DO PRE-SERVICE TEACHERS' BELIEFS AND CLASSROOM PRACTICES TOWARDS MATHEMATICS CHANGE WHEN THEY BEGIN TEACHING?

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by

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ABSTRACT

The purpose of this research was to follow up on university education majors once they leave UTEP and are expected to implement certain methods of teaching mathematics in their own classrooms. Two former education majors were the focus of this study. Data gathered from three sets of interviews with these teachers – one conducted right after university coursework, another after these teachers had one semester of teaching experience, and the final interview conducted at the end of the first year of teaching – were analyzed to determine if changes in these teachers' beliefs about teaching mathematics or in their classroom practices took place from the time they finished at UTEP to the end of their first year of teaching. Results show that some differences do occur in these teachers' beliefs and classroom practices, yet some remain constant. Also, results are not consistent between the two teachers who took part in this study.

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CHAPTER 1
INTRODUCTION

Throughout the last century, researchers in mathematics education claim that our ways of teaching mathematics and mathematics education need to be improved. In an interview done by Pool (1997), Caine stated, "the system of traditional education can be a threat that inhibits higher levels of learning" (para. 8). It was stated that Caine "connected the latest cognitive and neurological research to education" in order to find a way to maximize learning based on how the brain learns best (Pool, 1997, para. 1). Caine used the term "brain-based learning" to refer to this type of maximized learning. According to Pool's interview, children learn best when they are in a community, follow their own interests, and are constantly questioned and challenged. An example of implementing brain-based learning is when teachers ask real, live, critical questions that engage students mentally and are not necessarily in the book or workbook. These results are contrary to traditional approaches to teaching where students simply perform perfunctory routines and generate responses they know will be pleasing to the teacher.

Battista (1994) referred to a traditional approach to teaching mathematics as a "curriculum that is seriously damaging the mathematical health of our children" (para. 1). He stated that the traditional view of mathematics is that of a set of procedures to follow to obtain a specific result. This belief has led to mathematics teaching that focuses on computation, not on mathematical thinking. This way of teaching mathematics is a behaviorist approach, which means attention is given to observable behaviors, and in this case, the observable behaviors are simply the solutions to mathematics problems. According to research, however, instruction based on a behaviorist approach has been found to be deficient. Battista's (1994) research has also indicated that a traditional approach to teaching contradicts the way most students learn best and is ineffective.

Even the National Council of Teachers of Mathematics (NCTM) recognized the need to put an end to "mindless mimicry mathematics" (Battista, 1994, Reform Movement section, para. 1). NCTM called for reform in the mathematics classroom that involves abandoning mathematics curriculum that focuses on following a given set of rules and procedures that are

usually memorized. Opposed to this view of mathematics as a set of following procedures, Battista (1994) reported the following on NCTM:

> Proponents of reform envision classrooms in which students have numerous and various interrelated experiences which allow them to solve complex problems; to read, write, and discuss mathematics; to conjecture, test, and build arguments about a conjecture's validity; to value the mathematical enterprise, the mathematical habits of mind, and the role of mathematics in human affairs; and to be encouraged to explore, guess, and even make errors so that they gain confidence in their own actions. (Reform Movement section, para. 2)

NCTM has reported that a proper mathematics curriculum will reflect "conceptual understanding, reasoning, and problem solving" (Battista, 1994, Reform Movement section, para. 4).

Although research has indicated that traditional teaching approaches are not the best for maximizing students' learning, many teachers still use the traditional approach to teaching mathematics (Pool, 1997; Battista, 1994; Feiman-Nemser 2001). This may be due in part to the fact that teachers create a picture of what teaching and learning should be like from their own school experiences (Lortie, 1975) and most teachers themselves were taught in a traditional manner. This fact makes it difficult and challenging to switch to something that is neither comfortable nor familiar (Feiman-Nemser, 2001; Pool, 1997; Windschitl, 1999).

