Preservice Teachers' Beliefs about Mathematics and Science Content and Teaching

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Abstract

This study explored early childhood preservice teachers' beliefs about mathematics and science. Using a qualitative approach, preservice teachers' beliefs were analyzed before and after taking integrated mathematics and science methods courses. Major perceptions that emerged from the study concerned the qualities of effective teachers, teachers' influence on their students' learning and perceptions of the subjects, and the time and effort required to teach mathematics and science. Changes in the pre-service teachers' perceptions were also observed.

Preservice teachers enter teacher education programs with well-established beliefs about the teaching profession that are shaped by their experiences as students, and these beliefs typically remain stable throughout their teacher preparation program and into the early years of teaching. In addition to general teaching beliefs, preservice teachers who are prepared to teach all subject areas may have more precise and varying beliefs in particular subject areas, such as mathematics and science (Book, Byers, & Freeman, 1983; Buchmann, 1984; Fajet, Bello, Leftwich, Mesler, & Shaver, 2005; Feiman-Nemser, McDiarmid, Melnick, & Parker, 1988; Taylor & Sobel, 2001; Weinstein, 1989). Therefore, examining preservice teachers' perceptions in these areas is important in order to enhance their understandings of teaching strategies and content in mathematics and science. To this end, we explored early childhood preservice teachers' perceptions of teaching and content of mathematics and science. In doing so we sought to determine the influence of attending and participating in an integrated mathematics and science methods course on their mathematics and science teaching perceptions.

Teachers' Beliefs

Teachers' beliefs are "implicit assumptions about students, learning, classrooms, and the subject matter to be taught" (Kagan, 1992, p. 66). In her meta-analysis, Kagan concluded that teachers' beliefs about their profession fell into two categories: teaching self-efficacy and content-specific beliefs. Self-efficacy is the ability to produce the intended influence on students and has two facets: personal teaching efficacy and general or outcome teaching efficacy. Personal teaching efficacy refers to the belief teachers have in themselves as effective teachers. General teaching

efficacy deals with outcomes expectancy, such as the ability to improve students' achievement. Learning and knowing the field to be taught are considered content-specific beliefs (Ashton, 1884; Hoy & Woolfolk, 1990; Riggs, & Enochs, 1990).

Although a *causal* relationship between teachers' beliefs and classroom behaviors should not be assumed (Cobb, Wood & Yackel, 1990; Santagata, 2005), research suggests that teachers' beliefs influence their classroom practices (Mulholland & Wallace, 2001; Plourde, 2002; Schoeneberger & Russell, 1986), which in turn affect their students' learning (Carter & Norwood, 1997; Kagan, 1992; Pajares, 1992; Plourde, 2002; Raymond, 1997) and their students' perceptions of the subjects (Carter & Norwood, 1997). However, these beliefs usually remain unrecognized by the teachers (Kagan, 1992).

As Pajares summarized in his review of 16 studies, "beliefs must be inferred, and this inference must take into account the congruence among individual belief statements, the intentionality to behave in a predisposed manner, and the behavior related to the belief in question" (1992, p. 326). Thus, helping teachers to confront their beliefs and possibly facilitating changes in the ones that impact teaching practices negatively is vital to creating changes in classroom practices (Kagan, 1992). To do so, the first step is to examine teachers' beliefs in specific subject areas, such as mathematics and science. Indeed, a large body of research exists on elementary or middle grade teachers' and preservice teachers' beliefs about mathematics and science (e.g., Cakiroglu, & Boone, 2002; Kiviet & Mji, 2003; Tosun, 2000). However, few studies have examined similar beliefs amongst early childhood preservice teachers (i.e., Tsitouridou, 1999; Watters & Ginns, 1997).

