INVESTIGATION OF JORDANIAN PRE-SERVICE TEACHERS' BELIEFS ABOUT LEARNING AND TEACHING OF MATHEMATICS

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INVESTIGATION OF JORDANIAN PRE-SERVICE TEACHERS' BELIEFS ABOUT LEARNING AND TEACHING OF MATHEMATICS

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ABSTRACT

This study investigated Jordanian pre-service teachers' beliefs about the learning and teaching of mathematics. One aim of the study was to identify possible explanations for why Jordanian students score much lower than many of their global counterparts on international mathematics tests. On the 2007 Trends in International Mathematics and Science Study (TIMSS), Jordanian eighth-graders' average score was 427, far below the TIMSS scale average of 500. Jordan ranked 31st out of the 48 participating countries. On the 2011 TIMSS, Jordanian eighth-graders' average dropped to 406, and Jordan's overall ranking was 49th out of 56 participating countries and education systems.

In addition to investigating Jordanian pre-service teachers' beliefs, the findings were compared to the findings from a similar study in South Korea (Kim, 2009), the top performing country in mathematics in 2011 and second overall in 2007 on the TIMSS assessments.

The participants in this study were 441 pre-service teachers enrolled in 5 universities in Jordan, four public and one private. Participants' data were collected using a questionnaire survey, the same instrument that was used in the Korean study of 2009.

Nearly 95% of the Jordanian participants believed in the existence of a mathematical mind indicating that they view mathematics ability as fixed or stable. Other strong beliefs were about the importance of memorization, gender, and mathematics ability. Specifically, 65% of the participants believed that the best way to learn mathematics was to memorize all the formulas, and nearly 70% believed that math ability was not associated with a specific gender.

The comparison between Jordanian and Korean pre-service teachers produced significant results about the necessity for memorization and the belief in multiple methods for doing mathematics. Jordanian pre-service teachers believed strongly in the need to memorize in mathematics and in the existence of a single correct way to do mathematics. These are beliefs are not held by Korean pre-service teachers.

APPROVAL PAGE

The faculty listed below, appointed by the Dean of the School of Graduate Studies, have examined a dissertation titled "Investigation of Jordanian Pre-service Teachers' Beliefs About Learning and Teaching of Mathematics" presented by Adeeb M. Jarrah, candidate for the Doctor of Philosophy degree, and certify that in their opinion it is worthy of acceptance.

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CONTENTS

ILLUSTRATIONS

TABLES

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CHAPTER 1

INTRODUCTION

Teachers' beliefs are one of the critical components in determining teachers' practices and their level of effectiveness in the classroom (Ball, 1990a; Bizwick, 2007; Cross, 2009; Haser and Star, 2004; Thompson, 1992). Research on teachers' beliefs has shown direct impact from these beliefs on the performance of teachers and on the achievement of their students. The direct link between student achievement and teachers' beliefs has been investigated and documented over the past twenty years (Hofer 1999; House 2006; Koller, 2007; Mason, 2003; Mason & Scrivani, 2004). The study of in-service and pre-service teachers' beliefs is essential because research indicates that teachers' beliefs influence their practice, their students' beliefs and attitudes, and, perhaps most importantly, student achievement (Ball, 1990a; Bizwick, 2007; Cross, 2009; Haser & Star, 2004; Thompson, 1992).

Since research has indicated a link between teacher beliefs and student achievement, looking at the beliefs held by teachers could provide valuable information leading to increased student achievement. The primary justification for this study was the need to identify possible explanations for why Jordanian students score much lower than many of their global counterparts on international mathematics tests. According to the 2007 results from the Trends in International Mathematics and Science Study (TIMSS), Jordanian eighth-graders scored 427 on average in mathematics, which is much lower than the TIMSS scale average of 500. Additionally, Jordan ranked 31st out of 48 participating countries.

Furthermore, according to TIMSS 2011 results, the most current data and last administered cycle of TIMSS, Jordanian eighth-graders scored 406 on average which is a 21-

point decrease from their 2007 results. Jordan's overall ranking in 2011was 49th out of 56 participating countries and education systems.

Purpose of the Study

This study investigated Jordanian pre-service teachers' beliefs about mathematics. The results of this study provided information to address important questions regarding the teacher education program in Jordan and the beliefs of Jordanian teachers in the area of mathematics education. Additionally, this study explored the relationships between Jordanian pre-service teachers' beliefs and a variety of other factors by investigating the teachers' beliefs in comparison with their gender, age, prior experiences, mathematics methods classes, and their parents' level of education.

Research Questions

This study was designed to answer the following research questions:

1. What are the Jordanian elementary pre-service teachers' beliefs about the teaching and learning of mathematics?
2. What is the relationship between Jordanian pre-service teachers' beliefs and the selected variables?
    a. How do pre-service teachers' beliefs about mathematics teaching and learning differ by their age and gender?
    b. How do pre-service teachers' beliefs about mathematics teaching and learning correlate with the number of mathematics courses completed previously?
    c. How do pre-service teachers' beliefs about mathematics correlate with their parents' level of education?
    d. Are there differences in the beliefs of pre-service teachers based on the number of years they have been at the university?

The proposed study was designed to replicate the methods used in a previous study by Kim (2009). Kim's work examined the beliefs held by pre-service teachers in South Korea and how they correlated with specific individual characteristics. According to the 2007 results from TIMSS, South Korean eighth-graders scored 597 on average, which is much higher than the TIMSS scale average of 500. Additionally, South Korea ranked second out of 48 participating countries. Comparing the beliefs of Jordanian pre-service teachers to those of South Korean pre-service teachers will provide valuable information as to the differences in beliefs of these individuals in high versus low performing countries. (More detailed information on Jordan's ranking compared to other countries is presented in table 1). Therefore, the final research question of this study is:

3. How do the beliefs of Jordanian pre-service elementary teachers compare to the beliefs of South Korean elementary pre-service teachers?

In addition to replicating Kim's study, there are other reasons for this comparison of Jordanian and South Korean pre-service teachers. First, South Korea consistently ranks near the top in international assessments of mathematics achievement. In the last 4 cycles of TIMSS, South Korea ranked first or second among participating countries (for more information see table 3). The second reason for the comparison is the similarity of the education systems in both countries. Teacher education programs in both countries are managed and controlled by the government. Furthermore, the governments in both countries determine the admission quota of every university on an annual basis as well as specifying curricula and coursework.

Another reason for wanting to compare Jordanian beliefs to Korean beliefs can be attributed to some cultural similarities. Both cultures place a high value on education, and both are considered male-dominated societies. In general, the emphasis on education is a backbone of

both cultures, but the reason behind that emphasis is different. Due to the lack of natural resources, Jordanians value education highly, considerate it to be the path for improving social, economic, and political conditions. Similarly, South Koreans value education and strive to ensure that their children are afforded the best available learning opportunities because they believe that there is "no alternative road to success except through education" (Sorensen, 1994, p. 27)

Additionally, both countries are considered male-dominated societies, despite the progress that women have made in recent years. Thus the influence of fathers is important in the students' beliefs.

Table 1

**Average Mathematics Scores of Eighth-grade Students of Selected Countries Participating in TIMSS 2007 Assessment*

Rank	Country	Average
1	Chinese Taipei	598
2	**Korea, Rep. of**	**597**
3	Singapore	593
4	Hong Kong SAR	572
5	Japan	570
6	Hungary	517
7	England	513
8	Russian Federation	512
9	United States	508
10	Lithuania	506
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	TIMSS scale average	**500**
30	Turkey	432
31	**Jordan**	**427**
32	Tunisia	420
33	Georgia	410
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44	Kuwait	354
45	El Salvador	340
46	Saudi Arabia	329
47	Ghana	309
48	Qatar	307

*Data excerpted from National Center for Education Statistics, 2009

As seen in Table 1, there are three main sections. The first section includes the top performing countries whose average score is above the TIMSS scale average. The second section shows Jordan and its average score compared to top performing countries. The last section shows low performing countries which are mostly Middle Eastern Countries.

The fifth and most recent administration of TIMSS was carried out in 2011. Jordan joined nearly 60 other countries and education systems in the study. The word "countries,"

applies to independent political entities, whereas "education systems" refers to a portion of a country, nation, kingdom, emirate, or other non-national entities (e.g., Massachusetts, Florida, Dubai, etc.). Specifically, 57 countries and education systems participated at grade 4 in 2011and 56 at grade 8.

As shown in table 2, Jordanian eighth-graders scored 406 on average in mathematics, which is much lower than the TIMSS scale average of 500 and a decrease of 21 points from their score in 2007. The average mathematics scores of 8th-grade students decreased from 2007 to 2011 in only 6 countries. Jordan had the second highest decrease. (See figure 1). Among the 56 countries and education systems which participated in the 2011 study, Jordan ranked 49th.

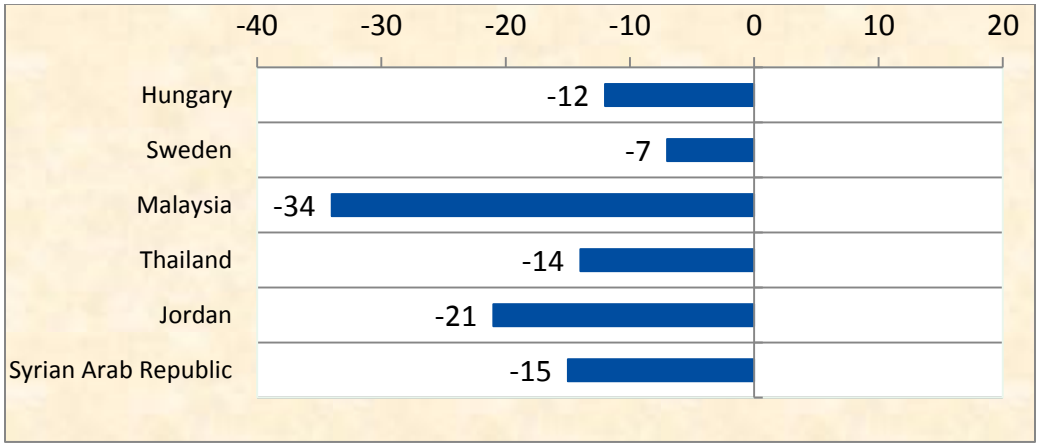

Figure 1: Countries with decreased scores from 2007 to 2011

Table 2

** Average mathematics scores of eighth-grade Students of Selected Countries Participating in TIMSS 2011 Assessment*

Rank	Country	Average
1	**Korea, Rep. of**	**613**
2	Singapore	611
3	Chinese-Taipei-CHN	609
4	Hong Kong-CHN	586
5	Japan	570
6	Massachusetts-USA	561
7	Minnesota-USA	545
8	Russian Federation	539
9	North Carolina-USA	537
10	Qubec-CAN	532
14	Israel	516
15	Finland	514
16	Florida-USA	513
17	Ontario-CAN	512
18	United States	509
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	TIMSS scale average	**500**
25	Italy	498
26	California-USA	493
31	Dubai-UAE	478
32	Norway	475
33	Armenia	467
34	Alabama-USA	466
35	Romania	458
36	United Arab Emirates	456
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43	Macedonia, Rep. of	426
44	Tunisia	425
45	Chile	416
46	Iran, Islamic Rep. of	415
47	Qatar	410
48	Bahrain	409
49	**Jordan**	**406**
50	Palestinian Nat'l Auth.	404
51	Saudi Arabia	394
52	Indonesia	386
53	Syria Arab republic	380
54	Morocco	371
55	Oman	366
56	Ghana	331

*Data excerpted from National Center for Education Statistics, 2011

While TIMSS was first administered in 1995 and every 4 years thereafter, Jordan did not start participating until 1999. Since then, Jordanian eighth-graders have scored 428, 424, 427, and 406.

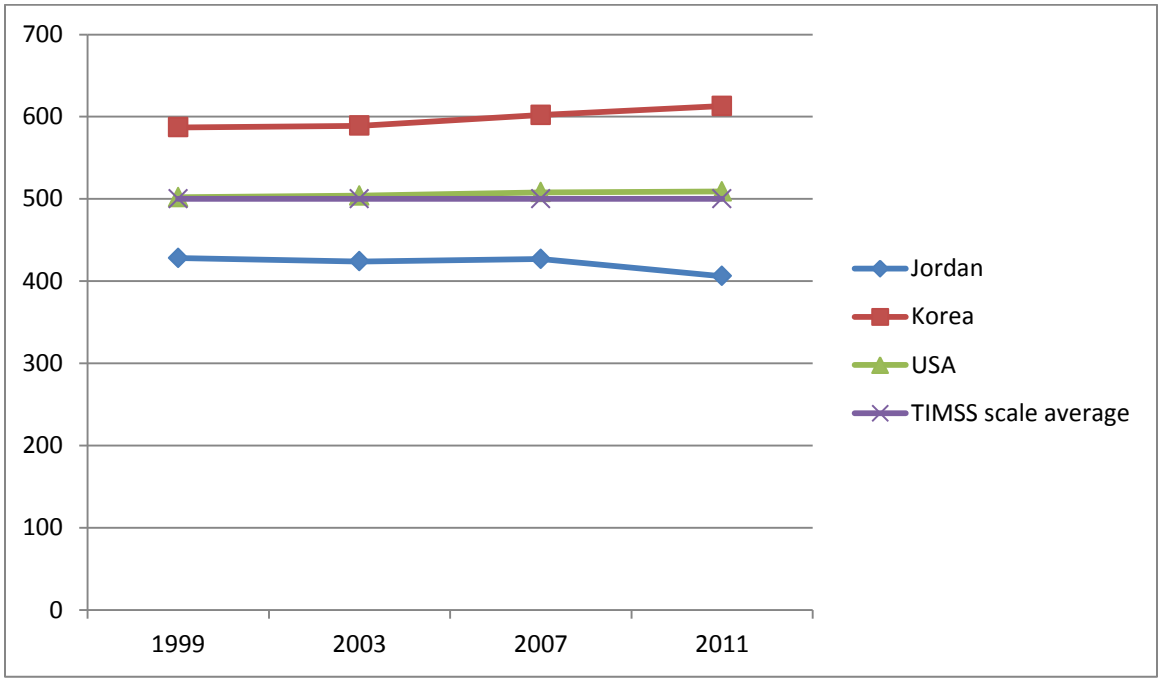

Figure 2: Change in Average TIMSS Scores over Time.

