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Shifting Preservice Teacher Beliefs: The Power of the Common Core State Standards in Mathematics

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Abstract

This study explored preservice teachers' beliefs about mathematics teaching and if the CCSSM has the power to shift these beliefs. Teacher beliefs are key determinants of instructional practices and classroom environments (Thompson, 1992). The professional development model designed by Loucks-Horsley, Hewson, Love, and Stiles (1998) was implemented using the: Set Goals, Plan, Do and Reflect which aligns with the National Research Council's (1999) report on the science of learning describing several important themes on how teachers learn and change. Based on survey analysis and personal essays about their belief on teaching mathematics the largest growth was found in the teachers acquiring an understanding of how and why the CCSSM are important in teaching.

Keywords: Beliefs, elementary preservice teachers, Common Core State Standards in Mathematics

Teacher beliefs are key determinants of instructional practices and classroom environments (Thompson, 1992). These beliefs are often called a teaching philosophy or core values. As teachers clarify and articulate their beliefs, they become the guiding principles upon which their planning and decision making is based. As a leader in mathematics education, understanding the role beliefs play in the work of teachers is crucial to providing targeted support and direction for teachers of mathematics. Implementation of the Common Core State Standards for Mathematics (CCSSM) (2010), in particular the Standards for Mathematical Practice, requires that teachers have both the will and capacity to facilitate instruction that enables students to reason critically and make sense of the mathematics. The ability of a leader to build teacher capacity of pedagogical practices that support the CCSSM is dependent on a teacher's beliefs of teaching, learning, and mathematics (NCSM, 2013).

Many teacher education programs are oriented around the concept of "reflective teaching" in order to prepare teachers to become reflective decision makers. The roots of reflective thinking go back to John Dewey (1916). In analyzing Dewey's definition, the first step is the "meaning making process" and in our context that would entail making sense of the CCSSM. Dewey's definition of reflection as a rigorous way of thinking is complex; he uses 30 unique, specialized terms. This can be simplified to describe the learner's movement from a state of disequilibrium to a state of equilibrium. Dewey believed that reflection took place in a community where one had to express themselves to others. Also, he believed in the "affective dimension," or the attitudes that a teacher brings to bear on the art of reflection. The phrase "experience plus reflection equals growth" (1916) is attributed to John Dewey. A common practice throughout most teaching careers is to write a "philosophy of teaching." Dewey defined philosophy as the *general theory of education* (Dewey, 1916, p. 383) or why do I teach the way I do?

Leaders in mathematics education classrooms play vital roles with respect to encouraging implementation of the CCSSM and the standards for mathematical practice. In the mathematics methods classrooms, instructors can highlight the power of teaching for deep mathematical ideas and that these methods may look different from those that students learned when they were in school. Often this conceptual approach includes visual models and multiple representations. Leaders must create the experiences and opportunities for reflection that allow teachers to examine their beliefs and how these beliefs align with the expectations of the CCSSM. This role of the mathematics education leader begins in the preparation of preservice teachers.

Review of the Literature

Just as students do not enter the classroom with a *tabula rasa*, mathematics teachers similarly enter the profession with their own knowledge, attitudes, experiences, and beliefs about teaching, learning, and mathematics. Each of these components contributes to the manner in which a teacher approaches instruction and the type of learning environment created. Teacher beliefs and the learning environment merge in the mathematics classroom (Thompson, 1992; Hoyles, 1992; Skott, 2001; Guskey, 1986). Thus, a teacher's belief can influence his or her approach to teaching mathematics (NCSM, 2013). Beliefs teachers' have about students can result in certain populations having limited access to the high level of rigor of mathematics content. "Based on their concept of *students' needs,* teachers select which parts of the reform documents are appropriate for their students" (Sztajin, 2003, p. 53). Undoubtedly, this privileged position of a certain type of mathematical knowledge in society affects the teaching and learning of the subject. The overall level of mathematical content must be raised, and the difference in societal groups must be eliminated. One of the first steps towards change is the belief of teachers.

