Carpenter and Lehrer (1999), Cobb and Bauersfeld (1995), Fennema and Romberg (1999), Ma (1999), Silver and Stein (1996), Stigler and Hiebert (1999) and Swafford (1995), this study seeks to develop and refine a Common Core curriculum model—or framework—which promotes student movement toward the integration of K-2 mathematical pedagogical knowledge (learned from others and from theory) with personal experience and reflection. This framework would be presented at local, state and national levels for feedback and revision.

Statement of Research Questions

How can we best assess the extent to which pre-service elementary teachers demonstrate ability to recognize, develop and use Common Core (or important) mathematical tasks for children in grades K-2 after having participated in a one-semester long undergraduate mathematics methods course MAED 3222 at UNC Charlotte? What factors benefit or hinder the development of high quality “Common Core mathematics lesson plans” for grades K-2? How can their abilities be supported and further nurtured in the context of the tightly woven fabric of the course?

Rationale

UNC Charlotte is North Carolina’s urban research university. It maintains a particular commitment to addressing the cultural, economic, and educational needs of the greater Charlotte area. The Department of Mathematics and Statistics aspires to remain at the forefront of growth and transition at UNC Charlotte into a research extensive university with more than 30,000 students. This vision is based, in part, on the understanding that the department’s mission is to interact with the larger university community and with the appropriate segments of the local, state and national communities to provide services relating to mathematics education. In light of the offerings of the new Common Core mathematics for all American students, we, the faculty of UNC Charlotte, are committed to helping our pre-service elementary education majors teach more effective mathematics lessons for Kindergarten through second grade. We seek to help beginning K-2 teachers use Common Core mathematics pedagogy to develop effective literature-based mathematics lessons for early childhood education.

Impact of Study

Using children's literature as a springboard to develop K-2 Common Core mathematics lessons, we believe that this curriculum and professional development project has significant implications for the design and implementation of similar elementary mathematics methods courses. Pre-service teachers in courses like this one move toward team and community building (while conducting individual and pair investigations within a multi-layered mentoring setting) to support growth in the development of deep conceptions of Common Core mathematics for the effective mathematics instruction of children in grades K-2.

Literature Review

The college years present a key opportunity for the development of intellectual complexity and civic identity, particularly for 18 to 22-year-old students. A college student's level of intellectual complexity is the most significant filter through which he or she interprets or ascribes meaning of all kinds. General education courses are often designed to deliberately foster students' encounters with complexity, but too often they do not take into account students' actual intellectual and psychological readiness for this learning experience (Knefelkamp, 2000).

Building on learning theory in higher education, we believe that classroom experiences that are linked to personal experience can contribute to students' cognitive and ethical growth (Perry, 1981; Rapaport, 1984; Finster, 1991). There exists an enormous body of work to help us conceptualize teaching and learning mathematics to pre-service elementary teachers (Ball and Bass, 2000; Brownell, 1935; Carpenter and Lehrer, 1999; Cobb and Bauersfeld, 1995; Fennema and Romberg, 1999; Grouws and Cebulla, 2000; Leitzel, 1991; Ma, 1999; NCTM, 1991; Shimahara, 1998; Shulman, 1987; Silver and Stein, 1996; Stigler and Hiebert, 1999; Swafford, 1995). The design of effective learning communities in higher education calls for a vision of student learning that takes into account the role of students' mental models in understanding and approaching learning tasks (Belenky et al., 1986; King and Kitchener, 1994; Kegan, 1994; Perry, 1970, 1981). We place our conceptualizations within this larger framework as well.

Methods

Phase One:

We will build a class portfolio comprised of student responses from each of the 50 study participants for each of the following four developmental course curriculum tasks. That is, we will collect work samples from all participants from the following four class sessions:

- 1) Third class session: Translating Snapshots of Algebraic Thinking
- 2) Ninth class session: Developing Original Lesson Plans (Initial)
- 3) Thirteenth class session: Adapting Lessons
- 4) Sixteenth class session: Developing Original Lesson Plans (Final)

The rationale for our choice of these particular sessions was based on students' abilities to develop original lesson plans collaboratively and individually in our pilot study. In the pilot study, the first two work samples from the third and ninth class sessions were developed by a group of pre-service elementary education students in a team-based approach to learning. The students conceptualized their lesson plans together (in teams of four) and finalized their products for contribution to a class portfolio (See Appendix C).