The results of the 2011 TIMSS study showed that the top performing countries have remained the same. Table 3 shows the top performing countries throughout the different TIMSS cycles. It is evident that East Asian countries continue to lead the world in mathematics achievement. At the eighth grade, Korea, Singapore, and Chinese Taipei outperformed all countries, followed by Hong Kong SAR and Japan. Similarly, Singapore, Korea, and Hong Kong SAR, followed by Chinese Taipei and Japan, were the top-performing countries in TIMSS 2011 at the fourth grade.

Table 3

** Top Performing Countries Throughout the Different Cycles of TIMSS at the Eighth Grade:*

Rank	1999	2003	2007	2011
1.	Singapore	Singapore	Chinese Taipei	Korea, Republic of
2.	Korea, Republic of	Korea, Republic of	Korea, Republic of	Singapore
3.	Chinese Taipei	Hong Kong SAR	Singapore	Chinese Taipei
4.	Hong Kong SAR	Chinese Taipei	Hong Kong SAR	Hong Kong SAR
5.	Japan	Japan	Japan	Japan
6.	Belgium-Flemish	Belgium-Flemish	Hungary	Russian Federation
7.	Netherlands	Netherlands	England	Israel
8.	Slovak Republic	Estonia	Russian Federation	Finland
9.	Hungary	Hungary	United States	United States
10.	Canada	Malaysia	Lithuania	England

*Data excerpted from National Center for Education Statistics.

Significance of the Study

This study advances the literature in mathematics education on the importance of the beliefs of teachers regarding the teaching and learning of mathematics. It also contributes to the growing field of international comparisons of beliefs. This study initiates the understanding of the role played by the beliefs of Jordanian pre-service teachers and how they may be affecting the mathematics achievement of Jordanian students. It is hoped that findings from this study will guide Jordanian universities in future reform efforts in the preparation of pre-service mathematics teachers which the research has shown, has a direct impact on student achievement.

Theoretical Framework

Teachers' beliefs have a profound influence on their classroom practices. As illustrated in Figure 3, in addition to curriculum and school setting, teachers' beliefs have a direct impact on classroom practices and students' beliefs. Furthermore, teachers' beliefs are considered a primary factor regarding the decisions teachers make on what should be taught and what path of instruction should be followed. Thus, if teacher preparation programs focus on teachers' beliefs,

encouraging healthy ones and challenging the unhealthy ones, students' achievement will be positively impacted.

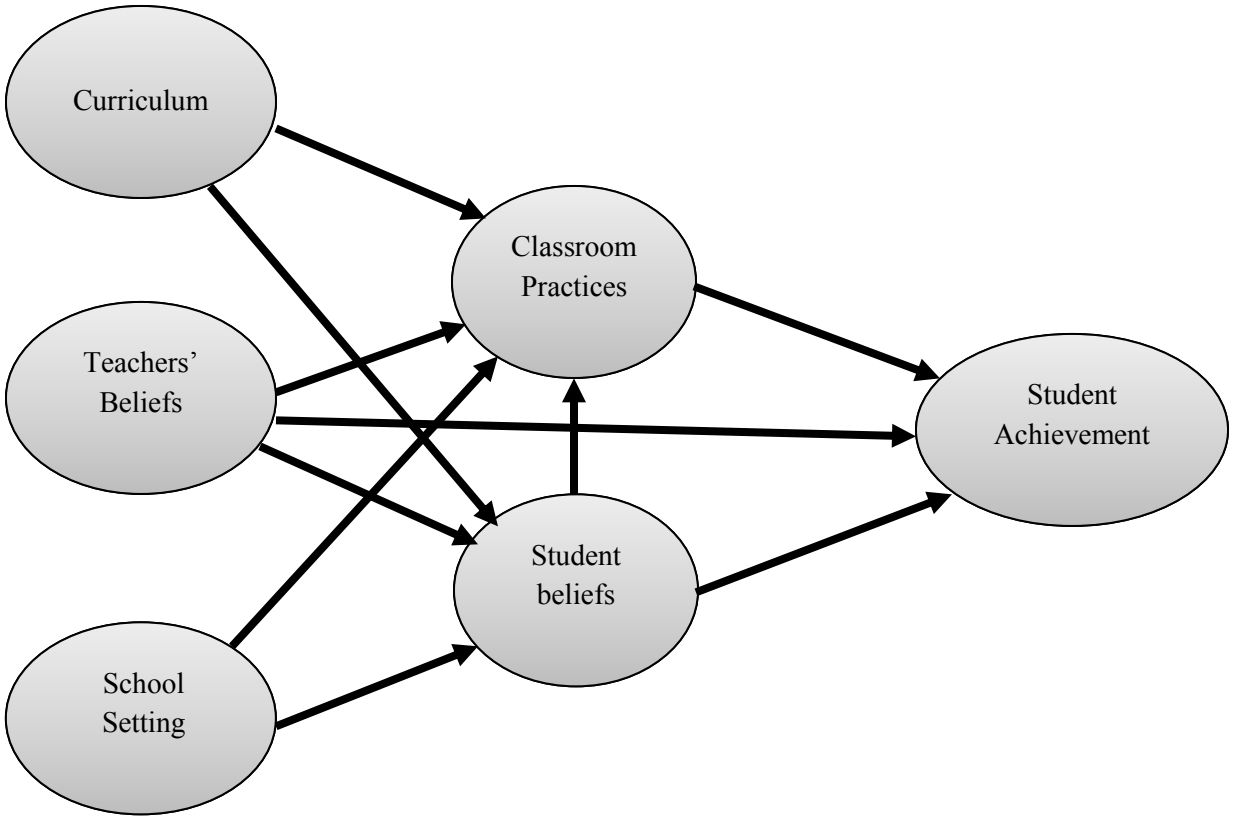

Figure 3: Factors Impacting Student Achievement.

Definition of Terms

For the purpose of this study, the following definitions are used:

Pre-service Teachers: Pre-service teachers are students enrolled in university courses designed to prepare them to teach in an elementary school. These courses are part of a program leading to elementary teacher certification

Teacher Beliefs: Teacher beliefs are teachers' assumptions about students, learning, classrooms, and the subject matter to be taught (Kagan, 1992).

Mathematics Methods Courses: Mathematics methods courses are classes pre-service teachers take during their education program. These courses are not only about subject matter within mathematics, they are also about children as learners of mathematics and about how mathematics can be learned and taught. Mathematics methods courses are considered the backbone of the teacher education program (Ball, 1990b).

Traditional Views of Teaching and Learning: The traditional views are based on direct transmission of knowledge by the teacher and absorption of knowledge by the students. In this view, students passively "absorb" mathematical structures invented by others and recorded in texts or known by authoritative adults. Teaching consists of transmitting sets of established facts, skills, and concepts to students.

Constructivist Views of Teaching and Learning: Within the constructivist view, students are active participants in the process of acquiring knowledge. Additionally, students work in groups and learning and knowledge are interactive and dynamic. Teachers who hold this view prefer to give students the chance to develop solutions to problems on their own, and allow students to play an active role in instructional activities.

MENA Countries: A region encompassing countries in the Middle East and North Africa. (Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates, West Bank and Gaza, and, Yemen.)

Delimitations of the Study

The researcher focused this study on pre-service elementary teachers enrolled in five universities in Jordan. Although other universities in Jordan could have been included, the researcher chose to limit the study to five universities to make data collection feasible. Additional information about the universities and their selection may be found in Chapter 3. In

addition, the researcher looked only at the beliefs of pre-service teachers, even though, it is recognized that there are other factors that also impact the performance of Jordanian students. Finally, the researcher chose to compare results from this study to those of a study in South Korea. Other countries could have been selected for comparison, but South Korea was chosen because students in South Korea typically perform very well on international mathematics assessments and pre-service teacher preparation programs are similar in both countries.

Limitations of the Study

A limitation of this study was that participants completed the survey on a voluntary basis. The interpretation of the items may vary among participants. Also, because the data in this study come from self-reported measures, there is always a concern about reliability and validity.

The concern with reliability arises from the instrument used. While the instrument was used and validated in previous studies (Kim, 2009), based on the results of correlation analysis, Cronbach's Alpha was very low (0.41). Additionally, there were weak inter-relationships among the 12 items. Furthermore, there is a concern that some participants may have answered in the way they thought was desired, (acquiescence bias) rather than stating their true beliefs.

CHAPTER 2

LITERATURE REVIEW

There have been many studies about the impact of teachers' beliefs, knowledge and their instructional methods on student achievement. However, most are situated in the United States and Europe. Although teachers' beliefs have been linked to academic achievement around the world, Jordanian educators have not yet paid enough attention to the topic and to its importance.

In the following section, a theoretical framework, definitions for teacher beliefs, and details of the role teacher beliefs play in the classroom practices are presented. In order to have a better picture of the proposed study, a description of the educational system in Jordan is also provided. Additionally, a review of the literature on pre-service teachers' beliefs about the teaching and learning of mathematics is discussed. In the last section, the literature on the relationship between teachers' beliefs and education reform is reviewed.

Importance of Teacher Beliefs

Beliefs that teachers hold toward mathematics are critical to the ways students engage in mathematical activities, to their overall conception about it, and for improving students' performance. As evidenced in many studies (Carpenter, Fennema, & Peterson, 1986; Cooney, 1994; Hersh, 1986; Raymond, Santos, & Masingila, 1991; Schoenfeld, 1985; Thompson, 1984; Frank, 1988), what goes on in classrooms is directly related and influenced by the beliefs which teachers hold. For example, if a teacher is more inclined to perceive mathematics as a male domain, his/her classroom activities and actions may be affected by that belief. Specifically, a teacher may not look out or call on both genders equally. These unfavorable beliefs may create equity issues in classrooms. Additionally, if a teacher believes that some students have a

mathematical mind and some don't, he/she may not try hard enough with struggling students of a particular gender.

In addition, previous studies have shown that many teachers "teach the way they were taught" (Ball, 1988; Frank, 1990). Therefore, the beliefs which teachers hold will be passed on to their students who might also teach someday. In other words, beliefs about mathematics, regardless of whether favorable or unfavorable, are being passed on from one generation to another. Thus, educational programs should take extra measures to enhance favorable beliefs and to eliminate unhealthy ones.

Research on Beliefs

The main purpose of the proposed study was to have a better understanding of the teacher beliefs that most dramatically influence mathematics learning and teaching in Jordan. Therefore, it is wise to have some agreement as to what "belief" means, specifically, comparing the differences between belief and knowledge. In addition, it is critical to explore why teachers' beliefs have a strong impact on student achievement.

While there is an extended body of literature about beliefs, there is no clear or unified definition among researchers (Ball, 1990a; Bizwick, 2007; Cross, 2009; Haser and Star, 2004; Thompson, 1992). Pajares (1992) defines beliefs as "deeply personal, rather than universal, and unaffected by persuasion. They can be formed by chance, an intense experience, or a succession of events, and they include beliefs about what oneself and others are like" (p.309).

Cross (2009) defined beliefs "as embodied conscious and unconscious ideas and thoughts about oneself, the world, and one's position in it." (p.326). He goes on to say "beliefs are personal, stable, and often reside at a level beyond the individual's immediate control or knowledge." (p.326). Leatham (2006) documented the difference between beliefs and knowledge. He states that there are things that we "just believe" which he describes as beliefs

and other things we “more than believe” which he refers to as knowledge. Pajares (1992) declares that belief is based on evaluation and judgment and, knowledge is based on objective fact. The definition used throughout this study was that teacher beliefs are teachers’ assumptions about students, learning, classrooms, and the subject matter to be taught (Kagan, 1992).

Teachers’ beliefs have a very strong impact on their actions because they are developed over many years of schooling and experiences in many different communities. It is for this reason that beliefs are resistant to change. Szydlik, Szydlik, and Benson (2003) surveyed 93 pre-service teachers to examine changes in their mathematical beliefs. They found that not only did those teachers’ beliefs about mathematics influence their teaching and learning practices, but also that their pre-existing beliefs were difficult to change. In fact, the majority of pre-service teachers complete their education program holding many of the same beliefs they held prior to beginning their education training.