Other research shows that teachers cannot effectively implement new approaches to teaching mathematics because of their own preconceived views of mathematics (Hersh, 1986; Battista, 1994). Because teachers themselves view mathematics as a set of computations to follow in order to obtain a specific result, they view teaching mathematics as demonstrating to students how to follow these specific procedures. Also, teachers may not have the proper mathematical knowledge needed to teach in this reformed manner (Ball, 1988; Thompson, 1992). In order for teachers to implement reform, they must gain new knowledge that their traditional beliefs had prevented them from acquiring before (Battista, 1994).

Furthermore, teachers may have a hard time breaking away from the traditional approach to teaching because they are influenced by others to follow this traditional style. Some school officials, politicians, and parents view mathematics as a set of procedures to follow and thus,

promote the teaching of mathematics in this fashion, making it more difficult for teachers to change (Battista, 1994).

Caine argued that although change out of the traditional methods of teaching is difficult, it is definitely important if the new approaches maximize students' learning. Caine discussed with Pool (1997) that she set out to show teachers how to implement a brain-based approach to teaching in the classroom. Soon after this took place, the district in which these teachers worked mandated a new program that was not consistent with the brain-based approach to learning. As a result, the teachers stopped using the new strategies on brain-based instruction and carried out the district's program. It was concluded that they did not continue with the brain-based approach out of fear of and passivity to the school district.

Research has shown that there are many challenges teachers face when trying to implement what Caine described as brain-based learning, or what others term, a constructivist approach (Feiman-Nemser, 2001; Pool, 1997). The first years of teaching are an adjustment period when teachers are learning and discovering new things and trying to adapt to their new role and environment (Feiman-Nemser, 2001). Teachers are working to gain acceptance from their colleagues, control of their situation, and credibility in their new profession (Fuller, 1969; Kagan, 1990). However, if change in the classrooms is going to take place, it will only come about as a result of the educators' actions (National Commission on Teaching and America's Future, 1996; Pool, 1997; Battista, 1994).

One answer to help encourage teachers to implement the methods of the reformed teaching of mathematics, despite the many challenges they face, is proper in-service teacher training (Feiman-Nemser, 2001; Battista, 1994). Gray (2001) believes that proper in-service training is one in which teachers are also taught in the constructivist approach. Gray (2001) stated the following:

> Advocates for change, among them constructivists, argue that schools must build on students' prior knowledge and adapt standardized curricula to encourage students to find and make meaning for themselves. For that to happen, teachers must be taught in the same manner. (p. 16)

It has also been suggested that a teacher mentor program would help teachers better transition into the field of teaching. New teachers would be assigned a mentor – a more

experienced teacher at the same school who was also trying to implement a reformed way of teaching mathematics. This mentor would serve as a support and guide to the new teachers and be willing to offer advice and help the beginning teachers deal with some of the challenge they will have to face (Feiman-Nemser, 2001).

Research shows that proper pre-service instruction can also help with the reform movement. This would include a program that helps pre-service teachers reexamine their beliefs about teaching and create images of what proper teaching should look like. According to Windschitl (1999), "[Constructivism] is a culture – a set of beliefs, norms, and practices that constitute the fabric of school life" (Constructivism as Culture section, para. 2). Thus, teachers' performance in the classroom can more easily change when their beliefs about mathematics and mathematics teaching change (Thompson, 1992). This means that teacher preparation courses must positively impact teachers' beliefs in order to be successful at influencing their teaching practices (Feiman-Nemser, 2001).

It is also important for pre-service teachers to experience being the students in a constructivist, reformed manner. If teachers are going to be expected to implement certain teaching methods in their own classrooms, it is important for them to experience mathematics in the same way their students should (Gray, 2001; Lindquist and Elliott, 1996). Thus, pre-service teacher education programs must be taught in the same way the students will be expected to teach when they enter their own classrooms.

It has been said that another element of the pre-service teacher curriculum should be more proper mathematics education. Teachers' beliefs are important in influencing their classroom practices, but if one does not have the proper mathematical knowledge he will not be able to successfully teach the subject (Thompson, 1992). According to the National Commission on Teaching and America's Future (1996), "What teachers know and can do makes the crucial difference in what teachers can accomplish" (p. 5). Ball (1988) states that even pre-service teachers are aware of the importance of possessing a better understanding of mathematics if they are expected to teach it properly. If teachers properly understand mathematics and are shown new methods for teaching mathematics, teachers may lead the way in implementing new approaches to teaching when they enter the classrooms (Battista, 1994).