To help solve this problem Battista (1994) recommends that teacher education institutions need to offer numerous mathematics courses for teachers that treat mathematics as sense-making, not rule following. Teachers should "learn mathematics in a manner that encourages active engagement with mathematical ideas" (Battista, 1994, p. 470). Learning to teach to new standards is not easy and requires time. According to Darling-Hammond and Ball (1998), many teachers must face their deeply held beliefs about learning and knowledge and must reconsider their assumptions about students when instructing with new standards. Even if teachers' beliefs align with new reforms, such as CCSSM, they often must develop new ways of teaching and assessing their work. Fortunately, when teachers' beliefs change, the result is new ways of viewing their instructional practice (Lambert, 2002).

"Thoughtful analyses of the nature of the relationship between beliefs and practice suggest that belief systems are dynamic, permeable mental structures, susceptible to change in light of experience" (Thompson, 1992, p. 149). The National Research Council's [NRC] (1999) report on the science of learning describes several important themes on how teachers learn and change. First, teachers need a strong foundation in the core content. Having a deep understanding of the core content allows teachers to then be skilled in how to make decisions about what students understand, need to understand, and how they can impart that knowledge. "Teachers who know a lot about teaching and learning, and who work in environments that allow them to know students well, are the critical elements of successful learning" (Darling-Hammond, 1998, p. 6). Learners are aided by self-monitoring and analysis of what and how they are learning. Thus teacher learning is enhanced by interactions that encourage them to articulate their views, challenge those of others, and begin to understand professional learning communities.

Similarly, the professional development design by Loucks-Horsley, Hewson, Love, and Stiles (1998) in Figure 1, suggests a framework for use as a guide to the process of designing and providing quality professional development. The original design emerged from collaborative reflection with outstanding professional developers about their programs for both mathematics and science teachers. However, as professional development "designers," they felt strongly that professional development was not about importing models but about a process of thoughtful, conscious decision-making. Figure 2, is a modified framework (Loucks,-Horsley, Love, Stiles, Mundry, & Hewson, 2003) with a major difference being a tighter link among standards and a vision for student learning and analysis of student learning. Also, a change from the word *reflect* to the word *evaluate* to signal the importance of rigorous evaluation of professional development and reflection is still a vital part of professional development design. The framework in Figure 2 is also a generic planning sequence, incorporating the following actions: committing to a vision and a set of standards, analyzing student learning data, goal setting, planning, doing, and evaluating. This framework describes professional design at its best. It is not a sequence of steps or a recipe to be followed, but rather a tool to alert planners to important bases to cover and to stimulate reflection and refinement. Both frameworks guided the preparation of the methods course.

Figure 1. Original Professional Development Design Framework (Loucks-Horsley, Hewson, Love, & Stiles, 1998).

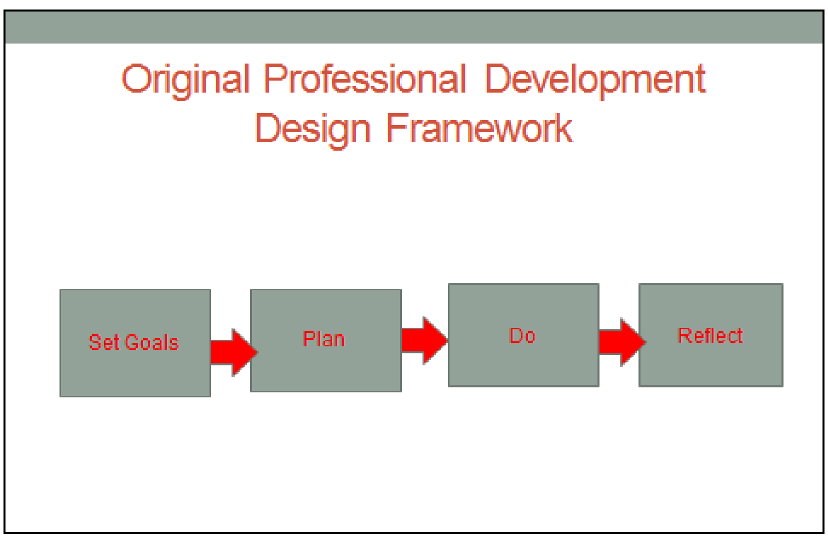
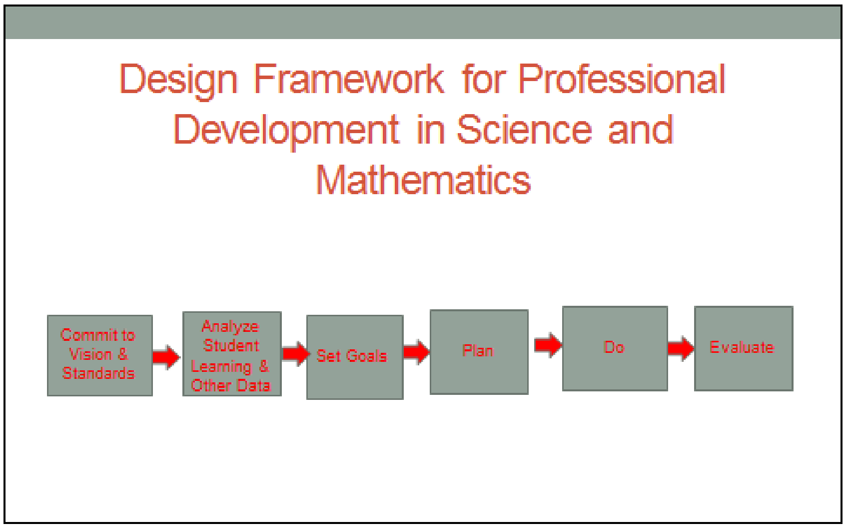