Beliefs about Mathematics

Mathematics education has been going through many reform initiatives. One of the cornerstones of these initiatives is the Curriculum and Evaluation Standards for School Mathematics introduced by the National Council of Teachers of Mathematics in 1989. According to that document, mathematics should be learned and taught as a connected and cohesive body of knowledge. Furthermore, the document highlighted that the role of the student should be changed from a passive receiver of information to an active participant in the learning process, thus advocating the change from a behaviorist perspective to one of constructivism. This necessitates that the teacher’s role should be changed from dispenser of knowledge to moderator and manager of learning experiences.

In order to accomplish these goals, significant changes had to be made in the area of students' and teachers' beliefs. Schoenfeld (1985) stated that "Beliefs about mathematics whether healthy held or not, are responsible for establishing a mathematical context within which one does mathematics" (p. 45).

During the past 30 years, several researchers have compiled lists of mathematical beliefs (Barger, 1999; Frank, 1988; Garofalo, 1989). While the wording and the number of beliefs included in the compiled lists differ, they certainly overlap. For example, Barger (1999) used several studies that looked into beliefs and their impact on mathematics learning and teaching in creating her list (see appendix H for researchers and their lists of beliefs they studied). In research conducted in 2009, Jeongyeon Kim used two instruments to investigate Korean pre-service teachers' beliefs about mathematics. The first instrument contained items from the instrument Barger used in 2009. Additionally, Jeongyeon Kim used several items from an instrument used by Zollman and Mason in 1992.

Because the current research study intended to replicate Kim's work in a different setting, her instrument, the Mathematics Belief Instrument, was used in its entirety. The specific beliefs included in that instrument are among the most studied of all beliefs about mathematics.

Based on the items in the Mathematics Belief Survey (see Appendix A), there were several beliefs about mathematics that are of primary interest in this study. Specifically, the researcher in this this study tried to determine to what degree Jordanian pre-service teachers believe that: (1) Mathematics is about memorizing; (2) Some people have a mathematical mind, and some don't; (3) The process is as important as the answer; (4) All important math concepts are already known; (5) Students who are good in math solve mathematical problems quickly; and, (6) Math is a male domain.

Memorization

As evidenced in many studies, teachers' beliefs about mathematics, about math teaching, learning, assessment, and about the general aims of mathematics education have great influence on the way students learn mathematics and their engagement in mathematical activities (Fang, 1996; Kagan, 1992; Thompson, 1992).

Specifically, if a teacher believes that the best way to learn mathematics is to memorize a set of rules or procedures, he/she might think that conceptual understanding is not of high importance. Ambrose (2004) states that "because prospective teachers' mathematics work in school consisted mostly of memorizing procedures; many assume that mathematics always requires memorization, even though they never heard a statement to that effect" (p. 93).

In the Mathematics Beliefs Instrument used in this study (see appendix A), the item that addressed the memorization belief was: "The best way to do well in math is to memorize all the formulas." The primary reason for including this variable was to highlight the importance and to find out what teachers believe regarding memorization vs. reasoning.

Mathematical Mind

"Mathematical mind" refers to the belief that mathematical ability is fixed. Teachers who believe in the existence of the "mathematical mind" provide an easy escape for struggling students who can simply say that they don't have a mathematical mind. Additionally, because there is a strong relationship between teachers' beliefs and classroom practices, teachers' action and activities may get influenced by the "mathematical mind" belief. For example, there might not be enough effort or remediation for students with low achievement based on this reasoning.

The "mathematical mind" belief may cause serious harm for students who really want to learn mathematics but have difficulty learning it. They may accept the fact that they don't have

what it takes to be good at mathematics, especially when they sense that their teacher is feeling the same way. Students may give up too quickly or they may not even try at all.

Furthermore, if teachers believe that mathematical ability is fixed among their students, they (students) will be grouped based on their abilities, for example, high-ability and low-ability. In doing so, teachers may provide experiences that reinforce that ability status, directly and indirectly.

There were two items addressing the "mathematical mind" in the Mathematics Belief Survey. They are: "Some people are good at mathematics and some are not" and "Some ethnic groups are better at math than others" (p. 214).

Process vs. Answer

The beliefs that mathematical problems usually have a single right answer or that students should focus more on answers than the processes used to get the right answer may yield serious negative consequences in learning mathematics. In a study which was done in the US, Stipek, Givvin, Salmon, & MacGyvers (2001) found that "Most American teachers have a conception of mathematics as a static body of knowledge, involving a set of rules and procedures that are applied to yield one right answer."

When teachers focus on the right answer more than the conceptual understanding/process in the classroom, students tend to spend a great deal of time trying to recall how the teacher solved the problem or trying to remember the specific steps in their textbooks without relying on their own thinking and reasoning. Therefore, when teachers provide students with opportunities to explain their mathematical thinking rather than focusing on the right answer, they (teachers) will have a better understanding of students' misconceptions. By understanding students' misconceptions, teachers will have opportunities to adjust their instructional classroom practices.

The survey items associated with this belief were: “In mathematics something is either right or it is wrong,” “Good mathematics teachers show students lots of different ways to look at the same question,” “Good math teachers show you the exact way to answer the math question you will be tested on,” “Math problems can be done correctly in only one way,” and “To solve most math problems you have to be taught the correct procedure.”

Nothing New in Mathematics

The primary reason this belief was included was to investigate whether pre-service teachers believe that everything important about mathematics has already been discovered. In other words, do pre-service teachers view mathematics as dynamic or fixed? Can students be creative doing math or are they simply required to memorize certain facts and procedures?

Teachers who believe there is nothing new that can be done in mathematics are potentially setting their students up for failure. Creativity should be encouraged, and students need to go beyond fact recitation to develop creative mathematical thinking. The NCTM (2000) Principles and Standards encouraged having a classroom where teachers adopt active learning, promote mathematical creativity, guide student discovery, and embrace multiple and unique interpretations of problems. Furthermore, students need to believe that mathematics it not always predictable; rather it can be surprising on many occasions. They need to believe that they can invent a way to do mathematics rather than relying only on what they’ve been taught.

Most teachers view mathematics from either the traditional or the constructivist perspective. Teachers with traditional beliefs describe mathematics as a collection of fixed and reliable concepts and skills (Romberg, 1992). Teachers who view mathematics as following set procedures invented by others that should be simply accepted and learned will have difficulty making sense out of mathematics (Battista, 1994). On the other hand, teachers with

constructivist beliefs encourage students to construct their mathematical knowledge and help their students like mathematics by allowing them to be creative through hands-on experiences and other strategies.

The items dealing with this variable were: “Everything important about mathematics is already known by mathematicians” and “In mathematics you can be creative and discover things by yourself.”

Time

Time spent working on math problems is an issue that has been discussed in several studies. Schoenfeld (1985, 1988) indicates that the majority of college students believe that all mathematical problems can be done in five minutes or less. Additionally, Barger (1999) argued that students typically give up working on mathematical problems after five minutes or even less.

Students and teachers who believe that mathematical problems must be solvable in five minutes or less are more likely to give up on problems that take longer. This variable is included in this study to highlight that while students must learn basic facts and procedures to solve mathematical problems quickly, it is also essential for them to believe that some mathematical problems may need deeper thinking which will require time beyond five minutes.

The item used to address this variable was: “To be good in math you must be able to solve problems quickly.”

Male Domain

Several researchers have investigated gender differences in mathematics learning (Hyde, Fennema, & Lamon, 1990; Hyde, Fennema, Ryan, Frost, & Hopp, 1990; Leder, 1990; Taylor, Pollard, Leder, & Atkins, 1996; Schatz Koehler, 1990). It has been documented that teachers’

beliefs about gender-related differences in mathematics education are essential to their behavior in classroom. Li (1999) states that:

> … the body of literature available to date suggests that, first, despite lack of conclusive evidence, teachers have different beliefs about male and female students. They tend to stereotype mathematics as a male domain; this has been reflected in teachers' tendency to overrate male students' mathematics capability, have higher expectations for male students and more positive attitudes about male students (p.63).

This belief is essential because what happens in the classroom is determined by the decisions that teachers make, decisions that are influenced by their beliefs. For example, when a teacher believes that mathematics is a male domain, there is a possibility that he/she will address more questions to boys than girls which will result in more attention and praise. On the other hand, a successful teacher should believe that girls have mathematical capabilities similar to boys. Additionally, when teachers believe that there are no or very small gender differences, they tend to provide meaningful experiences through appropriate instruction, praise, and guidance. These rich experiences and the continued support can positively influence students, and it will improve their attitudes toward mathematics.

There was one item addressing this belief in the survey: "Males are better at math than females."

Teachers' Beliefs about Mathematics and Future Practices

While a plethora of literature on pre-service teachers' beliefs is available in the United States and Europe, empirical studies about Jordanian pre-service teachers and their beliefs are still limited. In this section, the findings of studies from around the world are reported. The

importance of teachers' beliefs is well documented in many studies (Ball, 1990a; Bizwick, 2007; Cross, 2009; Haser and Star, 2004; Thompson, 1992).

Ball (1990) conducted a study, in the United States, using interviews, observation, and questionnaires to explore participants' ideas, feelings, and beliefs about teaching and learning mathematics. Working with 252 participants, she found that pre-service teachers, from elementary and secondary majors, generally believe that to know something in mathematics means to remember rules and to use the standard procedures without difficulty. This finding will have great influence on how they will teach mathematics later in their careers.

Cross (2009) conducted a study in two schools located in the southeastern United States. She investigated mathematics teachers' belief structures and their influence on instructional practices. She found that teachers' beliefs have great influence on their pedagogical and classroom practices, and teachers' beliefs play a critical role in shaping and organizing the learning process.

Stipek, Givvin, Salmon, and MacGyvers (2001) investigated the relationship between teachers' beliefs and the practices related to mathematics teaching. This study was also conducted in the United States. They worked with 21 fourth through sixth grade teachers and the participating students in the teacher's classroom. They found that the teacher's perception of their role in the classroom, whether to support and guide or transmit discrete knowledge, depended on the beliefs they held.

Cai and Wang (2009) investigated Chinese and U.S teachers' beliefs concerning effective mathematics teaching from the teachers' perspectives. The results of their study showed that teachers from the two countries hold different views on what constitutes effective mathematics teaching. Teachers from the U.S believe that students' mathematical understanding is

demonstrated by the ability to connect and apply knowledge to real life experiences. On the other hand, Chinese teachers believe that the mathematical understanding of students is demonstrated by connecting abstract knowledge pieces.

Understanding teachers' beliefs about mathematics and its teaching and learning is essential for mathematics teacher educators who struggle to design and implement effective programs with fruitful results. According to Hart (2002), there are many factors which impact the effectiveness of any teacher education program; however, teachers' beliefs must be considered as one of the primary components.

Teachers' Beliefs and Teacher Education Reform

Mathematics education has been going through reform around the world. For the past two decades, The National Council of Teachers of Mathematics (NCTM) has been the primary leader regarding reforming mathematics education (NCTM, 1989, 1991, 1995, 2000). NCTM believes that mathematics learning should be based on essential components such as communication, discussions, and collaboration. In other words, NCTM believes that there should be a shift from the traditional views to the constructivist views about mathematics and mathematics education. NCTM believes students should be part of the learning process by constructing their own knowledge. In contrast, the Jordanian education system is governed and controlled by the federal government, and the traditional views are still dominant.

Supporting the need for change in mathematics education, The Arab TIMSS Regional Report (2007) which is a publication to examine the results of Arab Countries states:

> Curricula in Arab countries have been reinforcing submission, obedience and compliance at the expense of creativity and critical thinking. The Report team stresses the need for an urgent shift from emphasis on rote learning and memorization, which have stifled the

creativity of Arab students, to greater emphasis on critical thinking, in line with international trends in mathematics and science (p. 1).

In order to have a better understanding of pre-service teachers' beliefs, an analysis of the sources of those beliefs is warranted. According to Pajares (1992), there are two primary sources for most of the beliefs people have. He labeled the two sources as emotion- packed experiences and cultural transmission.

According to Pajares (1992), emotion-packed experiences consist of previous episodes or events that influence the comprehension or the acceptance of subsequent events. He also argues that pre-service teachers may form their beliefs based on memories from their past or simply through influential teachers they might have had. Cultural transmission is the process of passing beliefs from person to person or from culture to culture. Therefore, education practitioners and researchers must investigate and understand pre-service teachers' beliefs before they can make any changes that will lead to improving mathematics education.

Education in Jordan

Jordan is a small country located in the heart of the Middle East. The population of Jordan is about six and a half million. As a country, Jordan has many challenges. The population growth is very high due to immigration caused by wars in neighboring countries, such as Iraq, The West Bank, Lebanon, and Syria. Also, Jordan has very limited natural resources. Unlike its rich neighbors, Jordan has no oil. Therefore, Jordan started investing in its human resources, specifically in educating its citizens and emphasizing the important role of education in improving their social, economic, and political conditions.