Changing Preservice Teachers' Beliefs

Preservice teachers usually enter teacher education programs with firm beliefs about what it takes to be an effective teacher (Book, Byers, & Freeman, 1983; Buchmann, 1984; Fajet, Bello, Leftwich, Mesler, & Shaver, 2005; Feiman-Nemser, McDiarmid, Melnick, & Parker, 1988; Taylor & Sobel, 2001; Weinstein, 1989). The mathematics and science teaching beliefs held by preservice teachers are often mixed with anxiety, hesitancy, and feeling of incompetent (Cheng, 2002; Hart, 2002; Kiviet & Mji, 2003; Sottile, Carter, Murphy, 2002; Tosun, 2000; Watters, & Ginns, 1997). Frequently, these beliefs do not surface until new teachers start teaching in their own classrooms (Doolittle, Dodds, & Placek, 1993; Zeichner & Tabacknick, 1981). Therefore, teacher education programs must challenge preservice teachers' beliefs in order to create a substantial paradigm shift (Pajares, 1992).

A recurring theme in the teacher education literature is that teacher education programs do little to change preservice teachers' beliefs (i.e., Bandura, 1997; Cakiroglu, & Boone, 2002; Hart, 2002; Jesky- Smith, 2002; Kelly, 2001; Kiviet & Mji, 2003; Plourde & Alawiye, 2003; Tosun, 2000). Yet, it is well established that preservice teachers' beliefs can be enhanced and/or changed through participating in appropriate methods courses (i.e., Bandura, 1997; Cakiroglu, &

Boone, 2002; Hart, 2002; Jesky- Smith, 2002; Kelly, 2001; Kiviet & Mji, 2003; Plourde & Alawiye, 2003; Tosun, 2000) that are taught by teacher educators who scaffold the students in confronting their beliefs (Kiviet & Mji, 2003). Furthermore, several studies have reported that preservice teachers' beliefs are influenced by their university professors and mentor teachers during their practicum (Calderhead, 1988; Hoy & Woolfolk, 1989). The goals embedded within methods courses include developing positive beliefs systems with preservice teachers (Finson, et al., 2002) and convincing them that mathematics and science are interesting (Crowther, 1998). Therefore, science and mathematics methods courses provide invaluable opportunities for teacher educators to change preservice teachers' beliefs.

Integrated Mathematics and Science Methods Courses as a Means for Change

Integrating mathematics and science is a common sense approach, which has high "face validity" (Czerniak, Weber, Sandmann and Ahern (1999; p.421) since these two subject areas are connected in real life. "As teachers and teacher educators, we should help our students see the connection between content and concept, rather than their separation" (Francis, 1996, p. 75) Mathematics and science integration has also been recommended for all grades in order to increase student learning (Berlin & Lee, 2005; Breadkamp & Copple, 1997; Czernak, Weber, & Sandman, 1999; Lonning & DeFranco, 1997; National Council of Teachers of Mathematics [NCTM], 2000; National Science Teacher Association [NSTA], 1996; Pang & Good, 2000), and improve students' perceptions toward mathematics and science (Berlin & Lee, 2005; Czernak, Weber, & Sandman, 1999; Haigh, & Rehfeld 1995; Koirala & Bowman, 2003; Lonning & DeFranco, 1994; Pang & Good, 2000).

Integrated courses are also an effective means of augmenting preservice teachers' beliefs about mathematics and science (i.e., Berlin & White, 2002; Foss & Pinchbach, 1998; Haigh, & Rehfeld, 1995; Hart, 2002; Kelly, 2001; Koirala & Bowman, 2003). A small body of research has suggested that teacher educators utilize an integrated approach to help early childhood preservice teachers overcome their feelings of anxiety (Cady & Rearden, 2007; Lake, Jones, & Dagli, 2004). If preservice teachers experience an integrated approach in their teacher education program, they are more likely to integrate mathematics and science into their own classrooms (Basista & Mathews, 2002).