Figure 2. Design Framework for Professional Development in Science and Mathematics (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003).



Purpose of the Study and Research Questions

By linking the essential elements of teacher beliefs with learning, standards reform, and professional development that was garnered from the literature, the purpose of this study was to determine preservice teachers' beliefs about mathematics teaching and if the CCSSM has the power to shift these beliefs. Our investigation sought to answer the questions, does instructing students about the CCSSM's suggestions for improving mathematics instruction alter their beliefs about math instruction? If so, in what ways?

Methodology

Subjects

Data were obtained from eleven undergraduate and graduate students in a fifth year teacher certification program who were enrolled in a three-hour graduate credit elementary mathematics methods course for fourteen weeks. All of the students were seeking dual certification in PreK-4 general education and K-6 special education. Participants were asked on the first course meeting to complete the *Objectives of a Mathematics Methods Course* survey (adapted from Brahier, 2011) (See Appendix A. Objectives of a Mathematics Methods Course), received instruction for the next several weeks that included strategies to implement the CCSSM, and were then asked to retake the *Objectives* survey during the fourteenth meeting and complete a beliefs essay by the eighth meeting. All subjects participated in both pre- and post-implementations of the survey, as well as the essay. In order to protect the participants' real name the eleven undergraduate and graduate students have been assigned a letter name, such as Participant A.

Instruments

The *Objectives* survey (Brahier, 2011) included sixteen Likert scale questions designed to rate the importance of essential components in the mathematics methods course (See Appendix A. Objectives of a Mathematics Methods Course). The data was categorized as "Pairs" when analyzing the sixteen pre- and post-questions. For example, pre-post survey for question one is titled Pair One, question two is titled Pair Two, and so on. The survey's rating system ranged from 5-extremely important, 4-very important, 3-important, 2-somewhat important, 1-not very important, and 0-unnecessary. The *Objectives* survey was chosen because it clearly defined essential components found in the CCSSM standards documents. Also, *Objectives* defined in the instrument were categorized by the essential components that aligned with the course:

- The ability to describe the significance, general content, application in lesson planning of the standards documents of the National Council of Teachers of Mathematics [NCTM], which include *Principles and Standards for School Mathematics* (2000), State Standards, and *The Core Curriculum State Standards in Mathematics* (2010);

- The role that effective lesson planning has on classroom environment/management;
- The use of effective, researched-based strategies, such as cooperative learning strategies, higher level questioning in mathematics instruction, and literacy integration;
- The ability to illustrate how, when, and why to use a variety of assessment strategies to collect data regarding student academic progress and the development of dispositions toward mathematics;
- The ability to demonstrate how, when, and why to use technology to identify and maximize student learning; and,
- The ability to continue to develop a positive disposition toward the field of mathematics by becoming familiar with, and participate in, programs provided for continued professional growth in the field of mathematics education.