Third class session: Translating Snapshots of Algebraic Thinking

Source: *NCTM Curriculum and Evaluation STANDARDS*, Grade 2

Ninth class session: Developing Original Lesson Plans

Source: *One Hundred Hungry Ants* by Elinor J. Pincus

Thirteenth class session: Adapting Lessons

Source: *NCTM Illuminations* Website, Grade Band: K-2

Sixteenth class session: Developing Original Lesson Plans

Source: *Earth Day, Hooray!* By Stuart J. Murphy

These initial lesson planning sessions served as community-building opportunities for the class, and laid the foundation for more refined individual investigations in Common Core mathematics lesson planning for grades K-2. For class sessions thirteen and sixteen, students worked independently to create original Common Core mathematics lessons for grades K-2.

Phase Two:

At the end of the course, each of the 50 study participants will create an original "literature-based lesson plan" for K-2 Common mathematics classes. Using a course-designed rubric (See Appendix B.) and qualitative research methodologies, we will build a class portfolio

of descriptions of students' understanding of Common Core mathematical tasks for K-2 classes comprised of student responses from the ten most effective lesson plans developed by the 50 study participants completing the culminating course project.

Phase Three:

We will synthesize the products of the ten most effective lesson plans developed by the 50 study participants into a class K-2 Common Core mathematics teaching module for (1) dissemination at local, state and national levels, and (2) incorporation into the teaching and learning of subsequent courses of MAED 3222 at UNC Charlotte.

Phase Four:

Building upon the findings of data collection and analyses of these three phases, and using the theory and practice of Knefelkamp, (2000), Perry (1970), Rapaport (1984), Burnham, (1986), Finster, (1991), Ball and Bass (2000), Carpenter and Lehrer (1999), Cobb and Bauersfeld (1995), Fennema and Romberg (1999), Ma (1999), Silver and Stein (1996), Stigler and Hiebert (1999) and Swafford (1995), we will construct a curriculum model that describes the study participants' movement toward recognizing and embedding Common Core mathematical tasks or "important mathematics" when designing lesson plans for the K-2 classroom. We will provide rich descriptions of student movement toward integration of K-2 mathematical pedagogical knowledge (learned from theory and others) with personal experience and reflection. We will also discuss implications of this model for the learning and teaching of undergraduate pre-service elementary majors at UNC Charlotte; and provide guidelines for the preparation of prospective elementary school mathematics teachers at local, state and national levels.

Evaluation

Using a course-designed rubric (See Appendix B) as well as qualitative methodologies, such as thematic analysis and grounded theory, the project director and the project curriculum consultant will construct rich assessments of students' emerging understandings of Common Core mathematical tasks in the context of student development of original lesson plans for K-2 mathematics classrooms. We will assess 50 pre-service elementary education majors' abilities to recognize, develop and embed Common Core mathematical tasks when designing original mathematics lessons for young learners.

All other student lesson plan work products collected in the four phases of the project will also be assessed using the course-designed rubric (See Appendix B). Ultimately, the results of these assessments (and the findings from foundational studies in mathematics pedagogy) will lead to the creation of:

- (a) a high quality Common Core mathematics curriculum module for grades K-2
- (b) a curriculum framework that describes study participants' intellectual and professional movement toward recognizing, developing and embedding Common Core mathematics tasks when designing original lesson plans for K-2 classrooms.

The project director will assess all student work using the rubric in Appendix B. The project curriculum consultant along with an outside mathematics educator (a faculty member at UNCC) will assess the ten most effective lesson plans developed for the culminating course project using the rubric in Appendix B. Triangulation via multiple data sources such as quantifiable rubric and qualitative analyses, and multiple researchers independently assessing student work using the same instrument will help strengthen our arguments about student growth.