Framing Integrated Mathematics and Science Methods Courses

Defining the integration of mathematics and science. Although integration of mathematics and science is strongly encouraged in early childhood classrooms and teacher education programs, there is some debate concerning the precise definition of integration (Jones, Lake, & Dagli, 2005). Among several researchers who have defined integration (e.g., Berlin & White, 1994; Davison, Miller & Metheny, 1995; Huntley, 1998; Lonning, DeFranco, & Weinland, 1998; Miller & Davidson, 1999), Davison and colleagues (1995) provide the most useful definition for this study. These researchers classified integration into five types: discipline specific integration,

content specific integration, process integration, methodological integration, and thematic integration. Thematic integration is particularly applicable in early childhood classrooms, where the teaching activity begins with a theme and then becomes a medium through which all the disciplines interact.

Constructivist methodology is recommended when integrating mathematics and science methods courses. Davison et al. (1995) state that "[c]onstructivist teaching and learning advocates building initial understanding and a development of meaning that is individual generated" (p. 9). Potential academic benefits to preservice teachers' being taught using the constructivist approach is well documented in the research (i.e.,Carter & Sottile, 2002; Cheng, 2002; Groves & Pugh, 2002; Riggs & Kimbrough, 2002; Taylor & Coll, 2002). This approach is also aligned with the study of the beliefs of early childhood preservice teachers about the subjects from a social cognitive theoretical perspective.

Incorporating social cognitive theory and a constructivist approach.

Much of the research that has examined teachers' beliefs towards science and mathematics is based on the social cognitive theory of Alfred Bandura. He defines self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (1997, p. 3), and believes that self-efficacy is shaped by four influential sources. First is the *enactive mastery experience*, which refers to actively performing the actions. The second source, *vicarious experience*, is when a person sees similar individuals performing the same actions. *Verbal persuasion* involves verbal feedback, such as encouraging words. Finally, *physiological and affective* states are the sources of self-efficacy. Methods courses for preservice teachers that include all four influential sources would enhance positive beliefs and self-efficacy (Bandura, 1997).

In the present study, preservice teachers experienced Bandura's (1997) four sources. First, they were actively engaged in hands-on activities, such as conducting science experiments and using mathematics manipulatives, which provided them with science and mathematics enactive mastery experiences. Second, they obtained vicarious experiences by watching their classmates and professors being actively engaged with the content, observing how to manage the activities, and connecting the mathematics and science content to a variety of teaching strategies. Additionally, the professors modeled how to teach mathematics and science to young children. Third, preservice teachers received positive reinforcement, or verbal persuasion, in the form of encouragement and praise, which helped them increase their efficacy both in the teaching and in the mastery of the content. Finally, experiencing the positive atmosphere and successful completion of the classroom activities helped to reduce their stress, increase their confidence, and assisted them in reaching a positive physiological and affective state. Arguably, such activities should help preservice teachers reconsider their views about teaching and learning mathematics and science. In turn, as preservice teacher reflect on their experiences in the

methods courses they should adopt more positive beliefs about teaching mathematics and science.

Our goal in the current study was to contribute to the mathematics and science knowledge base by examining whether integrated methods courses could enhance early childhood preservice teachers' beliefs towards mathematics and science. The approach we adopted emphasized thematic integration through collaboration and modeling. Collaborative teaching in methods courses has been recommended as a viable integration model in higher education (Nevin, Thousand, & Villa, 2009). One kind of collaborative teaching is "team teaching, where educators are partners who share responsibilities for planning, teaching, and assessing" (p. 570).

In our study, the methods courses were taught in separate sections. However, the *what* and *how* to teach were integrated, and a team-teaching approach was adopted. We developed course syllabi jointly, used the same text, had combined assignments, met regularly during the semester, and conducted 12 hours of team-teaching. Additionally, we approached the integrated mathematics and science courses using constructivist and socio-constructivist foundations, which included modeling correct content and appropriate early childhood strategies.