In addition to *Objectives* the participants wrote a beliefs essay during the seventh and eighth week of instruction. A beliefs essay is a subset of the students' philosophy of teaching, but this assignment was focused specifically on their beliefs about teaching mathematics and how the CCSSM will or will not affect their teaching of mathematics. All of the preservice teachers have a philosophy of education in their e-portfolio, which is one of the first assignments in the teacher certification program. The information in the beliefs essays were first categorized by the six essential components that paralleled with the *Objectives* survey mentioned above. Then, the essays were analyzed to determine if and how the CCSSM shifted their beliefs.

Procedure

After students completed the survey during the first course meeting, they were instructed following the NRC's (1999) learning principles regarding foundations in core content and Loucks-Horsley et al.'s (1998) professional development design framework (see Figure 1). The elementary mathematics methods course was developed with evidence-based, research-affirmed practices that included hands-on opportunities with technology and manipulative materials implemented in every class. The content and activities in the first six class sessions were intentionally designed to build a strong foundation in the core content and big ideas of mathematics education and an understanding of the CCSSM. *Elementary and Middle School Mathematics: Teaching Developmentally* (Van de Walle, Karp, & Bay-Williams, 2013) and *The Power of Picture Books in Teaching Math, Science, and Social Studies: PreK-8* (Author, 2009) were used in conjunction with the activities to support teachers when asking the essential question, "Why do I teach the way I do?"

Participants worked in collaborative groups with active learning strategies and were provided opportunities to make connections to CCSSM as part of each of the fourteen course sessions. The purpose for this learning environment was meant to offer the participants authentic opportunities on how to make decisions about what PreK-4 students know and will need to know mathematically, as well as how they can teach that information in a diverse mathematics classroom. After the introduction of the course, using the Loucks-Horsley et al. framework for Professional Development in Science and Mathematics (2003) (Figure 2), the instructors emphasized commitment to a vision and Standards, analyzing student learning, and setting goals as foundational portion of the course. To enhance their dialogue and strengthen connections between their beliefs in mathematics teaching and the CCSSM, during week seven and eight the participants viewed a webinar called New Resources for Illustrating the Mathematical Practices (Carnegie Learning, 2012). The webinar explains the CCSSM Standards and provides examples of real life classrooms modeling the connection between their personal beliefs and the standards reform. To understand the extent of any shifts that may have occurred, a brief essay about participants' beliefs about the CCSSM and its potential influence on their future classroom teaching was completed on the eighth week and analyzed qualitatively to determine if and how the CCSSM shifted their beliefs.

Furthermore, knowing that teacher learning is enhanced by interactions that encourage them to articulate and defend their beliefs, the remaining six course sessions were designed to target specific mathematical topics such as early numeracy, data and measurement, geometry, and algebraic thinking. Participants were encouraged to download and use *The Common Core* (Mastery Connect, 2011) application for their electronic tablet during collaborative group discussions. At this stage of development of the students, Figure 2 (Loucks-Horsley et al., 2003) continued to be the guiding model with an emphasis on plan, do and evaluate.

Students were then reissued the *Objectives* survey to determine whether or not their beliefs about the CCSSM's suggestions from improving mathematics instruction shifted following fourteen weeks of coursework.

Results

When identifying whether the CCSSM have the power to shift beliefs for improving mathematics instruction and in what ways, the descriptive mean change from the pre- and post- *Objectives of a Math Methods Course* survey were analyzed using paired sample *t*-tests. Only SPSS descriptive mean statistics were run to identify an increase or decrease in survey scores due to the small sample size. Furthermore, if the CCSSM have the power to shift beliefs for improving mathematics instruction, the qualitative data acquired from the participant's beliefs essay are used to explain how teachers' beliefs align with the CCSSM.

Based on the survey results from the paired sample *t*-test statistics (Table 1), there were significant positive differences in the participants' beliefs of the importance of mathematical objectives for the methods course from the first to the fourteenth course session. In particular, there was a mean increase in thirteen of the sixteen questions. Pair 1 and Pair 2, which identified the importance of learning how to describe the significance, general content, and application in lesson planning of the Standards documents of NCTM, State Standards, and CCSSM had a positive mean increase of 0.91

points (Pair 1) and 0.73 points (Pair 2). More importantly, as shown in Table 2, Pair 1 which directly targeted CCSSM, shows a positive statistical significance (p<.001).