The structure of the educational system in Jordan consists of a two-year cycle of pre-school education (kindergarten), ten years of compulsory basic education, and two years of secondary education. Upon the completion of the three levels, preschool, basic, and secondary,

students are required to take the General Certificate of Secondary Education Exam. Study books are standard books distributed by the Ministry of Education. The secondary education level consists of two years of study for students aged 16 to 18 who have completed the basic education level. In Jordan, education is free at all three levels, Pre-school, basic, and secondary.

Jordan still needs to focus on improving the quality of its basic and secondary education levels. In international assessments, such as TIMSS, Jordan has performed well in comparison to other Arab countries, but students scored much lower than the international average. Specifically, out of twelve Arab countries that participated at the eighth-grade level, Lebanon ranked first achieving a score of 449 and Jordan, which was among the first Arab countries to participate in TIMSS in 1999, ranked second with a score of 427 (See table 4).

Table 4

** Average Mathematics Scores of Jordanian Eighth-Grade Students Compared to Other Arab and Middle Eastern Countries, 2007*

Rank	Country	Average
	TIMSS scale average	**500**
24.	Israel	463
28.	Lebanon	449
30.	Turkey	432
31.	**Jordan**	**427**
32.	Tunisia	420
34.	Iran	403
35.	Bahrain	398
37.	Syria	395
38.	Egypt	391
39.	Algeria	387
41.	Oman	372
42.	Palestinian Nat'l Auth.	367
44.	Kuwait	354
46.	Saudi Arabia	329
48.	Qatar	307

*Data excerpted from National Center for Education Statistics, 2009

Interestingly though, in the last cycle of TIMSS, which was administrated in 2011, many Middle-Eastern countries outperformed Jordan. As matter of fact, Jordanian students were

among only a few countries that experienced a decline in their average mathematics scores. Table 5 shows a comparison of Middle Eastern countries throughout the different cycles of TIMSS at the eighth grade level.

Table 5

** Middle Eastern Countries Throughout the Different Cycles of TIMSS at the Eighth Grade Level:*

1999		2003		2007		2011	
Country	Average	Country	Average	Country	Average	Country	Average
Israel	466	Israel	496	Israel	463	Israel	516
Tunisia	448	Lebanon	433	Lebanon	449	UAE	456
Turkey	429	**Jordan**	**424**	Turkey	432	Turkey	452
Jordan	**428**	Iran	411	**Jordan**	**427**	Lebanon	449
Iran,	422	Tunisia	410	Tunisia	420	Tunisia	425
Morocco	337	Egypt	406	Iran	403	Iran	415
		Bahrain	401	Bahrain	398	Qatar	410
		Palestinian Nat'l Auth.	390	Syria	395	Bahrain	409
		Morocco	387	Egypt	391	**Jordan**	**406**
		Saudi Arabia	332	Algeria	387	Palestinian Nat'l Auth.	404
				Oman	372	Saudi Arabia	394
				Palestinian Nat'l Auth.	367	Syria	380
				Kuwait	354	Morocco	371
				Saudi Arabia	329	Oman	366
				Qatar	307		

*Data excerpted from National Center for Education Statistics

According to the World Bank, which is a key provider of loans and intellectual guidance to MENA (Middle East and North Africa), education reform should include several areas. It makes the following recommendation:

> …Most reforms in the region have attempted to engineer changes in the education system: building schools, hiring teachers, and writing curricula. The success of future reforms will require instead changes in the behavior of key education actors—teachers, administrators, and educational authorities. This is the road not traveled in the education sector (World Bank, 2008, p. XV).

Additionally, The World Bank pointed out several serious challenges regarding the teaching profession, it states:

> …while the majority of teachers are in possession of the required formal qualifications, and the current student teacher ratios do not suggest a significant shortage of teachers, there are significant challenges regarding teacher recruitment, utilization, professional development and morale. There is still a relatively low level of actual use of the new methods and approaches in the classroom, and the new learning materials are often used in a conventional teaching approach. Teacher morale remains low (World Bank, 2009, p. 2).

Jordanian teachers, along with several MENA countries, have adopted pedagogical reforms with characteristics such as student-centered learning, competency-based curricula, and focus on critical thinking. However, there is little evidence of a significant shift away from a traditional model of pedagogy. The main activities in the classrooms in MENA continue to be copying from the blackboard, writing, and listening to the teachers. Group work, creative thinking, and proactive learning are rare.

Previous Research on Mathematics Teacher Beliefs Outside of the United States

Although a great deal of research has been conducted on the beliefs of teachers, much of this research is limited to identifying and describing the beliefs of the teachers. There is limited research on how the beliefs of teachers in various countries compare and how these beliefs impact student achievement.

This study was designed to mirror a study conducted by Kim (2009) who investigated the beliefs of South Korean pre-service teachers. Unlike Jordan, South Korea scores near the top on international assessments of mathematics achievement. Comparing the beliefs of Jordanian pre-service teachers to South Korean South Korean pre-service teachers provided valuable information that can be used to improve the preparation of pre-service teachers in Jordan.

Kim's study involved 511 pre-service elementary teachers from five teacher education colleges. Kim used the Mathematics Beliefs Instrument (Hart, 2002; Zollman & Mason, 1992), the same instrument used in this study, to gather data about the beliefs of these pre-service teachers. Kim calculated the descriptive statistics (Mean, Standard deviation) for each item in the Mathematics Beliefs Instrument and those statistics were compared to similar statistics for the Jordanian pre-service teachers in this study. The results are presented in Table 6.

Table 6

Mean and Standard Deviation for Each Item in the Mathematics Beliefs Instrument in the Korean Sample

	Measure	M*	SD
1	Some people are good at mathematics and some are not.	3.01	.72
2	In mathematics something is either right or it is wrong.	2.46	.73
3	Good mathematics teachers show students lots of different ways to look at the same question.		
4	Good math teachers show you the exact way to answer the math question you will be tested on.	3.44	.74
5	Everything important about mathematics is already known by mathematicians.	2.60	.74
6	In mathematics you can be creative and discover things by yourself.	2.25	.67
7	Math problems can be done correctly in only one way.	2.51	.73
8	To solve most math problems you have to be taught the correct procedure.	1.29	.61
9	The best way to do well in math is to memorize all the formulas		
10	Males are better at math than females.	2.64	.69
11	Some ethnic groups are better at math than others.	1.73	
12	To be good in math you must be able to solve problems quickly.	2.14	.68

* 1: false – 4: true

Note. From " Investigation of Korean pre-service teachers' beliefs about mathematics: challenges and implications for effective teacher education " by Kim, J. Y, 2009, Unpublished doctoral dissertation, University of Missouri, Kansas City.

Additionally, Kim's study looked at three variables associated with past mathematical experiences (parents' attitudes toward math, private tutoring, and years of schooling) to determine the impact these variables had on the beliefs of pre-service teachers. Of these variables, only the parents' attitudes toward math had a significant correlation to the teacher beliefs score. In addition, two variables associated with current mathematical experiences (taking a methods course and purchasing math books) were found to be significantly correlated with the beliefs score for the Korean pre-service teachers.

The current study built on the findings of that Korean research and contributed new knowledge in a variety of ways. First, a better understanding of the beliefs held by teachers in Jordan was obtained. Second, through comparison of Jordanian beliefs to those from a country scoring well on international assessments, potential new information about the impact of teacher

beliefs on student achievement were identified. Because neither study was looking for causal relationships, additional research is needed to document the impact specifically. Finally, this information can used to provide guidelines useful in promoting a more effective teacher education program in Jordan. Previous research has shown that teacher beliefs are resistant to change and yet are very important factors in teacher performance. This study highlights the ways in which reshaping the beliefs of Jordanian teachers could be accomplished and suggests how reshaping the beliefs might affect Jordanian student achievement.

CHAPTER 3

METHODOLOGY

This quantitative study was conducted to investigate the beliefs of Jordanian pre-service elementary teachers regarding the teaching and learning of mathematics. Students in Jordan typically do not perform well on international assessments of mathematics achievement, and this study was designed to determine if the beliefs held by Jordanian teachers were one factor in this lack of achievement. Findings from this study were compared to those of a similar study conducted previously in South Korea. While the elementary pre-service programs in Jordan and South Korea are similar, students in South Korea perform well on international mathematics assessments. Therefore, comparing results from the proposed study to the South Korean study could provide valuable information about Jordanian pre-service elementary teacher preparation.

This study was designed to answer the following research questions:

1. What are the Jordanian elementary pre-service teachers' beliefs about the teaching and learning of mathematics?
2. What is the relationship between Jordanian pre-service teachers' beliefs and the selected variables?
    e. How do pre-service teachers' beliefs about mathematics teaching and learning differ by their age and gender?
    f. How do pre-service teachers' beliefs about mathematics teaching and learning correlate with the number of mathematics courses completed previously?
    g. How do pre-service teachers' beliefs about mathematics correlate with their parents' level of education?

h. Are there differences in the beliefs of pre-service teachers based on the number of years they have been attending the university?

3. How do the beliefs of Jordanian pre-service elementary teachers compare to the beliefs of South Korean elementary pre-service teachers?

Participants

The participants in this study were pre-service teachers enrolled in teacher education programs in Jordan. There were several reasons that participants in this study were pre-service teachers. First, as was stated earlier, this study was replicating a previous study conducted in 2009 in South Korea by Jeongyeon Kim investigating Korean pre-service teachers' beliefs about mathematics. Second, most pre-service teachers enter their education program with a wide range of beliefs and conceptions of teaching and learning (Booth, Abdulla, Lingham, Singh, Wilson & Armour, 1998). Therefore, it is possible that through well-designed teacher education programs, these beliefs can be addressed and restructured. Third, pre-service teachers are the group that becomes “change agents” in the primary and secondary schools. By working with pre-service teachers, it is possible to initiate change across the country as the pre-service teachers begin teaching in many different schools. Finally, by changing beliefs of pre-service teachers through their preparation program, it will be possible to impact both students they teach and in-service teachers who are their colleagues.

There are more than 20 universities in Jordan; however, only five universities were invited to participate, four public and one private. Jordan is a small country with a population of approximately six million people. Typically, each large city has at least one public and one private university. Due to cultural and economic factors, students attend the university in the city

in which their families reside. The majority of the universities are controlled by the Ministry of Higher Education and, as a result, they are quite similar in the programs they offer.

The five universities selected for this study were: Yarmouk University, University of Jordan, Al al-Bayt University, Mu'tah University, and Jadara University. Approximately 80% of Jordan's population lives in three major cities, Amman, Irbid, and Zarqa. Four out of the five selected universities are located in these cities. Mu'tah University is located in the south region of Jordan. The participants from the selected universities were, therefore, highly representative of the country's population as a whole.

Nine sections of the mathematics methods courses were available to the study. The University of Jordan had only one section while the other four institutions each had two. The nine sections contained approximately 500 pre-service teachers. Since it was not anticipated that all the pre-service teachers would choose to participate and since it was expected that some participants' data would be incomplete, an accessible population of 500 pre-service teachers was selected to ensure the availability of an adequate sample size. Ultimately, 441 participants completed the two surveys.

The number of participants from each university ranged from 49 to 156 (See Table 7). Yarmouk University had the highest number of participants, which was expected, because it had the highest number of students enrolled with a student population of approximately 40,000 students.

Table 7

Number of Pre-service Teacher Participants by University (N = 441)

University	Number of participants
Yarmouk	156
Mu'tah	73
Al-Bayt	82
Jordan	49
Jadara	81

Procedures

To complete this study, a proposal was submitted to the Social Sciences Institutional Review Board (SSIRB) at the University attended by the researcher. Approval from this body was requested before participants could be recruited. Preliminary contacts with Jordanian universities' officials were initiated after obtaining permission to conduct the study. Contacts with the department chair in each university were made, and letters of agreement were requested. Class schedules and faculty names were obtained through the university's website and/or by contacting registrar offices in the different universities.

As was mentioned earlier, nine sections were available for the study. Each participating university had two sections except the University of Jordan. All students enrolled in the mathematics methods classes in the selected institutions were recruited.

Consideration of Ethical Concerns

To insure confidentiality, no identifiable personal data such as name or students' ID numbers were collected. The surveys were anonymous. The researcher provided information about the study to potential participants prior to completing the surveys. This information was

provided both verbally and in writing. The information included the purpose of the study, procedures to be utilized, description of the instruments to be used, expected time commitment, potential benefits of the study, and any risks from the study. In addition, participants were informed that they were free not to complete the survey or to withdraw from the study at any time. An average of 15 minutes was required to complete the needed surveys. If participants finished early, they would turn in their completed surveys anytime. Because the time involved was so small, very few elected to withdraw during the data collections.

Data Collection and Analysis

Instruments

To conduct this study, a questionnaire survey which contained two parts was used. The first part, The Mathematics Beliefs Instrument (see Appendix A), was used in several studies previously. Zollman and Mason used it as part of larger instrument in 1992. Several items in the instrument were used by Barger in 1999. Kim used two different instruments which they were compiled by Barger in 1999 along with other published surveys from the literature as the basis for here instrument. Barger's instruments were compiled using surveys in other studies as a source (Aiken and Dreger, 1961; Buerk, 1985; Fennema and Sherman, 1976; Gourgey, 1982; Gwizdala and Steiback, 1990; Kogelman and Warren, 1978; Schoenfeld, 1989). Finally, the Mathematics Beliefs Instrument was used in 2009 by Jeongyeon Kim to investigate Korean pre-service teachers' beliefs about mathematics.