Given the above framework we designed the study around the following two research questions:

1. What are the beliefs and perceptions of early childhood preservice teachers towards mathematics and science content and teaching?
2. How do integrated mathematics and science method courses influence or change preservice teachers' perceptions and beliefs towards mathematics and science teaching and content?

Methods

Study Site, Participants, and Data Collection

Participating in the study was a cohort of 26 female undergraduate students enrolled in a large university in the southeastern United States. The students were in the final year of an undergraduate degree program in early childhood education. The participants were all enrolled in an early childhood mathematics methods course, an early childhood science methods course, and a practicum course. The two methods courses met twice a week, and the practicum course met once a week, with two days a week in a field placement. Classroom activities included team teaching, experiential lessons, the use of cooperative learning, and scaffolding strategies specifically targeted to teaching young children. Preservice teachers were assigned to one of the local elementary schools in a prekindergarten, kindergarten, first, or multi-age K/1 classroom. They participated fully in their assigned classrooms and conducted lessons in cooperation with their professors and mentor teachers.

The requirement for their methods and practicum classes was to design and implement a two-week thematic unit that demonstrated their ability to integrate mathematics and science content and teaching methodology. Of the 26 students enrolled in the three courses, 24 volunteered to participate in the current study. To protect confidentiality, pseudonyms were assigned to or selected by the preservice teachers.

As part of the two method courses the preservice teachers responded to 10 prompts provided by the professors via email, collectively referred to as e-journals. Journal reflections are a recommended assessment approach that can be used to monitor students' learning and development (Kovalchick, Milman & Elizabeth, 1998). The first and last e-journals concerned their mathematics and science beliefs. Specifically, the students were asked to reflect on the question, "*What are your perceptions of the teaching and content of mathematics and science?"* The open-ended responses in their e-journals were analyzed to gain a clearer understanding of the preservice teachers' in-depth perceptions. Then, for the purpose of triangulation (Patton, 2002) several focus group interviews were conducted. These interviews were held at the end of the semester with two groups of four or five preservice teachers.

Results

The two e-journal responses were coded by a doctoral student using a starter list of codes (Miles & Huberman, 1994) that emerged directly from the prompts. These codes included perceptions/beliefs of mathematics, perceptions/beliefs of science, perceptions/beliefs of teaching mathematics, and perceptions/beliefs of teaching science. Next, each of the four coded areas was further analyzed and like responses grouped together and new codes were formed when the data revealed information not related to the start codes. Once this process was completed, the doctoral student and the two researchers met to discuss the process, analyze the data within each of the categories, and arrive at 100% agreement on the final categories (Hatch, 2002). Each category was then interpreted based on the research questions.

Beginning of Semester

The preservice teachers' beliefs and perceptions were shaped by their experiences as students. The majority of the preservice teachers expressed that mathematics and science had never been their favorite or most-liked subjects while they were in school. This findings seems to reinforce previous research that suggest that preservice teachers' beliefs are shaped by their experiences as students (Fajet et, al., 2005; Feiman-Nemser & Buchmann, 1984; Kagan, 1992; Pajares, 1992; Tabachnick & Zeichner, 1984). Hannah, for example, explained that "… mathematics is not my strongest area, but I always enjoyed it because of my teachers." Likewise, Molly stated "I have never liked mathematics because I was always doing paper and pencil operations and it was always boring for me". Nonetheless, the preservice teacher seemed excited to learn both the content and how to teach it (e.g., Alicia, Hannah). For example, Piper said, "I have not had the best math[ematics] experience in school, but it should be the crucial part . . . . I have a positive

attitude and hope to love it." Only a few students stated that they were confident in their ability to teach the two subjects.

The preservice teachers appeared more concerned about teaching mathematics in comparison to teaching science. They also talked more about mathematics than science in their e-journals, and indicated that teaching mathematics was of more concern than teaching science.