Albeit, qualitatively ten out of the eleven participants beliefs about teaching mathematics were shifted due to the power of the CCSSM, Participant J was more reluctant to change. He believed, "Even if the Common Core Standards help to reinforce my philosophy, [he] thinks there will still be struggles with integrating them into education. The standards for each state have taken a long time to become an integrated part of education, and now that they are going to add a new set of standards, it is going to take more time to adjust to these standards. Even though the Common Core Standards have fewer standards, and are supposed to be clearer than what is currently published, it will still take time to integrate them." Participant O's thoughts on the other hand mirror those of the remaining ten preservice teachers, "Now that I have taken the time to really go through the goals of each CCSSM and explore the NCSM website, I am more aware of the various angles (no pun intended!) from which you can teach mathematics in the classroom. The best practices include those that teach students skills and strategies that forgo classroom instruction, and extend into the use of basic processing skills in society. These standards are geared toward producing effective citizens of the world. This starts by instructing students how to approach mathematical concepts in order to benefit their daily lives."

While Pair 1 was the only item that was statistically significant, the questions that identified illustrating how, when, and why to use a variety of assessment strategies to collect data regarding student academic progress all had positive mean increases (Pair 10, Pair 12, and Pair 13 in Table 1) Considering how, when, and why the CCSSM influences teaching and learning via assessment Participant K thought, "In order for math to stay relevant to students, their prior knowledge, culture, language and lifestyle must be integrated into their instruction as well as their assessment tasks. The CCSSM helps to clearly define which skills and concepts should be focused on. The CCSSM believes that deep learning of concepts should be emphasized. This can be done by: encouraging students to use manipulatives, diagrams, technology and more to enhance their learning experience. Students should be encouraged to communicate their mathematical thoughts through writing, gestures, concrete objects such as drawings, etc." Additionally, Participant C demonstrated change in her belief system when she asserted, "I feel that overall my beliefs about teaching begin with the students, but I have began thinking more passionately how specific practices from the CCSSM and assessment can enhance my beliefs on teaching math."

The use of effective researched based strategies such as higher level questioning in mathematics instruction and literacy integration also showed positive mean increases (Pair 4, Pair 8, and Pair 14 in Table 1). As Participant G explains, "The *CCSSM* aim to facilitate confidence and growth of mathematics in the student population. Their practices suggest that teachers should educate students on how to work on and persevere to solve mathematics problems while focusing on precision. They continue to suggest that teachers do so by teaching reasoning and explaining skills, modeling and tool usage, and pattern/structure locating and generalization abilities. Each of these elements of the *CCSSM* stand to highlight what students already know, build on that understanding and use the information to grow as mathematicians."

Even though qualitatively the participants did not mention the importance of the development and continuation of positive dispositions toward the field of mathematics, there were positive mean increases according to the pre- and post-surveys (Pair 15 and Pair 16 in Table 1).

Table 1. Paired Samples Statistics.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest1	3.45	11	.522	.157
	Posttest1	4.36	11	.505	.152
Pair 2	Pretest2	3.27	11	.905	.273
	Posttest2	4.00	11	.775	.234
Pair 3	Pretest3	4.27	11	.905	.273
	Posttest3	4.73	11	.467	.141
Pair 4	Pretest4	3.64	11	1.027	.310
	Posttest4	3.91	11	1.044	.315
Pair 5	Pretest5	3.73	11	1.009	.304
	Posttest5	3.82	11	.874	.263
Pair 6	Pretest6	4.27	11	1.009	.304
	Posttest6	4.55	11	.522	.157
Pair 7	Pretest7	4.36	11	1.027	.310
	Posttest7	4.36	11	.924	.279
Pair 8	Pretest8	4.36	11	1.027	.310
	Posttest8	4.73	11	.467	.141
Pair 9	Pretest9	4.27	11	1.272	.384
	Posttest9	4.27	11	.647	.195
Pair 10	Pretest10	4.45	11	.934	.282
	Posttest10	4.73	11	.467	.141
Pair 11	Pretest11	4.18	11	1.250	.377
	Posttest11	4.18	11	.751	.226
Pair 12	Pretest12	4.18	11	1.079	.325
	Posttest12	4.55	11	.688	.207
Pair 13	Pretest13	3.82	11	1.250	.377
	Posttest13	4.18	11	.751	.226
Pair 14	Pretest14	4.18	11	.982	.296
	Posttest14	4.55	11	.688	.207
Pair 15	Pretest15	4.27	11	1.489	.449
	Posttest15	4.45	11	.522	.157
Pair 16	Pretest16	3.73	11	1.009	.304
	Posttest16	4.09	11	.701	.211