All assessments of 50 students' work will be done by the project director. All qualitative data analyses will be written by the project director and the project curriculum consultant through constant feedback and consultation. And, all the rubric scores for the ten most effective lesson plans will be independently obtained from the project director, the project curriculum consultant, and the third mathematics educator. All these reports will be compiled in a final project evaluation report. This final report will be made available upon request.

Knowledge Dissemination

1. Evidence of success of this project will be provided to the UNC Charlotte teaching and learning community in several different formats:
 - a) Presentation or poster session during UNC Charlotte Teaching Week.
 - b) Presentations to all students enrolled in the elementary mathematics methods courses taught at UNC Charlotte (MAED 3222 and MAED 3224) in Fall 2013 and Spring 2014 [n = 200].

- c) Incorporation of Common Core mathematics teaching module into the course packet required for elementary mathematics methods course taught at UNC Charlotte (MAED 3222).
 - d) Presentation at Charlotte Teachers Circle.
<http://www.math.uncc.edu/~hbreiter/TeachersCircle/index.htm>
 - e) Presentation at the Center for STEM Education (targeting in-service teachers in Charlotte-Mecklenburg Schools currently implementing the Investigations curriculum—building upon earlier work completed by this researcher through previously funded STEM curriculum project [May 2011-August 2011] directed by Dr. David K. Pugalee of UNC Charlotte.
2. Evidence of success of this project will be provided to mathematics educators at the state level through a presentation at the annual North Carolina Council of Teachers of Mathematics in Greensboro, NC, in October, 2013.
 3. Evidence of success of this project will be provided to mathematics educators at the national level in two formats:
 - a) Presentation at the annual meeting of the National Council of Teachers of Mathematics in 2014.
 - b) Presentation at the annual meeting of the American Educational Research Association in 2014.
 4. Lastly, evidence of success of this project will be provided to mathematics educators at local, state and national levels through dissemination of the Common Core mathematics teaching module (comprised of ten exemplary original literature-based mathematics lesson plans for grades K-2) developed by the UNC Charlotte undergraduates participating in this study.

Human Subjects

Human Subjects Protocol Form will be submitted to the IRB office in order to collect, analyze and use 50 MAED 3222 students' work samples (original literature-based mathematics lesson plans). After receiving an IRB review status, required modifications will be made for final IRB approval.

Extramural Funding

N/A

Timeline

January 1-January 15, 2013: Investigate and choose children's literature; and develop guidelines for the Common Core literature-based mathematics course project that is integrated to the MAED 3222 course framework. Begin IRB protocol.

January 15-February 15, 2013: Obtain IRB approval for collecting student data. Begin collecting data for initial analysis of emerging curriculum tasks that pre-service teachers in MAED 3222 develop.

February 15-March 15, 2013: Continue collecting qualitative data for first part of analysis of curriculum tasks from team-based constructed Common Core mathematics lesson plans for grades K-2 (data from third and ninth class sessions).

March 15-April 30, 2013: Continue qualitative analyses of subsequent curriculum tasks for individually-constructed Common Core mathematics lesson plans for grades K-2 (data from thirteenth and sixteenth class sessions).

May, 2013: Collect exemplary Common Core literature-based lesson plans for K-2 mathematics classes (the ten most effective lessons). Assess the lessons using common rubric.

June, 2013: Prepare Common Core literature-based mathematics teaching module.

July, 2013: Develop Common Core mathematics curriculum framework for teaching in grades K-2.

July, 2013-October, 2013: Present findings and products at local and regional conferences and workshops.

2013-2014 Academic year: Continue to share findings and products at local, regional, and national conferences and workshops.