The Mathematics Belief Instrument consisted of 12 items using a four-point Likert scale (1-false, 2- more false than true, 3- more true than false, 4- true). The items in the survey were designed to measure pre-service teachers' beliefs as they progressed through their educational

programs. Specifically, they were designed to measure pre-service teachers' overall strength of agreement or disagreement with beliefs about mathematics and its teaching and learning.

One aim of this study was to investigate the relationship between pre-service teachers' beliefs and specific variables: age, gender, grade level, parents' educational level, parents' attitude about mathematics, whether the participant had a chance to communicate with someone who majored in mathematics, whether the participant engaged in mathematics activities outside the classroom, the level of the participant's mathematics achievement, the number of completed mathematics methods courses, the number of completed mathematics courses, and experience student teaching. These variables were selected by Kim because the literature indicates they may affect teachers' beliefs, and they were included in the second part of the survey (see Appendix B.)

The official language in Jordan is Arabic; therefore, both parts of the instrument were translated into the Arabic language. A certified and licensed translator completed the translation process. In Jordan, there are certain offices whose specialty is to translate English documents into Arabic and vice versa. The investigator utilized one of these offices and paid the required fee for the translation. Both the English and Arabic versions of the instrument were available to participants, and each participant was free to choose the version he or she wanted to complete. Arabic speaking individuals helped the researcher at the time of actual data collection. Additionally, the researcher, who is fluent in both Arabic and English, was also present when the surveys were administrated.

Instructions were given in English, the language used to teach in the selected universities. Because it was important to accurately determine beliefs, student questions during the completion of the survey were answered. However, students rarely asked questions.

Data Analysis

Analysis of the data was completed using version 20 of SPSS (Statistical Package for the Social Sciences). SPSS is software for managing data and calculating a wide variety of statistics. When data collection was complete, preliminary data analysis was conducted to check for missing data and to eliminate cases where necessary. Additionally, data were analyzed to determine whether assumptions of normality were met. Histograms were utilized to determine if the assumption of normal distribution of data for each variable was met, and each set of data were examined for outliers. Interestingly, the results indicated that the collected data were not normally distributed.

Research Question One. The first research question was: What are the Jordanian pre-service teachers' beliefs about mathematics? To examine this question, descriptive statistics were used. The means and standard deviations were determined for the pre-service teachers' responses on the twelve items of Mathematics Belief Survey.

To investigate whether there was an inter-relationship among the 12 items in the Mathematics Beliefs Instrument, pair wise correlation coefficients were completed for each pair. Because the data were not normally distributed, Spearman's correlation was used.

Research Question 2. In order to answer research question 2, what is the relationship between Jordanian pre-service teachers' beliefs and the background variables such as age, gender, grade level, and parents' level of education, Spearman's correlation was also used. The relationship between each item/belief in the Mathematics Beliefs Instrument and each background variable were investigated in this way.

Prior to conducting Spearman's correlation, the chi-square statistic was proposed and used for assessing the relationships in an effort to answer research question 2. However, the

output yielded many unsatisfactory cell counts where the expected frequency was less than 5. The researcher next tried to combine categories so chi-square assumptions could be met. The results were not meaningful or valid to report because the categories had to be collapsed so much that analysis was meaningless.

Research Question 3. The third research question is: How do the beliefs of Jordanian pre-service elementary teachers compare to the beliefs of South Korean elementary pre-service teachers? The researcher for the South Korean study (Kim, 2009), calculated and reported the means and standard deviations for each item on the Mathematics Belief Survey. The descriptive statistics from both studies (South Korean study by Kim in 2009 and the Jordanian study) were analyzed and compared to determine if significant differences existed on specific questions. Additionally, investigations of overlap between confidence intervals were conducted to draw better conclusions regarding the differences between the populations.

CHAPTER 4

RESULTS

The purpose of this study was to investigate the beliefs of Jordanian pre-service elementary teachers regarding the teaching and learning of mathematics. The study was conducted at five different universities across Jordan. Data were collected using two instruments: The Mathematics Belief Instrument (see Appendix A) and the Background Instrument (see Appendix B). The first instrument was designed to measure pre-service teachers' beliefs about mathematics and its teaching and learning. The second instrument requested specific demographic information such as teachers' age, gender, prior mathematics experiences, and parents' level of education. The relationship between these variables and pre-service teachers' beliefs was evaluated.

Both instruments were made available to participants in Arabic and English. One side of the instrument was written in English and the back side had the same questions translated into Arabic. All verbal instructions were given in English and Arabic. Participants who chose to complete the instrument in the English version, however, were very few – only 35 out of 441 or 8 %.

While there were plenty of courses offered during the fall 2012 semester from which the researcher could choose, nine sections of the mathematics methods course were selected for inclusion in this study. A total of 500 pre-service teachers were invited to participate and of these, 441 participants completed both surveys.

The data were collected and analyzed to investigate the following research questions:

4. What are the Jordanian pre-service teachers' beliefs about the teaching and learning of mathematics?

5. What is the relationship between Jordanian pre-service teachers' beliefs and the selected variables?
    i. How do pre-service teachers' beliefs about mathematics teaching and learning differ by their age and gender?
    j. How do pre-service teachers' beliefs about mathematics teaching and learning correlate with the number of mathematics courses completed previously?
    k. How do pre-service teachers' beliefs about mathematics correlate with their parents' level of education?
    l. Are there differences in the beliefs of pre-service teachers based on the number of years they have been attending the univeristy?
6. How do the beliefs of Jordanian pre-sevice elementary teachers compare to the beliefs of South Korean elementary pre-serivce teachers?

The remainder of this chapter is organized in three sections. The first section provides demographic data for the participants. Descriptive statistics are provided in the second section. The third and final section gives the results of the analysis of the research questions.

Demographic Data

Demographic data on the following variables were collected: age, gender, grade level, parents' educational level, parents' attitude about mathematics, whether the participant had a chance to communicate with someone who majored in mathematics, whether the participant engaged in mathematics activities outside the classroom, the level of the participant's mathematics achievement, the number of completed mathematics methods courses, the number of completed mathematics courses, and experience student teaching. The demographic data were collected and analyzed to have a better description of the participants.

As is very common with elementary education majors, the participants in this study were primarily female with 360 of the 441 participants (81.6%) being female (see Table 8).

Table 8

Gender of Participants (N = 441)

	N	%
Male	81	18.4
Female	360	81.6

Most of the participants (96.8%) were between the ages of 18 and 23 (see Table 9). Students in Jordan enter college shortly after they pass the general secondary examination called Tawjihi. Children start school usually by the age of 6. The Jordanian educational system involves ten years of compulsory basic education and two years of secondary academic or vocational education. Therefore, the typical starting age for university students is 18 years.

Table 9

Age of Participants (N=441)

Age	*N*	%
17	1	0.2
18	14	3.2
19	111	25.2
20	121	27.4
21	113	25.6
22	53	12.0
23	14	3.2
>23	14	3.1

University students in Jordan are classified by the year of enrollment (first, second, third, and fourth) instead of using the terms that are more common in the United States (freshmen, sophomores, juniors, and seniors). Thirty-four of the 441 participants (7.7%) were first year (freshmen) students, 203 (46%) were second year (sophomores) students, 150 (34%) were third

year (juniors) students, and 54 (12.2%) were in their fourth year (seniors). Table 10 shows these results.

Table 10

Grade Level of Participants (N=441)

Age	*N*	%
First Year	34	7.7
Second Year	203	46.0
Third Year	150	34.0
Fourth Year	54	12.2

As seen in Table 11, 70.3% of the participants reported that their father's educational level was high school or below and 74.8% reported high school or below for their mothers' educational background. The data about parents' educational level were collected and analyzed because there are a number of studies which indicate that student achievement and attitude are highly correlated with the educational attainment of parents. For instance, in one study, students whose parents had less than high school education obtained lower grades in mathematics than those whose parents had higher levels of education (Campbell, Hombo, & Mazzeo, 2000).

Table 11

Educational Level of Participants' Parents (N = 441)

	Father		Mother	
	N	*%*	*N*	*%*
Below High School Education	149	33.8	177	40.1
Graduated High School	161	36.5	153	34.7
Graduated 2-year college	53	12.0	60	13.6
Graduated 4-year college	32	7.3	28	6.3
Graduated Graduate School	46	10.4	23	5.2

Examining the data about parents' attitudes about mathematics reveals that nearly 80% of the parents have positive or very positive attitudes about mathematics (see Table 12). This is very important because of the tremendous influence that parents' attitudes have on their children's education. Hall and Davis (1999), for example, report that parental attitudes are extremely influential in the student's performance in mathematics. The link between parental attitudes about mathematics, the learning outcomes for students, and development of students' beliefs has been documented by a number of other researchers including Lehrer & Shumow (1997) and Tiedemann (2000).

Table 12

Attitude about Mathematics of Participants' Parents (N=441)

	N	%
Very Negative	34	7.7
Negative	21	4.8
Uncertain	63	14.3
Positive	234	53.1
Very Positive	115	26.1

Data from individual participants about the number of courses they had completed (see Table 13) reveal interesting results. As was stated earlier, while the instruments were available in

Arabic and English, most participants completed the Arabic version. During the translation process, the questions from the survey about the number of content courses and mathematics methods courses completed by participants were almost certainly misunderstood. The questions in the survey were: "How many courses in math content (e.g., Calculus, Geometry, Algebra) did you take prior to enrolling in college?" and "How many courses in math teaching methods (e.g., mathematics curriculum design, learning and teaching in mathematics, elementary mathematics methods, secondary mathematics methods) did you take?"

However, the translated version (Arabic version) could be interpreted to ask for the number of "workshops" the participants had completed instead of courses. This is the most probable reason why almost 60% of participants reported zero for the completed courses. (This will be discussed further in chapter 5).

Table 13

Number of Mathematics Content and Mathematics Education Courses Taken by Participants (N = 441)

	Math Content		Math Education	
	N	*%*	*N*	*%*
0	261	59.2	285	64.6
1	91	20.6	86	19.5
2	50	11.3	47	10.7
3	20	4.5	10	2.3
4	7	1.6	1	0.2
>4	12	2.7	12	2.7

Table 14 summarizes the participants' answers for the following question: "What was the level of your mathematics achievement?" This question was designed to addresses students' achievement in mathematics classes compared to other students in their class. Nearly 75% of participants (329 out 441) reported that they were average, above average, or high.

Table 14

Level of Mathematics Achievement of Participants (N=441)

	N	%
Low (20%)	12	2.7
Below Average (20-40%)	100	22.7
Average (40-60%)	74	16.8
Above Average (60-80%)	169	38.3
High (Greater than 80%)	86	19.5

Results of the analysis of the research questions

Research Question 1. The first research question of this study was: What are the Jordanian elementary pre-service teachers' beliefs about the teaching and learning of mathematics?

In order to answer this question, descriptive statistics (mean and standard deviation) were calculated. According to the results of descriptive statistical analysis, Jordanian pre-service teachers reported mixed responses on the Mathematics Belief Instrument. The highest mean and strongest agreement were found on item 1, "Some people are good at mathematics and some are not," (M = 3.63 out of 4) which measures the existence of what is sometimes referred to in the literature as a "mathematical mind." As can be seen in Table 15, the total number of participants who strongly believe in this item was 412 out of 441 (93.4%).

Other items showing strong beliefs (mean above 3.0) were items 8, 3, and 4. Item 8, "To solve most math problems you have to be taught the correct procedure," had a mean of 3.50. Three hundred and ninety four participants reported that this statement is true or more true than false (89.4%). On item 3, "Good mathematics teachers show students lots of different ways to look at the same question" the mean was 3.39 with 376 participants selecting true or more true than false (85.2%). Lastly, item 4, "Good math teachers show you the exact way to answer the

math question you will be tested on," had a mean of 3.26 with 361 participants reporting that this statement is either true or more true than false.

Study participants strongly disagreed with item 10, "Males are better at math than females," (M=2.00). Nearly 70% of the participants reported that the statement about gender and math ability is either false or more false than true (302 out of 441).

Other items with means below 2.6 were items 7, 11, and 5. On item 7, "Math problems can be done correctly in only one way," participants' disagreement was clear. Only 98 out of 441who participated in this study believed the statement was true (22.2%). Item 7, "Some ethnic groups are better at math than others," had a mean of 2.47 with only 79 participants believing the statement was true (17.9%). Similarly, item 5 "Everything important about mathematics is already known by mathematicians" reported a mean of 2.55 with only 107 participants out of 441 reporting their agreement with the statement.

For the remaining beliefs in the instrument, items 2, 6, 9, and 12, the means were clustered in the mid-range between "more true than false" and "more false than true." Item 2, "In mathematics something is either right or it is wrong," had a mean of 2.82 with 212 participants (48.1%) reporting that they do not agree or disagree with the statement. Item 6, "In mathematics you can be creative and discover things by yourself," had a mean of 2.97 with 249 of participant (46.1%) believed that the statement is "more true than false" or "more false than true." The mean for item 9, "The best way to do well in math is to memorize all the formulas," was 2.81 with 223 participants (50.4%) clustered in the middle. Similarly, item 12, "To be good in math you must be able to solve problems quickly," had a mean of 2.64 with 235 of the participants (53.3%) in the middle range.