Table 2. Paired Samples Test.

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pretest1 - Posttest1	-.909	.539	.163	-1.271	-.547	-5.590	10	.000
Pair 2	Pretest2 - Posttest2	-.727	1.104	.333	-1.469	.014	-2.185	10	.054
Pair 3	Pretest3 - Posttest3	-.455	1.128	.340	-1.212	.303	-1.336	10	.211
Pair 4	Pretest4 - Posttest4	-.273	1.555	.469	-1.317	.772	-.582	10	.574
Pair 5	Pretest5 - Posttest5	-.091	1.300	.392	-.964	.783	-.232	10	.821
Pair 6	Pretest6 - Posttest6	-.273	1.191	.359	-1.073	.527	-.760	10	.465
Pair 7	Pretest7 - Posttest7	.000	1.095	.330	-.736	.736	.000	10	1.000
Pair 8	Pretest8 - Posttest8	-.364	1.027	.310	-1.054	.326	-1.174	10	.267
Pair 9	Pretest9 - Posttest9	.000	1.095	.330	-.736	.736	.000	10	1.000
Pair 10	Pretest10 - Posttest10	-.273	.905	.273	-.880	.335	-1.000	10	.341
Pair 11	Pretest11 - Posttest11	.000	1.183	.357	-.795	.795	.000	10	1.000
Pair 12	Pretest12 - Posttest12	-.364	.924	.279	-.985	.257	-1.305	10	.221
Pair 13	Pretest13 - Posttest13	-.364	1.362	.411	-1.279	.551	-.886	10	.397
Pair 14	Pretest14 - Posttest14	-.364	1.206	.364	-1.174	.447	-1.000	10	.341
Pair 15	Pretest15 - Posttest15	-.182	1.401	.423	-1.123	.760	-.430	10	.676
Pair 16	Pretest16 - Posttest16	-.364	1.206	.364	-1.174	.447	-1.000	10	.341

Discussion

The data validates the idea that the CCSSM does have the power to shift beliefs for improving mathematics instruction. Predominantly the shift in beliefs is found in the use of effective researched based strategies such as higher level questioning in mathematics instruction, literacy integration, illustrating how, when, and why to use a variety of assessment strategies regarding student academic progress, and the development of positive dispositions toward mathematics. By continuing to develop a positive disposition, or "beliefs," toward the field of mathematics these preservice teachers are more likely to present students with appropriately challenging mathematics while providing students with necessary supports to ensure learning of the content. Participant G said it best when affirming how her beliefs align with the CCSSM, "Teaching the set of skills required for math comprehension allows children to discover all that is math and build on that knowledge *ad infinitum*. When teaching reading or writing, students are educated on how to see patterns and decode or how to produce words and follow a basic process for recording and sharing ideas. Why would the math teaching process differ than that of any other basic life skill? Math is simply a mode of expression that describes the world in a way that all can understand despite culture or language. We must embrace the *CCSSM* and give today's children the toolkit they need to explain and understand the world around them. Those children are our future, and math needs to be a language with which they will succeed."

What became of particular interest when analyzing the data was identification of beliefs the preservice teachers already held towards mathematics and instruction, regardless if the CCSSM influenced them. Based on the pre- and post-survey analysis, students already held a belief in the importance of effective lesson planning on classroom environment-management, cooperative learning strategies, and technology in the classroom. Yet, because their beliefs in mathematics instruction shifted in other areas connected to these three topics, new beliefs emerged.