Qualities of an effective teacher. By summarizing studies of preservice teachers' beliefs about the characteristics of effective teachers, Fajet et al. (2005) identified two of the most commonly cited qualities: professional competence and affective qualities. Professional competencies are content-specific knowledge, or knowledge in the content area, and pedagogical skills are imparting the knowledge to students, getting students interested in the subject, promoting students' creativity, and providing experiments or hands-on activities. Affective qualities include kindness, supportiveness, caring, patience, approachability, ability to entertain and friendliness.

Consistent with the literature, the preservice teachers' in this study exhibited various levels of teaching efficacy. Concerning the professional competence of an effective teacher who teaches mathematics and science to young children, the preservice teachers' indicated that teachers must spark students' interests and enthusiasm in mathematics and science, and provide students with hands-on experiences. Expanding on this theme, Hannah said, "If the teacher makes the subject area fun, the students will want to learn even boring or difficult materials." Alicia stated that "If the lessons are interesting and taught in a fun way the children will pay attention and therefore, learn the material"
Savannah said that "I want to be available for my students" and "If I make science interesting, then children will want to learn." Alexandra indicated that "It can be as interesting as you make them interesting." Alexis expressed that "being enthusiastic is difficult."

They also worried about their pedagogical effectiveness, their ability to impart the knowledge to their students, and the skills needed to simplify mathematics and science concepts appropriately for young children. The majority of the preservice teachers indicated that their biggest concern was breaking the subjects down to the children's level and making lessons meaningful for them. Alicia wrote, "I am not sure about what is appropriate to the grade level. The K-1 class is a little bit harder." Alexis raised a similar concern by indicating that it was "sometimes difficult to explain science questions and science is hard to teach someone else especially who is in low level." Several preservice teachers also expressed concern about making the lessons interesting for children. Examples here include "Challenge is to find the many ways to cultivate student's interests in science and math[ematics] and learning the why of how children understand what they are experiencing" (Alexandra); "the children will not think the lesson is interesting" (Cheree)"; and "I am worried about the children will not enjoy her lessons and the lessons will not run smoothly" (Kami).

Teachers' influence on their students' learning and perceptions. The data supported previous research findings indicating that teachers' beliefs influence their students' learning and perceptions towards subject areas (Carter & Norwood, 1997). For example, one student wrote that "The teacher has to be enthusiastic in order for the students to be enthusiastic" (Kami & Alexis); and another said that "The teacher's attitude toward math[ematics] greatly influences a child's attitude toward learning. I have not had the best math[ematics] experience in school, but I think it should be the crucial part of the curriculum" (Piper). Other comments were that "A good teacher makes the subject interesting. Teachers are the most important factor whether the students like or are good at the subject or not" (Savannah), and "I want to make the children's perceptions of both subject be enthusiastic and eager to learn (Krystal)"

End of Semester

Meaning and challenge of integration. Regrettably, only a small number of preservice teachers used the term *integration* in their final e-journals. Krystal said that, "I feel like the two subjects are so related" and Vanessa indicated that "content areas overlap and they can be integrated" ; yet neither of them stated that they planned to combine them in their classrooms. " Alicia stated that "Math[ematics] can be made fun and used in combinations with other curricular areas." Maria appeared to expand the integration of mathematics and science with other subject areas.

> I learned that many math[ematics] activities involve science and it is nice because it makes things easier. Math[ematics] and science had so much common. It is easy to place math[ematics] and science concepts in other subject areas. I want to incorporate the subjects and make a better-rounded class.

For others, integration referred to incorporating those two subjects in the daily schedule. For example, Leila said, "Mathematics and science both are important and should be integrated and involved every day." Then, Olivia stated that she found time to integrate mathematics and science in her teaching schedule. Skyler, on the other hand, articulated that mathematics and science "should be integrated" but she was not specific about what she meant by integration.

Several preservice teachers expressed concern about the time and effort required in order to teach mathematics and science lessons through experiential and constructivist approaches. Vivian commented on how "time consuming," the preparation was and Alexis said, "There is probably not always enough time for an experiment," reflecting the challenge of integrating hands-on science lessons into the daily school schedule.