References

- Ball, D. L., & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. In J. Brophy (Ed.), *Advances in research on teaching, Vol. 2: Teachers' knowledge of subject matter as it relates to their teaching practice* (pp. 1-48). Greenwich, CT: JAI Press.
- Beishuizen, M. (1993). Mental strategies and materials or models for addition and subtraction up to 100 in Dutch second-graders, *Journal for Research in Mathematics Education*, 24 (4), pp.294-323.
- Belenky, M. F., Clinchy, B. M., Goldberger, N. R., & Tarule, J. M. (1986) *Women's ways of knowing: The development of self, voice, and mind*. New York: Basic Books.
- Brownell, W. A. (1935). Psychological considerations in the learning and teaching of arithmetic. In W. D. Reeve (Ed.), *The teaching of arithmetic* (Tenth Yearbook of the National Council of Teachers of Mathematics, pp.1-31). New York: Columbia Teachers College, Bureau of Publications.
- Burnham, C.C. (1986). The Perry scheme and the teaching of writing. *Rhetoric Review*, 4: 152-156.
- Carpenter, T. P., & Lehrer, R. (1999). Teaching and learning mathematics with understanding. In E. Fennema & T.A. Romberg (Eds.), *Mathematics classrooms that promote understanding* (pp.19-32). Mahway,NJ: Erlbaum.
- Cobb, P., & Bauersfeld, H. (Eds.). (1995). *The emergence of mathematical meaning: Interaction in classroom cultures*. Hillsdale, NJ: Erlbaum.
- Common Core State Standards Initiative (CCSSI).(2010). Common core state standards for mathematics. Washington, D.C.: National Governors Association Center for Best Practices and the Council of Chief State School Officers.
<http://www.corestandards.org/the-standards>.
- Dacey, L. & Polly, D. (2012). CCSSM: The big picture. *Teaching Children Mathematics*, February: 378-383.

- Fennema, E., & Romberg, T. A., (Eds.). (1999). *Mathematics classrooms that promote understanding*. Mahwah, NJ: Erlbaum.
- Finster, D. C. (1991). Developmental instruction: Part II. Application of the Perry model to general chemistry. *Journal of Chemical Education*, 68: 752-756.
- Fuson, K.C. (1992). Research on whole number addition and subtraction, in: D.A. Grouws (Ed.) *Handbook of Research on Mathematics Teaching and Learning* (New York) Macmillan.
- Greene, R.G. (1997). *When a line bends a shape begins*. New York: Houghton Mifflin.
- Grouws, D. A., & Cebulla, K. (2000). Elementary and middle school mathematics at the crossroads. In T. L. Good (Ed.), *American education: Yesterday, today, and tomorrow* (Ninety-ninth Yearbook of the National Society for the Study of Education, Part 2, pp. 209-255). Chicago: University of Chicago Press.
- Hiebert, J. & Carpenter, T.P. (1992). "Learning and teaching with understanding" in *Handbook of research on mathematics teaching and learning*, (Ed.) D.A. Grouws, New York: Macmillan.
- Kamii, K. (1985). *Young children reinvent arithmetic: implications of Piaget's theory*. New York: Teacher's College Press.
- King, P. M., & Kitchener, K. S. (1994). *Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults*. San Francisco: Jossey-Bass.
- Kegan, R. (1994). *In over our heads: The mental demands of modern life*. Cambridge, MA: Harvard University Press.
- Knefelkamp, L.L. (1974). Developmental instruction: Fostering intellectual and personal growth of college students. (Unpublished doctoral dissertation, University of Minnesota, Minneapolis).
- Knefelkamp, L. L. (2000). Encountering diversity on campus and in the classroom: Advancing intellectual and ethical development. *Diversity Digest*, (Spring/Summer).
- Leitzel, J. R. C. (Ed.). (1991). *A call for change: Recommendations for the mathematical preparation of teachers of mathematics* (MAA Reports, vol. 3). Washington, D.C.: Mathematical Association of America.
- Ma, L. (1999). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States*. Mahwah, NJ: Erlbaum.