Feiman-Nemser (2001) also reports that a proper pre-service teacher program is one in which there is a partnership between university faculty who teach content courses and those who are responsible for student teaching, or field experience. Integrating course work with field work allows student teachers to more easily apply what they are learning in their classrooms to the lessons they are presenting at their training school. If university education courses are set up in a reformed or constructivist manner, pre-service teachers can more easily conduct their fieldwork in this manner and receive support from university faculty.

Proper pre-service and in-service training is important to help the reform effort, but some suggest that it is not one or the other that makes the most difference, but the combination of the two (Feiman-Nemser, 2001). Learning to teach takes time and it does not end when pre-service teachers graduate from university course work. Teachers learn the most once they actually start their career, so it is important to have proper training at all levels and create "a curriculum for learning to teach over time" (Feiman-Nemser, 2001, Summary and Conclusions section, para. 1).

Problem

Research has shown that proper instruction for pre-service teachers may result in proper mathematics instruction for the students of these future teachers (Feiman-Nemser, 2001; Battista, 1994). Several pre-service education programs are implementing constructivist methods of teaching and encouraging future educators to implement these methods in their classrooms. At the university where the research took place, a pedagogical approach to teaching titled *An Integrated, Collaborative, Field-Based Approach to Teaching and Learning Mathematics* is being implemented in education and mathematics courses and offered in a cohort setting for pre-service teachers (Dogan-Dunlap, 2006). In this program, faculty who teach content courses and those who are responsible for fieldwork, work in collaboration with one another. The goal of this approach is to enhance pre-service teachers' mathematical knowledge by making positive changes on their attitude towards and perception of mathematics. It is expected that a positive attitude towards mathematics will result in an increase in motivation and confidence to learn and think mathematically (Conte, 1991; Zentall & Zentall, 1983). The expectation is that pre-service teachers with enhanced content knowledge and higher confidence will graduate future students

with not only a better understanding of mathematics but also with a positive attitude toward and perception of mathematics.

Research has shown that students who take part in the *Integrated, Collaborative, Field-Based Approach to Teaching and Learning Mathematics* may experience a positive change in attitude towards mathematics and may be more motivated to teach mathematics and implement the methods in their classrooms (Dogan-Dunlap, 2006).

Although research has been done on the attitudes of pre-service teachers while they were a part of university instruction and it has been shown that this pedagogical approach has been successful in changing the attitudes and perceptions of many of the pre-service teachers in mathematics, there has not been any investigation on the success of these pre-service teachers in implementing these approaches or methods in their own classrooms. Just a few studies have been conducted on other teacher education programs to show whether these programs promote change or explore the empowerment of teachers (Whitney, Golez, & Nagel, 2002). This study looks at what happens when two former students of the *Integrated, Collaborative, Field-Based Approach to Teaching and Learning Mathematics* graduate and begin teaching.

Rationale

If pre-service teachers are graduating from university instruction after having learned methods to teach mathematics that promote true understanding and appreciation of the subject matter, yet if they are not implementing these methods to their classrooms and promoting the same mathematical knowledge and positive attitude towards mathematics to their students, then the efforts of the university instructors are not truly a success. "Teachers are key to the success of the current reform movement in U.S. mathematics education" (Battista, 1994). It must be determined whether these teachers are able to overcome factors and be successful at implementing university practice.

Implications

This study has implications for many involved in the education field. First, there are implications for university pre-service educators. They will learn if their efforts to encourage pre-service teachers to carry out certain methods in their classrooms have been a success. Many

pre-service teacher educators do not follow their students into the classroom, thus they do not know if their former students are applying what they learned while they were with them. If there is something that is preventing teachers from applying these methods then those factors can be identified and adjustments can be recommended in order to be successful in the implementation of the methods learned at the university.