Mathematics and science courses as a means for change. The preservice teachers stated in their final e-journals that the methods courses had helped them learn the subject content, strategies to teach mathematics and science content to young children; thus, increasing their confidence in their ability to understand and master the content and. By the end of the semester, their ability to

teach children mathematics and science had also improved. Taylor for example described her experience by stating the following:

> I was hesitant but I learned so much about using manipulatives and exploration with science through the courses and my mentor. I feel that I can use these tools and the knowledge that I gained to have a successful math[ematics] and science learning in the classroom. I have gained so much knowledge through the courses. The ideas and different methods have given me the confidence and assurance.

Likewise, Leila affirmed, "I learned so many things about math[ematics] and science through readings and hands-on activities that made me fully competent to teach math[ematics] and science." Olivia commented that the class was "very resourceful," and Skylar expanded on that by stating, "I have learned how to approach both the math[ematics] and science curriculums, where to find resources, how to teach math[ematics] and science in a hands-on constructivist way, and how to engage children in facilitating their own learning." Alexis indicated that her perceptions had changed and continued that "At first I was apprehensive, now I feel more prepared."

Other students were slightly more cautious, "I do not feel I know the way to teach everything, but I have the resources to look back" (Alexandra). The preservice teachers' statements seemed to demonstrate a clear and reasonable confidence in mathematics and science content and teaching at the end of the semester.

The use of experiential learning or hands-on activities was the most commonly referred to benefit of the methods courses. The preservice teachers expressed that the hands-on opportunities provided during the methods courses had helped them to understand and learn the subject content. These activities also demonstrated how mathematics and science content were both learnable and teachable. They were able to transform their own hands-on, constructivist learning experiences into lessons with their students in their field placements. Savannah reported, "I learned using hands-on activities, and I used them in my unit and found them to be very helpful." Similarly, Alicia indicated that "I keep in mind that teaching them is hands-on and minds-on." Then, Olivia stated that she learned how to make mathematics more fun for the students using manipulatives and games. Thus, it seems that the preservice teachers taught their students using the same strategies they learned in the methods courses.

The majority of the preservice teachers expressed improvement in their perceptions and self-efficacy related mathematics and science by the end of the semester. They iterated that they felt more confident in the teaching and content of the mathematics and science after completing the methods courses and their two-week unit. "I have become more comfortable with mathematics after the two-weeks teaching" (Alicia). On the other hand, a few preservice teachers reported an increased anxiety regarding mathematics and science teaching and content. "I did not realize how

simple I needed to make things for the children. I think teaching math[ematics] is harder" (Diana).

Discussion and Conclusion

In the current study, we explored early childhood preservice teachers' perceptions of the teaching and content of mathematics and science. In doing so we examined whether attending and participating in integrated mathematics and science methods courses led to changes in their overall perceptions. Our findings support and extend previous research in the following areas: 1) preservice teachers' bring their belief systems along with them as they enter teacher education programs (i.e., Halpin, 1999; Hunker & Madison, 1997); 2) preservice teachers' beliefs have been shaped by their experiences as students in both elementary and secondary school years and these beliefs are often negative towards science and mathematics content areas (Kiviet & Mji, 2003; Sottile, et al., 2002; Tosun, 2000); 3) preservice teachers need support in order to change their perceptions (Bandura, 1997; Kiviet & Mji, 2003; Plourde & Alawiye, 2003); and 4) carefully structured methods courses can change or alter preservice teachers' perceptions and beliefs (e.g., Cakiroglu, & Boone, 2002; Kiviet & Mji, 2003). Additionaly, the findings contribute to the research by specifically studying early childhood preservice teachers, a largely underrepresented population.