- Murphy, S. J. (2004). *Earth Day—Hooray!* New York: Harper Collins Publishers.
- National Council of Teachers of Mathematics. (1991). Professional standards for teaching mathematics. Reston, VA: National Council of Teachers of Mathematics.
- Perry, W. G. (1970). Forms of intellectual and ethical development in the college years. New York: Holt, Rinehart and Winston.
- Perry, W. G. (1981). Cognitive and ethical growth: The making of meaning. In A. Chickering & Associates (Eds.), *The modern American college*. San Francisco: Jossey-Bass.
- Pinczes, E. J. (1993). *One Hundred Hungry Ants*. Boston: Houghton Mifflin Company.
- Rapaport, W. J. (1984). Critical thinking and cognitive development. *Proceedings of the American Philosophical Association*, 57: 610-615.
- Sheets, C. (in press). *Elementary Mathematics in Context*. Charlotte: Information Age Publishing.
- Sheets, C. & Cifarelli, V.V. (2011). Developing instructional sequences in pre-service elementary mathematics teacher education. *International Symposium: Elementary Mathematics Teaching*. Prague, The Czech Republic.
- Sheets, C. & Sevim, V. (2011). Developing mentoring models for pre-service K-2 elementary teacher education. Mentoring Institute, University of New Mexico, Albuquerque, New Mexico.
- Shimahara, N. K. (1998). The Japanese model of professional development: Teaching as a craft. *Teaching and Teacher Education*, 14, 451-462.
- Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57, 1-22.
- Silver, E. A., & Stein, M. (1996). The QUASAR Project. The “revolution of the possible” in mathematics instructional reform in urban middle schools. *Urban Education*, 30, 476-521.
- Stigler, J. W., & Hiebert, J. (1999). *The teaching gap: Best ideas from the world’s teachers for improving education in the classroom*. New York: Free Press.
- Storeygard, J. (Ed.) (2009). *My Kids Can: Making Math Accessible to All Learners, K-5*. Portsmouth, NH: Heinemann.
- Swafford, J. O. (1995). Teacher preparation. In I. M. Carl (Ed.), *Prospects for school mathematics* (pp. 157-174). Reston, VA: National Council of Teachers of Mathematics.

- Thompson, I. (1997). The early years number curriculum today, in: I. Thompson (Ed.) *Teaching and learning early number*.(Buckingham, Open University Press.)
- Torosyan, R. (2000). Encouraging consciousness development in the college classroom through student-centered transformative teaching and learning. (Unpublished doctoral dissertation, Columbia University, New York).

APPENDIX A

The eight standards for mathematical practice describe expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important “processes and proficiencies” with longstanding importance in mathematics education. The first of these are the NCTM process standards (1991) of problem solving, reasoning and proof, communication, representation and connections. The second are the strands of mathematical proficiency specified in the National Research Council’s report *Adding It Up* (2001): adaptive reasoning, strategic competence, conceptual understanding, procedural fluency, and productive disposition.

Standards for Mathematical Practice: Common Core State Standards

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

APPENDIX B

Rubric for Common Core State Standards (CCSS) Lesson Plan Assessment

<u>Indicator</u>	<u>Description</u>	<u>Points</u>	<u>Comments</u>
		0Pts, 1Pt, 2Pts, 3Pts	
Lesson Structure	Lesson has appropriate content for grade level and follows prescribed CCSS format correctly		
Lesson Objectives	CCSS objective(s) are listed and are measureable and appropriate		
Evidence Of Embedding CCSS Mathematical Tasks	CCSS mathematical tasks are present in each component of the lesson plan		
Assessment Of Lesson	CCSS assessment is clearly stated and matches the CCSS objective(s)		

Column Totals:

Grand Total:

Overall Comments on the Plan:

Scoring Guide for Common Core State Standards (CCSS) Lesson Plan Assessment

Indicator

Lesson Structure	<p><u>0 Points:</u> The lesson seems incomplete. The lesson does not follow CCSS format.</p> <p><u>1 Point:</u> The lesson is nearly complete but is lacking in depth. Teacher may need to seek outside resources for the lesson. However, the lesson does follow CCSS format.</p> <p><u>2 Points:</u> The lesson and supporting resources are complete and in depth but do not provide adaptations for students with special needs or more motivated learners. The lesson follows CCSS format.</p> <p><u>3 Points:</u> The lesson and supporting resources are complete, deep and adaptable. The lesson offers extensions for more motivated learners and/or learners with special needs. The lesson follows CCSS format.</p>
Lesson Objectives	<p><u>0 Points:</u> The lesson provides no connection to the CCSS curriculum.</p> <p><u>1 Point:</u> The lesson appears to be related to CCSS curriculum standards but connections are not made explicit.</p> <p><u>2 Points:</u> The lesson provides connections to CCSS curriculum standards with vague references to the core curriculum.</p> <p><u>3 Points:</u> The lesson clearly supports CCSS curriculum standards appropriate to the target student group and makes explicit references to the CCSS.</p>
Evidence of Embedding CCSS Mathematical Tasks	<p><u>0 Points:</u> The lesson is lacking CCSS mathematical tasks throughout the plan.</p> <p><u>1 Point:</u> The lesson contains exactly one CCSS mathematical task.</p> <p><u>2 Points:</u> The lesson contains exactly two CCSS mathematical tasks in the plan.</p> <p><u>3 Points:</u> The lesson contains CCSS mathematical tasks throughout the plan.</p>

Assessment of Lesson

0 Points: The assessment seems inappropriate or lacking.

1 Point: The assessment is nearly complete but not aligned with CCSS objective(s).

2 Points: The assessment is complete and somewhat aligned with CCSS objective(s).

3 Points: The assessment is complete and well-aligned with CCSS objective(s).

Interpretation of Total Score for Rubric for Lesson Plan Assessment

Total Score

0 Points	Failing CCSS Plan
1-3 Points	Unsatisfactory CCSS Plan
4-7 Points	Satisfactory CCSS Plan
8-11 Points	Well-developed CCSS Plan
12 Points	Exemplary CCSS Plan

APPENDIX C

- (i) During the third class session, the class translates snapshots of algebraic thinking into their own original lesson plans. The original curriculum pieces are extracted from the National Council of Teachers of Mathematics Curriculum and Evaluation Standards Addenda Series, Grade 2. Each team collaborates to produce one product for a “team share” and a “total class share.” This assignment is not graded. However, one work product from each team is saved for contribution to a “class portfolio.”
- (ii) During the ninth session, the class reads and uses as a springboard the book by Elinor J. Pinczes, “One Hundred Hungry Ants,” to develop an original lesson plan. The entire class adopts the same behavioral objective for their plan: The student will be able to identify all factors of 100. Each student in the class submits an assignment for a “team share” and a “total class share.” This assignment is not graded. One work product from each team is saved for contribution to the class portfolio. Through the act of solving this curriculum task (i.e., designing a lesson plan for finding all the factors of 100 using a piece of well-known children’s literature as a springboard) these students explored aspects of mathematics that was new and exciting for them.

The very act of designing the lesson plans made explicit for these pre-service elementary teachers the mathematics inherent in the lesson for students aged five to seven. While designing this lesson on *factors*, these students incorporated set models in Part 1 by determining the set of groups of ants; length models in Part 2 by using arrays to model the factors; and physical models in Part 3 to relate their lesson plan to a real world context. The constituent parts of their lesson demonstrate where the mathematics lies in this experience for these students. Before participating in this curriculum activity, these pre-service teachers had never thought this deeply about factors of 100 or how to represent factors of 100 via multiple representational tools and models. Close examination of these students’ work products reveals the extent to which pre-service elementary education majors begin to incorporate multiple representational tools and models when conveying important mathematical ideas to children.
- (iii) During the thirteenth session, the class adapts curriculum from the National Council of Teachers of Mathematics Illuminations website to develop an original lesson plan

for teaching a mathematics lesson in grades K-2. This assignment is assessed by the professor using a course-designed rubric for a grade (See Appendix B).

- (iv) During the sixteenth session, the class reads and uses as a springboard the book by Stuart J. Murphy, “Earth Day Hooray!” to develop an original lesson plan to teach place value as modeled in the story. Each student in the class submits an assignment for a “team share” and a “total class share.” This assignment is not graded. However, one work product from each team is saved for contribution to the class portfolio.