In summary, beliefs of Jordanian pre-service teachers are very mixed. Out of the four items revealing strong beliefs (Items 1, 8, 3, and 4), item 1 which relates to the idea of natural or fixed mathematical ability seemed to be the strongest. However, while they showed strong beliefs about natural talent (Item 1, M=3.63), they also showed relatively strong beliefs about math ability by ethnic groups (Item 11, M=2.47). Additionally, participants showed varied beliefs about math requiring single solutions (Item 2, M=2.82) and memorization of formulas (item 9, M=2.81).

Table 15

Descriptive Statistics for Individual Items in the Mathematics Beliefs Instrument (N=441)

	Mean	*SD*	True*	More True than False*	More False than True*	False*
Some people are good at mathematics and some are not.	3.63	0.67	71.9	21.5	4.3	2.3
In mathematics something is either right or it is wrong.	2.82	1.08	35.6	27.9	20.2	16.3
Good mathematics teachers show students lots of different ways to look at the same question.	3.39	0.87	60.3	24.9	9.1	5.7
Good math teachers show you the exact way to answer the math question you will be tested on.	3.26	0.89	50.3	31.5	12.0	6.1
Everything important about mathematics is already known by mathematicians.	2.55	1.07	24.3	28.3	26.3	21.1
In mathematics you can be creative and discover things by yourself.	2.97	0.94	33.5	40.4	16.1	10.0
Math problems can be done correctly in only one way.	2.35	1.13	22.2	21.5	26.1	30.2
To solve most math problems you have to be taught the correct procedure.	3.50	0.74	63.3	26.1	8.4	2.3
The best way to do well in math is to memorize all the formulas.	2.81	1.06	33.6	30.2	20.4	15.9
Males are better at math than females.	2.00	1.09	14.3	17.2	23.6	44.9
Some ethnic groups are better at math than others.	2.47	1.02	17.9	33.6	26.5	22.0
To be good in math you must be able to solve problems quickly.	2.64	1.07	29.0	24.5	28.8	17.1

*Percentage of participants.

Research Question 2. The second research question of this study was: What is the relationship between Jordanian pre-service teachers' beliefs and the selected variables?

a. How do pre-service teachers' beliefs about mathematics teaching and learning differ by their age and gender?
b. How do pre-service teachers' beliefs about mathematics teaching and learning correlate with the number of mathematics courses completed previously?
c. How do pre-service teachers' beliefs about mathematics correlate with their parents' level of education?
d. Are there differences in the beliefs of pre-service teachers based on the number of years they have been at the university?

This question was four-fold. A correlation test was run for each belief. Each item/belief in the Mathematical Belief Instrument was correlated with each variable in the background questionnaire to determine if a relationship existed and what the characteristics of that relationship were. Spearman's correlation coefficient was the statistical measure used because the data were not normally distributed.

For reporting purposes, instead of separating results by parts, a, b, c, and d, the reseracher chose to report information for each belief correlated to all participant characteristics. Tables 16 to 27 show these results.

Table 16 provides the correlation results between the first item/belief, "Some people are good at mathematics and some are not," and the characteristics from individual participants. The results show that a realtionship exists between this belief and the number of math methods courses already taken by the participant. The correlation was significant at the 0.05 level. Furthermore, the correlation was negative (-0.104) indicating that the fewer math methods

courses the participant had completed, the stronger the belief. Addtionally, a relationship also existed beteen this belief and the age of the participant. The correlation coefficient for age was siginificat at the 0.01 level. The correlation was also negative (-0.139) indicating that the older the student was, the less strong this belief become.

Table 16

Correlation Between Personal Characteristics of Participant and Item 1: Some people are good at mathematics and some are not (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	-0.139	0.003**
Gender	0.041	0.388
College Grade Level	-0.066	0.168
Father's Educational Level	-0.030	0.527
Mother's Educational Level	-0.077	0.108
Parents' Attitude about Mathematics	0.058	0.224
Did the participant communicate with family member who majored in mathematics	-0.064	0.181
Participation in Math activities outside the classroom	-0.091	0.055
Participant's achievement level	0.021	0.655
Number of math content courses taken	-0.074	0.122
Number of math teaching Methods Courses taken	-0.104	0.029*
Has participant done his/her student teaching	0.038	0.430

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

The correlation between belief 2, "In mathematics something is either right or it is wrong," and the selected variables did not yield any significant results (see table 17). The meaning of this will be discussed in chapter 5.

Table 17

Correlation Between Personal Characteristics of Participant and Item 2: In mathematics something is either right or it is wrong. (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	-0.024	0.612
Gender	-0.048	0.319
College Grade Level	-0.044	0.359
Father's Educational Level	0.018	0.709
Mother's Educational Level	-0.028	0.562
Parents' Attitude about Mathematics	-0.018	0.705
Did the participant communicate with family member who majored in mathematics	0.001	0.987
Participation in Math activities outside the classroom	0.028	0.552
Participant's achievement level	0.085	0.075
Number of math content courses taken	-0.034	0.148
Number of math teaching Methods Courses taken	-0.037	0.435
Has participant done his/her student teaching	-0.024	0.613

Table 18 shows the correlation results between belief 3, "Good mathematics teachers show students lots of different ways to look at the same question," and the selected variables. Interestingly, father's educational level had a correlation coefficient of 0.104 which was significant at the 0.05 level. The correlation was positive indicating that the more education the father has, the stronger the belief is.

Table 18

Correlation Between Personal Characteristics of Participant and Item 3: Good mathematics teachers show students lots of different ways to look at the same question (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	-0.068	0.155
Gender	0.046	0.330
College Grade Level	-0.042	0.374
Father's Educational Level	0.104	0.030*
Mother's Educational Level	0.061	0.205
Parents' Attitude about Mathematics	0.077	0.107
Did the participant communicate with family member who majored in mathematics	-0.067	0.158
Participation in Math activities outside the classroom	-0.031	0.519
Participant's achievement level	0.058	0.226
Number of math content courses taken	-0.023	0.634
Number of math teaching Methods Courses taken	0.022	0.639
Has participant done his/her student teaching	-0.026	0.587

*Correlation is significant at the 0.05 level (2-tailed)

Belief 4, "Good math teachers show you the exact way to answer the math question you will be tested on," also did not yield any significant results (see table 19).

Table 19

Correlation Between Personal Characteristics of Participant and Item 4: Good math teachers show you the exact way to answer the math question you will be tested on (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	-0.070	0.143
Gender	0.054	0.258
College Grade Level	-0.003	0.953
Father's Educational Level	-0.078	0.103
Mother's Educational Level	0.016	0.738
Parents' Attitude about Mathematics	0.073	0.124
Did the participant communicate with family member who majored in mathematics	-0.033	0.493
Participation in Math activities outside the classroom	0.061	0.199
Participant's achievement level	0.050	0.298
Number of math content courses taken	-0.025	0.606
Number of math teaching Methods Courses taken	-0.046	0.330
Has participant done his/her student teaching	-0.070	0.142

Table 20 shows the correlation results between belief 5, “Everything important about mathematics is already known by mathematicians,” and the selected variables. Belief 5 had 3 significant relationships with the following variables:

1. Communication with family member who majored in mathematics.
2. Number of math methods courses already taken by participant.
3. Completion of student teaching.

The first characteristic had a negative correlation coefficient (-0.100) which was significant at the 0.05 level. This indicates that the more the participants communicate with their family, the less they believed about item 5. The second characteristic had a positive correlation coefficient (0.110) which was significant at the 0.05 level. The correlation means that the more courses participants completed, the stronger the belief becomes. This is an unhealthy belief that should be challenged. The third characteristic also had a negative correlation coefficient (-0.117) which was significant at the 0.05 level. The relationship means that if participants taught, they are less likely to believe in item 5. Again, almost half of participant did not student teach (45%).

Table 20

Correlation Between Personal Characteristics of Participant and Item 5: Everything important about mathematics is already known by mathematicians (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	-0.002	0.969
Gender	0.016	0.741
College Grade Level	0.038	0.423
Father's Educational Level	0.051	0.289
Mother's Educational Level	0.064	0.176
Parents' Attitude about Mathematics	0.047	0.325
Did the participant communicate with family member who majored in mathematics	-0.100	0.036*
Participation in Math activities outside the classroom	0.020	0.674
Participant's achievement level	0.055	0.246
Number of math content courses taken	0.068	0.156
Number of math teaching Methods Courses taken	0.110	0.021*
Has participant done his/her student teaching	-0.117	0.014*

*Correlation is significant at the 0.05 level (2-tailed)

There were three significant relationships with belief 6, "In mathematics you can be creative and discover things by yourself," and the selected variables (see table 21). The three variables were:

1. Participation in math activities outside the classroom.
2. Participant's achievement level.
3. Completion of student teaching

The first characteristic had a negative correlation coefficient (-0.211) which was significant at the 0.01 level. This indicates that the more activities participants participated in, the less likely they were to believe they could be creative in mathematics. However, it is worth noting that over 85% of participants (376 out of 441) reported that they did not participate in any math activities. The second characteristic had a positive correlation coefficient (0.131) which was significant at the 0.01 level. The correlation means that the higher participant's achievement level, the stronger the belief that they could be creative and discover things by themselves. The

third characteristic had a negative correlation coefficient (-0.138) which was significant at the 0.01 level. The relationship means that if participants had completed their student teaching, they were less likely to believe that they could be creative.

Table 21

Correlation Between Personal Characteristics of Participant and Item 6: In mathematics you can be creative and discover things by yourself (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	-0.071	0.137
Gender	-0.072	0.129
College Grade Level	-0.020	0.681
Father's Educational Level	0.006	0.897
Mother's Educational Level	0.026	0.579
Parents' Attitude about Mathematics	0.029	0.550
Did the participant communicate with family member who majored in mathematics	-0.045	0.345
Participation in Math activities outside the classroom	-0.211	0.000**
Participant's achievement level	0.131	0.006**
Number of math content courses taken	0.013	0.787
Number of math teaching Methods Courses taken	0.012	0.800
Has participant done his/her student teaching	-0.138	0.004**

**Correlation is significant at the 0.01 level (2-tailed)

Two variables had a significant relationship with belief 7, "Math problems can be done correctly in only one way." First, the number of mathematics content courses was significant at the 0.05 level. The correlation coefficient was (0.097) meaning that the more math content courses the participant completed, the stronger their belief in item 7. The second relationship existed with the number of mathematics methods courses already taken was. The correlation was positive and had a correlation coefficient of 0.137. Again, the positive correlation means that the more math methods courses the participant completed, the stronger their belief tended to be. This correlation was significant at the 0.01 level (see table 22).

Table 22

Correlation Between Personal Characteristics of Participant and Item 7: Math problems can be done correctly in only one way (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	-0.035	0.463
Gender	0.062	0.197
College Grade Level	0.038	0.430
Father's Educational Level	-0.024	0.621
Mother's Educational Level	0.017	0.716
Parents' Attitude about Mathematics	0.023	0.632
Did the participant communicate with family member who majored in mathematics	-0.012	0.808
Participation in Math activities outside the classroom	0.055	0.246
Participant's achievement level	0.043	0.370
Number of math content courses taken	0.097	0.042*
Number of math teaching Methods Courses taken	0.137	0.004**
Has participant done his/her student teaching	-0.030	0.532

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Table 23 shows the correlation between belief 8, "To solve most math problems you have to be taught the correct procedure," and the selected variables. The number of mathematics method courses already taken was the variable that showed a significant relationship with this belief. The correlation was negative (-0.107) and significant at the 0.05 level. The negative correlation means that the more mathematics methods courses participants have completed, the weaker the belief is. This is unhealthy belief that needs to be challenged and hopefully changed. (To be discussed further in chapter5.)

Table 23

Correlation Between Personal Characteristics of Participant and Item 8: To solve most math problems you have to be taught the correct procedure (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	0.020	0.680
Gender	0.016	0.734
College Grade Level	0.074	0.119
Father's Educational Level	0.002	0.973
Mother's Educational Level	0.009	0.856
Parents' Attitude about Mathematics	0.053	0.263
Did the participant communicate with family member who majored in mathematics	-0.023	0.629
Participation in Math activities outside the classroom	0.071	0.138
Participant's achievement level	0.082	0.086
Number of math content courses taken	-0.035	0.468
Number of math teaching Methods Courses taken	-0.107	0.024*
Has participant done his/her student teaching	0.057	0.231

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Father's educational level was the only variable that had a significant relationship with belief 9, "The best way to do well in math is to memorize all the formulas." The correlation was significant at the 0.05 level and negative (-0.095). The relationship indicates that the more educated the father, the less emphasis the participant put on memorizing formulas (see table 24).