The questions identifying the importance of effective lesson planning on classroom environment/management (Pair 11 in Table 1) had a zero mean increase. This illustrates the participants already value the importance of successful design for learning. Good lesson planning is essential to the process of teaching and learning. A teacher who is prepared is well on their way to a successful instructional experience. However, even though they hold this foundational belief, the importance of creating lesson plans with the eight mathematics practices that focus of PreK-4 mathematics program became more important (Pair 3 in Table 1). This emerging knowledge of teaching with content in mind, rather than behavior in mind, indicates growth in the importance of teaching mathematics. Participant A supported this finding when he wrote, "While I believe CCSS are a great place for me as an educator to begin developing and planning, the traits and characteristics of my classroom and its students will be the driving force behind my implementation of particular practices. The benefit of using the CCSS as my guide, is knowing which direction to point my educational compass and steer my students towards." Additionally, Participant L began to realize how she can implement this objective in her classroom, "Overall, teachers need to teach with their students in mind so when formatting my lessons and units, I need to determine what practices and assessment should be focused on for my particular group of students. Students' success in mathematics is my ultimate goal."

Furthermore, the participants entered the learning experience with a firm belief of research-based strategies on cooperative learning, which resulted in a zero mean increase for Pair 9 (Table 1). Cooperative learning strategies such as think-pair-share, jigsaw, and group investigations are beneficial in the mathematics classroom because students develop a sense of community and commitment, which supports positive peer teaching. Another beneficial aspect of cooperative learning in the classroom is the increased amount of resources gained from a group. This will allow students to make better decisions and justify answers as they work through problems with more understanding and background information. "The *Common Core Standards* emphasis on learning and doing mathematics impacts positively on my beliefs about how to teach mathematics in the classroom" said Participant K. "For example, having a student show and justify his or her understanding of a problem proves comprehension much more than completion of a worksheet showing no depth of knowledge. The need for student engagement, discussion time, and extension opportunities is provided through the design of the activity's question and its reliance on conceptual understanding of key ideas.

Yet, the remaining learning strategies that discussed higher level questioning in mathematics instruction, and literacy integration both had positive mean increases (Pair 4, Pair 8, and Pair 14 in Table 1). This finding appears to indicate that preservice teachers understand how questioning and literature in the content area can be as useful a strategy as cooperative learning. In particular the use of questioning in cooperative groups was a prominent theme in the qualitative findings. Participant L realized, "In order to fully grasp math concepts, it is important that students will be able to problem solve and then explain their processes so they will be able to apply it to a different problem in the future. Therefore, unlike the speaker who highlighted problem solving and attending to precision, I will highlight problem solving and reasoning and explaining in my math units."

The final preexisting belief was about demonstrating when and why to use technology, which had a zero mean increase (Pair 7). However, Pair 5 and Pair 6, which both discuss how to use technology, had a positive mean increase (Table 1). This observation is rather eye opening in regards to supporting 21st century learners in the mathematics classroom. There is a vast difference between understanding when and why to use technology versus how to use technology in classroom instruction. Similar to the standards found in the CCSSM, knowing how to use technology means creating lessons that have active engagement, participation in groups, frequent interaction and feedback, and connections to the real world. Additionally, knowing how to use technology in the mathematics classroom offers educators effective ways to reach different types of learners and assess student understanding through multiple means, which supports teachers "growth mindset."

The data also supports previous work about professional development design. By constructing the fourteen week course sessions around the NRC's (1999) learning principles about foundations in core content and the Loucks-Horsley et al. framework (1998) Set Goals, Plan, Do and Evaluate design, it was observed that participants naturally began collaborating to explain or defend the rationale behind mathematical topics, learning strategies, how the standards influence lesson planning and assessment for each grade level, and why manipulatives, either concrete or virtual, were explicitly chosen. Essentially, the preservice teachers were learning and thinking in ways they believe their students should learn.

Changing Teacher Beliefs for CCSSM Implementation

Useful to mathematics leaders would be to determine which of the other pivotal documents in mathematics education field have on impact on beginning teachers' beliefs on implementing the CCSSM, such as the National Association of Education of Young Children's (NAEYC) statement, *CCSSM: Caution and Opportunity for Early Childhood*

Education and NCTM's statement on early childhood education. One of the next steps would be to provide several other classrooms of preservice teachers with the same instructional experiences to determine if the results can be duplicated or improved in those classrooms. Another useful task would be to provide the same quality experiences but with different pivotal documents, and compare the results in the impact on teachers' beliefs toward implementing the CCSSM.