Participating in the integrated methods courses challenged the early childhood preservice teachers to confront their content bias and anxieties. The integrated nature of the courses required the students to reflect on their beliefs and practices, and allowed them to take part in scaffolding experiences with their teacher educators and mentors. In turn, these activities seemed to have altered the preservice teachers' beliefs and attitudes by the end of the semester. This finding is consistent with previous studies that have found that an integrated methodology improves preservice teachers' beliefs about mathematics and science content (i.e., Berlin & White, 2002; Foss & Pinchbach, 1998; Haigh, & Rehfeld, 1995; Hart, 2002; Kelly, 2001; Koirala & Bowman, 2003), and decreases levels of anxiety (Cady & Rearden, 2007; Lake, Jones, & Dagli, 2004). The content of the preservice teachers' e-journals revealed that their perceptions and beliefs about mathematics and science content and teaching had improved during the semester.

Citing beliefs rooted in their student years and prior positive and negative experiences related to mathematics and science, the preservice teachers worked throughout the semester to reconcile their old beliefs with their growing perceptions of themselves as effective teachers. These preservice teachers stated that an effective teacher was one who was enthusiastic to teach, and one that ignited students' enthusiasm to learn. Moreover, they believed that the effective teacher is one who engages students so that they are interested in the various subject areas. At the same time, the preservice teachers felt that a teacher should be entertaining and creative, use hands-on approaches, and incorporate experiments. Other preservice teachers maintained that the qualities of an effective teacher include the ability to impart knowledge to very young children and have

sufficient knowledge in the subject area, particularly in the area of science. These qualities lend support to the consensus of opinion reported in recent literature addressing this topic (e.g., Fajet et al., 2005; Ng et al, 2009).

When analyzed more closely, the preservice teachers' examples implied that they gave greater importance to, and had greater self-efficacy in, the affective qualities of an effective teacher, as opposed to developing subject area competence. At the same time, they cited that one of their main concerns was breaking the subjects down to a child's level, and to make lessons meaningful for them. Such findings are encouraging, particularly for teacher educators.. Oftentimes, early childhood preservice *and* inservice teachers do not have adequate subject area training and/or knowledge, yet are thoroughly skilled in affective teaching (Cochran-Smith & Lytle, 1999). Our goal in the two methods courses was to scaffold the preservice teachers purposely in both areas. What others might see as contradictory, we view as positive evidence of our success.

Overall, the early childhood preservice teachers in this study expressed negative beliefs towards the content areas of mathematics and science before they entered the methods courses. Possibly, these beliefs stemmed from years of negative interactions with the subjects and teachers who taught them. However, after completing the methods courses and two-week teaching unit, the early childhood preservice teachers' perceptions and beliefs towards mathematics and science improved (i.e., Erickson, 1995; Foss & Pinchbach, 1998; Haigh, & Rehfeld, 1995; Hart, 2002; Kelly, 2001). In order for teacher educators to impact, change, and improve the well established beliefs of their preservice teachers, methods courses must be carefully analyzed to meet the needs of the students. As revealed in the final e-journals, our preservice teachers felt that the hands-on experiences and strategies utilized in the methods classes were critical elements that contributed to their growth. The mathematics and science methods courses were designed to balance content and teaching strategies using both theory and hands-on experiences. Equally important was having the preservice teachers' reflect, via their e-journals, on both the content and strategies and the two-week unit that required our students to teach their lessons in the field. For early childhood teacher education, all of these elements are necessary components for methods classes in order to change preservice teachers' perceptions and beliefs.

As with any research endeavor, our study had several limitations. All preservice teachers enrolled in the early childhood education program were females; thus, we were not able to study gender differences. Future research that explores preservice teachers' concerns and challenges, in addition to the factors that influence their' perceptions should shed more light on this topic. Follow-up studies that explore how preservice teachers teach mathematics and science after graduating from a teacher education program, could yield information on the effects of their preparation program on their beliefs and teaching strategies. Finally, a quantitative pre-post research design with explicit emphasis on self-efficacy beliefs in mathematics and science could provide more precise findings.

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