Table 24

Correlation Between Personal Characteristics of Participant and Item 9: The best way to do well in math is to memorize all the formulas (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	0.089	0.062
Gender	0.046	0.340
College Grade Level	0.062	0.194
Father's Educational Level	-0.095	0.046*
Mother's Educational Level	-0.022	0.647
Parents' Attitude about Mathematics	-0.018	0.711
Did the participant communicate with family member who majored in mathematics	0.048	0.311
Participation in Math activities outside the classroom	0.066	0.169
Participant's achievement level	-0.039	0.412
Number of math content courses taken	-0.005	0.918
Number of math teaching Methods Courses taken	-0.050	0.290
Has participant done his/her student teaching	-0.018	0.713

*Correlation is significant at the 0.05 level (2-tailed)

Table 25 shows the results between belief 10, "Males are better at math than females," and the selected variables. Age and gender both showed a significant relationship with this belief. The correlation coefficients for both variables were significant at the 0.01 level. However, age had a positive correlation (0.191) and gender had negative correlation (-0.346). The positive correlation between age and this belief means that the older the participants are, the stronger they feel about belief 10. The negative relationship between this belief and gender suggests that girls –the majority of the participants- do not agree with the statement. The belief that boys are better than girls in math is unhealthy and should be subject to change. Over 80% of participants were females.

Table 25

Correlation Between Personal Characteristics of Participant and Item 10: Males are better at math than females (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	0.191	0.000**
Gender	-0.346	0.000**
College Grade Level	0.020	0.675
Father's Educational Level	0.011	0.822
Mother's Educational Level	-0.004	0.927
Parents' Attitude about Mathematics	0.016	0.741
Did the participant communicate with family member who majored in mathematics	0.006	0.896
Participation in Math activities outside the classroom	-0.083	0.080
Participant's achievement level	-0.058	0.220
Number of math content courses taken	-0.011	0.818
Number of math teaching Methods Courses taken	-0.024	0.612
Has participant done his/her student teaching	-0.028	0.564

**Correlation is significant at the 0.01 level (2-tailed)

Participant's achievement level was the only variable that showed a significant relationship with belief 11, "Some ethnic groups are better at math than others." The correlation coefficient was negative (-0.119) and significant at the 0.05 level. It indicates that the higher the participant's achievement level is, the less likely he/she is to believe that some ethnic groups are better than others.

Table 26

Correlation Between Personal Characteristics of Participant and Item 11: Some ethnic groups are better at math than others (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	0.088	0.064
Gender	-0.036	0.445
College Grade Level	0.044	0.353
Father's Educational Level	-0.031	0.521
Mother's Educational Level	0.037	0.440
Parents' Attitude about Mathematics	-0.041	0.385
Did the participant communicate with family member who majored in mathematics	0.029	0.538
Participation in Math activities outside the classroom	0.071	0.138
Participant's achievement level	-0.119	0.013*
Number of math content courses taken	0.005	0.922
Number of math teaching Methods Courses taken	0.028	0.559
Has participant done his/her student teaching	-0.039	0.412

*Correlation is significant at the 0.05 level (2-tailed)

The last item correlated with the selected variables was item 12, "To be good in math you must be able to solve problems quickly." There were no significant relationships between this item and any of the selected variables.

Table 27

Correlation Between Personal Characteristics of Participant and Item 12: To be good in math you must be able to solve problems quickly (N=441)

	Correlation Coefficient	Sig. (2-Tailed)
Age	0.063	0.184
Gender	-0.014	0.765
College Grade Level	0.019	0.691
Father's Educational Level	-0.020	0.678
Mother's Educational Level	0.012	0.801
Parents' Attitude about Mathematics	0.091	0.056
Did the participant communicate with family member who majored in mathematics	-0.068	0.153
Participation in Math activities outside the classroom	-0.006	0.908
Participant's achievement level	-0.045	0.342
Number of math content courses taken	0.005	0.917
Number of math teaching Methods Courses taken	0.021	0.659
Has participant done his/her student teaching	-0.045	0.350

Table 28 shows a summary of the statistically significant correlations between Mathematics Beliefs and Background characteristics

Table 28

Significant correlations between Mathematics Beliefs and Background characteristics

Mathematical Mind	Characteristic	rho	p value
• Some people are good at mathematics and some are not.	1. Age	-0.139	0.003**
	2. Methods Courses	-0.104	0.029*
• Some ethnic groups are better at math than others.	1. Achievement level	-0.119	0.013*
Memorization			
• The best way to do well in math is to memorize all the formulas	1. Father's Educational Level	-0.095	0.046*
Process vs. Right Answer			
• In mathematics something is either right or it is wrong.			
• Good mathematics teachers show students lots of different ways to look at the same question.	1. Father's Educational Level	0.104	0.030*
• Good math teachers show you the exact way to answer the math question you will be tested on.			
• Math problems can be done correctly in only one way.	1. Content courses	0.097	0.042*
	2. Methods Courses	0.137	0.004**
• To solve most math problems you have to be taught the correct procedure.	1. Methods Courses	-0.107	0.024*
Creativity			
• In mathematics you can be creative and discover things by yourself.	1. Outside Math Activities	-0.211	0.000**
	2. Achievement level	0.131	0.006**
	3. student teaching	-0.138	0.004**
• Everything important about mathematics is already known by mathematicians.	1. Family Communication	-0.100	0.036*
	2. Methods Courses	0.110	0.021*
	3. student teaching	-0.117	0.014*
Time			
• To be good in math you must be able to solve problems quickly.			
Gender			
• Males are better at math than females.	1. Age	0.191	0.000**
	2. Gender	-0.346	0.000**

**Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level

Research Question 3. The third research question of this study was: How do the beliefs of Jordanian pre-service elementary teachers compare to the beliefs of South Korean elementary pre-service teachers? In order to answer this question, the descriptive statistics from both studies (South Korean study by Kim in 2009 and the Jordanian study) were compared. The researchers in both studies used the same questionnaire, the Mathematics Belief Instrument. The means and standards deviations for each question in the instrument were calculated. For the complete comparison see table 29.

Jordanian pre-service teachers' beliefs were stronger in 10 out of the 12 items which were included on the Mathematics Belief Instrument. The two beliefs which the Korean pre-service teachers held more strongly were 3 and 10. Item 3, "Good mathematics teachers show students lots of different ways to look at the same question," and item 10 read "Males are better at math than females."

Participants from both countries hold strong beliefs about the existence of the "mathematical mind" (Item 1: Some people are good at mathematics and some are not). This particular belief had the highest mean in the Jordanian sample (M=3.63) and the second highest in the Korean study (M=3.01). Additionally, participants from both countries disagree with the idea of differential ability by ethnic groups.

The biggest differences in means were found in items 7 and 9. In the Jordanian sample, item 7, "Math problems can be done correctly in only one way," had a mean of 2.35 while in the Korean sample, the mean was only 1.29. In item 9, "The best way to do well in math is to memorize all the formulas," the Jordanian mean was 2.81 compared to 1.73 for the Koreans (see table 16). These differences will be discussed more fully in chapter 5.

Additionally, the researcher was interested in the difference between means as well as the specific values of the means themselves. Therefore, the confidence intervals were calculated for the 12 different means in the Mathematics Belief Instrument. The items were expected to group into six specific beliefs: Mathematical mind, memorization, process vs. single right answer, creativity, time, and gender. According to table 16, ten out of the12 means do not have overlapping confidence intervals which could be interpreted as showing that the means are significantly different between Jordan and Korea.

Item 3 and 10 were the only items with overlapping confidence intervals which indicates that pre-service teachers in both countries hold similar beliefs.

Table 29

Descriptive Statistics for Individual Items in the Mathematics Beliefs Instrument: Jordan and. Korea

	Jordan		**Korea**	
Beliefs	M* (n1 , n2)**	SD	M* (n1 , n2)**	SD
Mathematical Mind				
• Some people are good at mathematics and some are not.	3.63 (3.57 , 3.69)	0.67	3.01 (2.95 , 3.07)	0.72
• Some ethnic groups are better at math than others.	2.47 (2.37 , 2.57)	1.02	1.79 (1.73 , 1.85)	0.75
Memorization				
• The best way to do well in math is to memorize all the formulas	2.81 (2.71 , 2.91)	1.06	1.73 (1.67 , 1.79)	0.68
Process vs. Right Answer				
• In mathematics something is either right or it is wrong.	2.82 (2.72 , 2.92)	1.08	2.64 (2.58 , 2.70)	0.73
• Good mathematics teachers show students lots of different ways to look at the same question.	3.39 (3.31 , 3.47)	0.87	3.44 (3.38 , 3.50)	0.74
• Good math teachers show you the exact way to answer the math question you will be tested on.	3.26 (3.18 , 3.34)	0.89	2.60 (2.54 , 2.66)	0.74
• Math problems can be done correctly in only one way.	2.35 (2.24 , 2.46)	1.13	1.29 (1.24 , 1.34)	0.61
• To solve most math problems you have to be taught the correct procedure.	3.50 (3.43 , 3.57)	0.74	2.64 (2.58 , 2.70)	0.69
Creativity				
• In mathematics you can be creative and discover things by yourself.	2.97 (2.88 , 3.06)	0.94	2.51 (2.45 , 2.57)	0.73
• Everything important about mathematics is already known by mathematicians.	2.55 (2.45 , 2.65)	1.07	2.25 (2.19 , 2.31)	0.67
Time				
• To be good in math you must be able to solve problems quickly.	2.64 (2.54 , 2.74)	1.07	2.15 (2.08 , 2.22)	0.78
Gender				
• Males are better at math than females.	2.00 (1.90 , 2.10)	1.09	2.14 (2.07 , 2.21)	0.75

* 1: false – 4: true

** The upper and lower bounds of a 95% confidence interval

CHAPTER 5

DISCUSSION

This chapter presents an overall summary of the study. Specifically, it includes a review of the purpose of the study, the research questions, a brief description of the methodology, and a discussion of the findings and the limitations. In the last section, recommendations and suggestions for future research studies are detailed.

Review of Purpose of Study

The main goal of this study was to investigate and examine Jordanian pre-service teachers' beliefs about the learning and teaching of mathematics. Since research has indicated a link between teacher beliefs and student achievement (Hersh, 1986; Raymond, Santos, and Masingila, 1991; Thompson, 1984; Schoenfeld, 1985; Frank, 1988; Carpenter, Fennema, and Peterson, 1986; Cooney, 1994), looking at the beliefs held by teachers could provide valuable information leading to increased student achievement. The primary justification for this study is the need to identify possible explanations for why Jordanian students' score much lower than many of their global counterparts on international mathematics tests. According to the 2007 results from the Trends in International Mathematics and Science Study (TIMSS), Jordanian eighth-graders scored 427 on average in mathematics, which is much lower than the TIMSS scale average of 500. Additionally, Jordan ranked 31st out of 48 participating countries.

Since the start of this study, TIMSS 2011 results have become available, and they are now the most current data. According to TIMSS 2011, Jordanian eighth-graders scored only 406 on average in mathematics which is a 21- point decrease from their 2007 results. Jordan's overall ranking in 2011was 49th out of 56 participating countries and education system.

The following research questions were addressed in this study:

1. What are the Jordanian pre-service teachers' beliefs about the teaching and learning of mathematics?
2. What is the relationship between Jordanian pre-service teacher's beliefs and the selected variables?
    a. How do pre-service teachers' beliefs about mathematics teaching and learning differ by their age and gender?
    b. How do pre-service teachers' beliefs about mathematics teaching and learning correlate with the number of mathematics courses completed previously?
    c. How do pre-service teachers' beliefs about mathematics correlate with their parents' level of education?
    d. Are there differences in the beliefs of pre-service teachers based on the number of years they have been at the university?
3. How do the beliefs of Jordanian pre-service teachers compare to the beliefs of South Korean pre-service teachers?

The participants in this study were pre-service teachers enrolled in teacher education programs in Jordan. Five universities were selected for this study: Yarmouk University, University of Jordan, Al al-Bayt University, Mu'tah University, and Jadara University. A total of 441 pre-service teachers participated. The participants completed a questionnaire survey which contained two parts: background information and the Mathematics Belief Instrument. The Mathematics Belief Instrument was designed to measure beliefs about the learning and teaching of mathematics (see Appendix A). One aim of this study was to investigate the relationship between pre-service teachers' beliefs and specific variables such as teachers' age, gender, prior mathematics experiences, parents' level of education, and participation in mathematics methods

classes. These variables were selected because the literature indicates they have been identified as characteristics that may affect teachers' beliefs. They were included in the second part of the survey (see Appendix B.)

Conclusions

Research Question 1: The first research question of this study was: What are the Jordanian elementary pre-service teachers' beliefs about the teaching and learning of mathematics?

Summary of results: In order to answer this question, descriptive statistics (mean and standard deviation) were calculated.

Discussion: The results showed that the beliefs of Jordanian pre-service teachers were mixed. In the following section, each item/belief in the Mathematics Belief Instrument is discussed separately.

Belief 1- Mathematical Mind: Item 1 addressed the belief that there is such a thing as the mathematical mind. The item asked participants' level of agreement with the following statement: "Some people are good at mathematics and some are not." This belief had a mean of 3.63 out of 4 and a standard deviation of 0.67. This was by far the strongest among the beliefs tested by the Mathematics Belief Instrument.

The implications of believing in the existence of the "mathematical mind" revolve around the importance of understanding what students are capable of doing. This, in turn may impact students' academic performance and how to improve it. If teachers view mathematics ability as fixed or stable, they might unknowingly communicate that belief through their instructional practices. Specifically, they might expect more effort and involvement only from students they think have a "mathematical mind." This is a belief that should be targeted as one on which to

focus with Jordanian pre-service teachers. Reshaping this belief could be used to improve mathematics learning and achievement among Jordanian students which would show up in future TIMSS assessments as more students are challenged to do better in mathematics and fewer are allowed to just "get by."