Pre-service and in-service teachers can also benefit from this study. They can learn whether (what kind of) changes occur once the transition is made from pre-service to in-service teaching. Once they are aware of these changes (if any) they can make adjustments in order to ensure that proper mathematics instruction continues to take place.

Administrators will have a better understanding of teaching practices that university instructors are trying to promote and that their teachers are attempting to integrate in the classroom. If this is not taking place, then they can help teachers in doing implementation. This may promote communication between university faculty and school administrators. If pre-service teachers are walking into classrooms with ideas on how to teach mathematics, yet their administrators are promoting other methods, then there is conflict. If all those involved in education work together, then more success can be achieved.

Research Question

This focus of this study is to address the following question and sub-questions:

Do pre-service teachers' beliefs and classroom practices towards mathematics change when they begin teaching?

Sub-Question One

How do teachers' initial plans for teaching mathematics compare with their actual classroom practices?

Sub-Question Two

Are former UTEP education students implementing what they learned at UTEP in their classrooms?

Sub-Question Three

Do attitudes of pre-service teachers towards teaching mathematics change once they step into the classroom?

CHAPTER 2

LITERATURE REVIEW

Turn Away From Traditional Teaching

Successful classrooms used to be described as, "those where the teacher talks and students speak only in response to questions to which the teacher already knows the answers;… we looked for orderly chairs, straight rows, and teachers in charge" (Lindquist & Elliott, 1996, para. 14). Lindquist and Elliott also stated that unfortunately, too many mathematics classrooms in the United States are still set up in this manner: "check the homework, show how to do the next set of exercises, and have students begin the exercises" (para. 15). This is also called the "reciting" approach by some researchers (Kilpatrick, Swafford, & Findell, 2001). Feiman-Nemser (2001) described this type of conventional classroom as one in which the teacher talks and the students learn merely by listening to the teacher.

In this type of classroom, the focus of the mathematics curriculum is given to computation. This view of mathematics has been termed behaviorism, which means attention was on obvious behaviors, such as correct answers and procedures, and no attention was given to mathematical thinking. Battista (1994) further described the perspectives of the behaviorist teachers:

> Mathematics educators of the past lamented the fact that students often did not understand concepts or why certain procedures worked. But there seemed to be universal agreement that computation was important. Computational topics drove the mathematics curriculum, especially in the elementary years. (Reform Movement section, para. 3)

Extensive research has shown that this traditional approach to teaching mathematics is now obsolete and unproductive, and behaviorist approaches to teaching have been found to be insufficient (Battista, 1994). The type of mathematics instruction in which meaning is not emphasized "misrepresent[s] mathematics to the students… [and] also accounts in large part for their poor performance in national and international assessments" (Thompson, 1992, p. 128). According to research done by Renate Nummela Caine, "The system of traditional education can

be a threat that inhibits higher levels of learning" (as cited in Pool, 1997, para. 8). She and Geoffrey Caine "have connected the latest cognitive and neurological research to education" (para. 1). In an interview conducted by Pool (1997), Caine discussed her ideas of brain-based learning, which refers to maximizing learning by understanding how the brain works best. Caine's studies led her to develop "12 learning principles that emphasize connections and patterns our brains make" (para. 2). According to her results, in order for children to learn best, they need to be in a community, follow their own interests, and they need to constantly be questioned and challenged. This is contrary to traditional approaches to teaching, where students simply produce perfunctory routines and generate responses they know the teacher wants (Pool, 1997).

Devlin (1999) stated that when simple computation is emphasized over other problem solving strategies in a mathematics classroom, students turn away from it because it causes mathematics anxiety in many of them. He declared that students' attitudes towards mathematics will change when less focus is placed on these procedural skills and more importance is given to the concepts behind the rote computations. He emphasized that the objective of a mathematics curriculum is not to turn students' away from mathematics, but to help them understand and appreciate mathematics.

Recognizing the need for change in the mathematics classroom, the National Council of Teachers of Mathematics (NCTM) called for reform in the mathematics classroom. One of the goals was to abandon the idea that mathematics is simply a rigid system in which rules are followed to produce a pre-determined response and extra emphasis is given to "accuracy, speed, and memory" (as cited in Battista, 1994, Reform Movement section, para. 1). According to NCTM, proper mathematics does not involve thoughtless drills and tests of memorized computations.