As mathematics leaders it is essential to create learning environments that ensure teachers understand and have a strong foundation in the core content or big ideas in mathematics. Having a deep understanding of the CCSSM and eight principles in mathematics allows teachers to be proficient at decision making about what students know, need to know, and how they can impart that knowledge. This strong foundation supports the use of assessment, learning strategies, and integration of technology.

Most importantly, beliefs and practices must be considered holistically in understanding teaching and learning and in considering the professional learning opportunities for teachers (Bay-Williams & Karp, 2010). For meaningful and lasting change to occur, teachers need to engage in practical inquiry (Franke, Fennema, Carpenter, Ansell, & Behrend, 1998) and to move back and forth among a variety of settings to learn about new instructional strategies, to try them out in classrooms, and to reflect on what they observed in a collaborative setting (Borko, Mayfield, Marion, Flexer, & Cumbo, 1997). Whatever approach is used, it is clear beliefs and practices are linked, and emphasis on both is vital for professional development and a shift in teachers' beliefs.

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Appendix A

Objectives of a Mathematics Methods Course

The following are objectives for an elementary mathematic education course. For each of the following objectives, rate it on a scale of 0-5 (circle the number), using the following scale in terms of "what a student should learn in a mathematics education program to become a successful teacher":

5—Extremely Important, 4—Very Important, 3—Important, 2—Somewhat Important, 1—Not Very Important, 0—Unnecessary

1. Describe the significance and general content of the Standards documents of the National Council of Teachers of Mathematics—*Principles and Standards for School Mathematics* and *The Core Curriculum State Standards in Mathematics.*

0 1 2 3 4 5

2. Demonstrate an understanding of the philosophy and content of the Pennsylvania of Academic Standards for Mathematics, Pre-K-3 and Elementary.

0 1 2 3 4 5

3. Describe (and illustrate in lesson planning) how to make the eight mathematics practices the focus of Pre-K-4 mathematics program.

0 1 2 3 4 5

4. Describe popular learning theories that attempt to explain how students learn mathematics, such as the theory of Piaget (the constructivist viewpoint), direct instruction and inquiry-based learning.

0 1 2 3 4 5

5. Explain how research in mathematics and technology education is conduct, reported, and applied to reform in teaching and learning practices, with an emphasis on differentiating between appropriate and inappropriate us of technology.

0 1 2 3 4 5

6. Illustrate how to use technology (e.g., calculators, computer software, applets, interactive white board, and internet) and identify the benefits of technology to maximize student learning.

0 1 2 3 4 5

7. Identify, select and use appropriate technology resources to meet specific teaching and learning objectives.

0 1 2 3 4 5

8. Give examples of questioning strategies for the classroom that promote mathematical thinking and dialogue (discourse).

0 1 2 3 4 5

9. Use cooperative learning strategies in mathematics instruction.

0 1 2 3 4 5

10. Recognize the essential components of a lesson plan and prepare a mathematics lesson plan which includes outcomes, materials, a motivating activity, a structured sequence of experiences for the students, differentiated instruction, a logical closure, a planned extension, and a plan for assessment.

0 1 2 3 4 5

11. Describe a variety of strategies that teachers can use to promote positive classroom management and the role that effective lesson planning has on classroom environment.

0 1 2 3 4 5

12. Illustrate the ability to use a variety of assessment strategies to collect data, including electronic means, regarding student academic progress and the development of dispositions toward mathematics.

0 1 2 3 4 5

13. Explore a variety of ways in which teachers can gather field tested ideas for use in one's own classroom, including electronic sources.

0 1 2 3 4 5

14. Use literacy strategies and children's literature in mathematics instruction.

0 1 2 3 4 5

15. Continue to develop a positive disposition toward the field of mathematics.

0 1 2 3 4 5

16. Become familiar with and participate in programs provided for continued professional growth in the field of mathematics education, including the NCTM, PCTM, EPCTM, etc., including by means of the Internet and other electronic sources.

0 1 2 3 4 5

(Adapted from Daniel Brahier, 2011)