Sawyer (1999) commented on an interesting theory he came across in Ghana. It stated that there are two parts to every subject: "One is the husk, the subject as seen from the outside by the uninitiated; the other is the kernel, the essential meaning of the subject, as perceived by those who had found the way to the heart of it" (para. 1). According to this theory, most of the teachers who came to America in the middle of the 20th century were husk teachers. They taught mathematics as seen only from the outside, not looking deep into problems, but simply carrying

out instructions to obtain specific results. This approach was believed to portray mathematics as uninteresting, beyond understanding, and fearsome. Contrary to this method, the kernel method of teaching allowed students to understand the problems they faced and make sense of the solutions, thus, inspiring them to engage in new questions and mathematical understanding. Sawyer (1999) stated his support of what is termed the kernel method, which parallels some of the ideas of the reformed mathematics curriculum of today.

How Mathematics Should Be Taught

Instead of the traditional style of teaching mathematics, supporters of change have expressed their thoughts as to what a proper mathematics classroom should resemble. One of the main emphases of change is to throw out the "mathematics-as-computation" driven curriculum and replace it with one in which students obtain a good understanding of the mathematical concepts and are able to reason and think through problems (Battista, 1994).

A constructivist approach to teaching has been found to be more effective than the former behaviorist approach. Windschitl (1999) clearly described the constructivist setting when he stated:

> Constructivism is premised on the belief that learners actively create, interpret, and reorganize knowledge in individual ways. These fluid intellectual transformations occur when students reconcile formal instructional experiences with their existing knowledge, with the cultural and social contexts in which ideas occur, and with a host of other influences that serve to mediate understanding. With respect to instruction, this belief suggests that students should participate in experiences that accommodate these ways of learning. Such experiences include problem-based learning, inquiry activities, dialogues with peers and teachers that encourage making sense of the subject matter, exposure to multiple sources of information, and opportunities for students to demonstrate their understanding in diverse ways. (Constructivism as Culture section, para. 1)

Feiman-Nemser (2001) described a constructivist approach to teaching as one in which students "construct" or develop an understanding of mathematics on their own. Attention is placed on conceptual understanding and students are able to think critically. Teachers are called to talk less and listen more to students as the students share and explain their understanding of mathematics, which is gained from meaningful investigation and problem solving.

Lindquist and Elliott (1996) referred to NCTM's five expectations for a sound mathematics classroom:

- Students working together to make sense of mathematics
- Students relying more on themselves to determine whether something is mathematically correct
- Students learning to reason mathematically
- Students learning to conjecture, invent, and solve problems
- Students learning to connect mathematics, its ideas, and its applications (para. 16)

According to other research, an appropriate classroom setting is one in which students and teachers share the responsibility of the class. Teachers have on-hand a wide variety of teaching and learning strategies. In this classroom, there never ceases to exist questioning and analysis, and both students and teachers constantly seek to discover answers to their questions, resulting in students and teachers learning together (Pool, 1999).

Others in favor of reform in the mathematics classroom have reported that mathematics involves a great deal of thought processing and reasoning. Thus, teachers should guide their students into being able to make sense of the mathematics presented. They envisioned a mathematics classroom as one in which students are able to:

> …solve complex problems; to read, write, and discuss mathematics; to conjecture, test, and build arguments about a conjecture's validity; to value the mathematical enterprise, the mathematical habits of mind, and the role of mathematics in human affairs; and to be encouraged to explore, guess, and even make errors so that they gain confidence in their own actions. (Battista, 1994, Reform Movement section, para. 2)

Thompson (1992) states that a mathematics classroom should be:

> … one in which students engage in purposeful activities that grow out of problem situations, requiring reasoning and creative thinking, gathering and applying information, discovering, inventing, and communicating ideas, and testing those ideas through critical reflection and argumentation. (p. 128)

Change Is Difficult

As it has been stated, much research has shown that a change out of the traditional style of teaching is necessary to enhance students' learning and understanding of mathematics.

However, research has also shown that this transition from traditional education is difficult, and in some cases, is not taking place (Feiman-Nemser, 2001; Pool, 1997).

One of the reasons why a shift in our mathematics curriculum is difficult to undertake is because most teachers grew up in traditional settings and this is with what they are most familiar (Pool, 1997). As Windschitl (1999) indicated, "Most of us are products of traditional instruction; as learners, we were exposed to teacher-centered instruction, fact-based subject matter, and a steady diet of drill and practice" (Images of Teaching section, para. 1). Battista (1994) added "almost all current teachers were educated at the elementary, secondary, and university levels in curricula that promoted the conception of mathematics as procedures rather than as sense-making" (Reasons for Teachers' Beliefs section, para. 1). Most higher education courses follow the traditional style of teaching – students sit and listen to the lecture, trying to retain the information that the professor is relaying. Successful completion of most university courses requires students to regurgitate the information that was presented in a lecture.

Teachers create a picture of what teaching, learning, and students are supposed to be like from their own elementary and secondary school experiences (Lortie, 1975). Calderhead & Robson (1991) reported that many pre-service teachers view the role of teaching as relaying information and they define learning as taking in and memorizing what is presented. These images and preconceived beliefs with which pre-service teachers begin their teacher preparation courses makes it more difficult for them to adapt new ideas and be ready to implement new ways of teaching (Feiman-Nemser, 2001).

It has also been reported that teachers are so used to traditional methods that they even expect their teacher in-service trainings be conducted in a traditional manner. According to Gray (2001) when a teacher in-service training was set up in a constructivist manner, the teachers felt uneasy. They wanted more structure and "they expected to sit passively and listen to an instructor tell them exactly what to do, how to do it, and on what topic to do the unit" (Gray, 2001, p. 16). Because teachers have been exposed to this type of teaching method throughout their educational experiences, they are more likely to be guided by these powerful and very familiar images when they enter into their own classrooms (Windschitl, 1999).

Teachers are not the only ones who feel more comfortable with a traditional classroom setting. It has been shown that most members of the community also favor an approach to

teaching mathematics that is based on procedural knowledge. As stated by Battista (1994), "Unfortunately, the prevailing view of educators and the public at large is that mathematics consists of set procedures and that teaching means telling students how to perform those procedures" (Reform Movement section, para. 7). He continued:

> The school environments in which teachers now teach demand this rule-based view of mathematics. Their mathematics textbooks support it. State and district testing programs assess adherence to it. Most parents, school officials, and politicians -- all of whom dictate curricula to teachers -- also see mathematics as sets of rules to follow. (Reasons for Teachers' Beliefs section, para. 1)

Because so many people who influence educators also have a view of mathematics as a set of procedures to follow, they will be weary of new methods that are so unlike the ones they grew up with throughout their schooling (Windschitl, 1999), thus making it more difficult for teachers to step out of this view and begin an unfamiliar approach.

Before change can take place in the classroom, teachers must first change the way they view mathematics. As stated by Hersh (1986), "One's conception of what mathematics is affects one's conception of how it should be presented" (p. 13). In order to transform what goes on in the mathematics classroom, teachers need to adjust their ways of teaching, and their approaches to teaching can be modified when teachers' conceptions about mathematics change (Thompson, 1992). These new approaches are not simply instructional methods that can be added onto the existing curriculum. "Rather, [constructivism] is a culture – a set of beliefs, norms, and practices that constitute the fabric of school life" (Windschitl, 1999, Constructivism as Culture section, para. 2). As a result, prior to the occurrence of change, teachers must first adopt new beliefs, and it is difficult to implement new beliefs on some teachers, as it requires a change in some of their values. Battista (1994) commented on the importance of teachers' beliefs to the reform movement:

> However, many teachers have beliefs about mathematics that are incompatible with those underlying the reform effort. Because these beliefs play a critical role not only in what teachers teach but in how they teach it, this incompatibility blocks reform and prolongs the use of a mathematics curriculum that is seriously damaging the mathematical health of our children. (para. 1)