Belief 2- Process vs. single right answer: The belief in the importance of processes rather than just the single right answer was addressed by item 2, "In mathematics something is either right or it is wrong." This item had a mean of 2.82 and a standard deviation of 1.08. The mean for this item indicates that Jordanian pre-service teachers' belief about this item is relatively neutral. Nearly 50% of the participants said that the statement is "more true than false" or "more false than true."

When teachers focus on the mathematical thinking rather than the single right answer, students' conceptual understanding and achievement will more likely increase. Jordanian teacher preparation programs should emphasize that their students/future teachers should be taught that: 1) it is essential to know how students understand the mathematical concepts in order to help them to improve their mathematical understanding; and, 2) they need to look beyond the surface of the student's answer.

The implication of this belief is that low achieving students are more likely to be concerned only with getting the single right answer instead of focusing on the process used to find that right answer. When this belief gets communicated and accepted by students, they may look beyond the right answer in international assessment such as TIMMS study. In simple words, Jordanian teachers should believe that knowing how to solve a problem is as important as getting the right solution.

Belief 3- Process vs. single right answer: One of the items tested for this belief was item 3. It stated "Good mathematics teachers show students lots of different ways to look at the same question." The mean and the standard deviation for this belief were 3.39 and 0.87. This was another strong belief held by Jordanian pre-service teachers, and it had one of the smallest standard deviations. When teachers focus on the single right answer more than the conceptual understanding/process in the classroom, students tend to spend a great deal of time trying to recall how the teacher solved the problem or trying to remember the specific steps in their textbooks without relying on their own thinking and reasoning. Jordanian teachers should provide students with opportunities to explain their mathematical thinking rather than simply focusing on the single right answer. By doing so, teachers will be able to better identify students' misconceptions and to help students not get discouraged if their answer was wrong but the process was correct. Ultimately, Jordanian students will be better prepared when faced with problems which are not identical to something they have done in their classrooms.

Belief 4- Process vs. the right answer: Item 4 stated that "Good math teachers show you the exact way to answer the math question you will be tested on." This item had a mean of 3.26 and a standard deviation of 0.89. Once again, this was a belief strongly held by Jordanian pre-service teachers. It is worth noting that item 3 also asked participants for their agreement with "lots of different ways to look at the same question." Both items 3 and 4 had strong means, which appears contradictory; however, item 4 was could have been interpreted by students as a single right way to answer math questions which would make the two questions compatible. The researcher used this item even though the question was unclear because the exact same item was used in the Korean study. Clearly, it will be necessary to reword the questions that address these two items in future research.

The belief about an exact way to solve a math question is an unhealthy one. Jordanian pre-service teachers should be persuaded that math problems may be solved in a variety of ways and that there may not be a single best way. By adopting this belief and sharing it with students, Jordanian students may be more comfortable expressing their individuality and originality. This, in turn, may lead to improvement in their achievement scores in international assessment studies.

Belief 5- Mathematics is static: Item 5, "Everything important about mathematics is already known by mathematicians," had a mean of 2.55 and a standard deviation of 1.07. More than half of the participants (232 out of 441) believed the statement was true or more true than false which is not the desired outcome. This item addresses the unhealthy belief that mathematics is not creative, and it is not possible for new mathematical discoveries to be made.

Jordanian educators throughout different preparation programs should focus on this belief. When students start believing that mathematics is not static and that it keeps changing, they will see that their task is not simply learning old materials designed by someone else.

Belief 6- Mathematics is static: Item 6, "In mathematics you can be creative and discover things by yourself" had a mean of 2.97 and a standard deviation of 0.94. The mean indicates that this belief is relatively strong. It was encouraging to find that 74% of the participants (326 out 441) believed that the statement was true or more true than false.

Interestingly, items 5 and 6 addressed the same belief and addressed it with contradicting statements. The fact that both statements had relatively positive means (2.55 and 2.97) could indicate that Jordanian pre-service teachers misunderstood one or the other item. It could also indicate that they interpreted item 6 to mean that they believed it was possible to discover mathematics that was already known by someone else. If so, this is a positive belief that should

be supported. Clearly future research needs to be done in order to determine the exact nature of Jordanian pre-service teachers' beliefs about the status of mathematics knowledge.

The Jordanian positive belief about creativity in mathematics should be encouraged and built on. Teachers need to believe and encourage students that they can invent new ways to do mathematics rather than relying only on what they've been taught. Students with this belief may try to solve mathematic problems which they have not seen before in different assessment projects such as TIMSS.

Belief 7- Process vs. the right answer: Item 7, "Math problems can be done correctly in only one way," had a mean of 2.35 and a standard deviation of 1.13. The statement in the survey was opposite in direction from the desired belief. While a small mean was desired, almost half of the participants believed the statement was true or more true than false. The mean indicates that this belief was neither strong nor weak; therefore, with the right guidance and structures, the belief could be reshaped. Furthermore, the standard deviation is large enough to suggest that this belief is widely varied with Jordanian pre-service teachers.

The belief that math problems can be done in multiple ways is significant and should be targeted as pre-service teachers go through their preparation programs.

Belief #8: Process. This variable addressed the importance of the process involved in mathematics. To assess this belief, the following item was included in the survey: "To solve most math problems you have to be taught the correct procedure." This item had a mean of 3.50, and a standard deviation of 0.74, indicating that it was one of the strongest beliefs, second only to the belief in the mathematical mind.

This may suggest, however, that Jordanian pre-service teachers believe that students are expecting to be taught the right process rather than figuring out mathematical problems on their

own, which is less healthy. Additionally, the belief statement seems to say that there's only one correct procedure, which in reality is not true. It would be beneficial to students if this belief would be targeted among pre-service teachers. By doing so as teachers, they will empower their students to think for themselves and consider alternative algorithms or strategies. As a result, their students will try to figure things out on their own instead of falling back on memorizing certain procedures. On tests such as TIMSS, students will be less likely to be afraid or unwilling to try problems they have not seen or worked before.

Belief 9- Memorization: Item 9 was used to address the belief that mathematics relies heavily on memorization. It stated "The best way to do well in math is to memorize all the formulas." The primary reason for including this variable was to find out what teachers believed regarding memorization vs. reasoning.

The item had a mean of 2.81 and a standard deviation of 1.06. Nearly 65% of the participants believed that the statement was true or more true than false. This belief is unhealthy and should be changed. A lower mean was more desired because the question was negatively worded. These findings/beliefs are very important for the teaching and learning of mathematics. If for instance a teacher believes that the best way to learn mathematics is to memorize a set of rules or procedures, he/she might think that conceptual understanding is not of high importance. Research and major recommendations for the past 30 years say that teachers and students should rely more on reasoning and less on memory when doing mathematics (NCTM, 1989, 2000 & Common Core State Standards Initiative, 2010).

Learning mathematics may require recalling certain rules or formulas; however, Jordanian teachers should promote a teaching approach in which understanding and process dominate memorization. When students rely on memorization and how to follow the teacher's

direction only, there is a possibility that they will not think critically to solve non-routine math problems such as those included in the TIMSS study.

It is worth noting that there is a possibility that the participants in this study were reacting to the need to memorize formulas as opposed to the more general belief of the importance of memory in mathematics. This, like many other beliefs in this study, should be researched further in future studies.

Belief 10- Gender: The item that addressed this belief in the survey was "Males are better at math than females." Lower scores were desired because the statement was negatively worded; the healthy belief is that neither gender is better than the other at mathematics. Interestingly, this belief had a mean of 2.00, which was the lowest mean among all items and a standard deviation of 1.09. Almost 70% of the participants disagreed with the statement.

This belief about gender differences is important, and it has a strong connection to what takes place in the classroom. For example, when a teacher believes that mathematics is a male domain, there is a possibility that he/she will address more questions to boys than girls which will result in more attention and praise. Similarly, research has shown that teachers often probe more with males or ask more thought-provoking questions. On the other hand, a successful teacher should believe that girls have mathematical capabilities similar to boys. Additionally, when teachers believe that there are no or very small gender differences, they tend to provide meaningful experiences through appropriate instruction, praise, and guidance. These rich experiences and the continued support can positively influence students, and it could improve attitudes and achievement scores in different assessments including the TIMSS study.

Belief 11- Mathematical Mind: Item 11, "Some ethnic groups are better at math than others." The goal of this item was to determine whether pre-service teachers believed that

mathematics ability is connected to certain ethnicities. This belief had a mean of 2.47 and a standard deviation of 1.02. Once again, lower scores were desired because the item was negatively worded. The results from item 11 and item 1 revealed interesting results. The goal of both items was to investigate teachers' belief about the existence of a "mathematical mind." Regarding item 1, participants strongly agreed that some people are naturally better than others at mathematics (M=3.63). However, item 11 showed that pre-service teachers' beliefs with respect to ethnicity were mixed. Out of 441 participants, 227 agreed with the statement and 214 disagreed.

Believing that mathematical abilities belong to certain races or ethnicities is unhealthy and should be targeted for change. Teachers should believe that everyone has the ability to learn and perform mathematics.

Belief 12- Time: The specific item used for this belief was: "To be good in math you must be able to solve problems quickly." The belief had a mean of 2.64 and a standard deviation of 1.07. Again, lower scores were desired because the belief was negatively worded. Based on the number of participants who agreed and disagreed, the belief about time spent working on math problems produced mixed results. Two hundred and thirty-six participants out of 441 reported that this statement was true or more true than false. Pre-service teachers' belief about how quickly students must solve math problems may affect their classroom experiences or the activities they choose for their students. Teachers must adopt the belief that while some basic facts and procedures should be mastered to solve mathematical problems quickly, it is also essential to believe that some mathematical problems may need deeper thinking which will require a longer time.

Research Question 2: The second research question of this study was: What is the relationship between Jordanian pre-service teachers' beliefs and the selected variables?

e. How do pre-service teachers' beliefs about mathematics teaching and learning differ by their age, grade level, and gender?
f. How do pre-service teachers' beliefs about mathematics teaching and learning correlate with the number of mathematics courses completed previously?
g. How do pre-service teachers' beliefs about mathematics correlate with their parents' level of education?
h. Are there differences in the beliefs of pre-service teachers based on the number of years they have been at the university?

Summary of results:

In order to answer this question, Spearman's correlation test was conducted to investigate the relationship between items in the Mathematics Belief Instrument and participants' characteristics. The next sections will discuss each belief, healthy or unhealthy and the relationships that existed among the characteristics studies.

Discussion:

Belief 1- Mathematical mind: The first belief, "Some people are good at mathematics and some are not," was significantly correlated with the number of mathematics methods courses taken and with the age of participants. The belief about the existence of a "mathematical mind" is unhealthy and needs to be challenged and changed. First, this belief had a negative correlation with the number of mathematics methods courses already taken by the participant (-0.104). The negative correlation indicates that the fewer mathematics methods courses the participant had completed, the stronger the belief. This is good because it suggests that the methods courses may be effectively challenging this belief.

The second significant relationship was with the age of the participant. Again, the correlation was negative (-0.139) indicating that the older the student was, the less strong the belief became. In general, this is also a desirable result. As was stated previously, this is an unhealthy belief and to see that Jordanian pre-service teachers are less likely to believe it as they get older is a positive thing for their future students. The two significant relationships also indicate that the current education system in Jordan is implementing the necessary means to reshape pre-service teachers' belief in a mathematical mind as they go through the required mathematics methods classes.

Belief 2- Process vs. single right answer: The belief, "In mathematics something is either right or it is wrong," did not show any significant relationship with any of the participants' characteristics at the time of the study. This belief is unhealthy and since this is not a belief that research supports, the Jordanian education system could address it overtly. Changing this belief among teachers will have a direct impact on students' attitudes toward mathematics. For example, many students will start believing that process is as important as the right answer. In early grades, when students give answers for math questions asked by teachers, they (students) watch for immediate feedback from the teacher to determine whether they got the answer right or wrong. Emphasizing the importance of process instead of "a single right answer" will create a richer experience that will translate into improved critical thinking for Jordanian students.

Belief 3- Process vs. single right answer: The belief, "Good mathematics teachers show students lots of different ways to look at the same question," is a healthy belief and needs to be encouraged. It had a significant relationship with the level of education for participants' fathers (0.104). The relationship was positive indicating that the more educated the father is, the stronger

is the belief. There is a possibility that the positive relationship could mean that participants are influenced most by their father when it comes to the importance of process in mathematics.

Belief 4- Process vs. single right answer: The question testing for this belief was not a good question. It asked participants the following: "Good math teachers show you the exact way to answer the math question you will be tested on." This is an ambiguous question which could be understood differently based on the participant's interpretation. The goal of the question was to highlight the importance of the process that should take place when doing mathematics. However, part of the question, the words "exact way," seemed to indicate that the question was emphasizing "one right way" to answer math questions. Interestingly, this belief was not related to any characteristics. Mathematics education programs should focus on process and understanding, not on a single right way to work a problem. In future studies, this question needs to be reworded to eliminate ambiguity.

Belief 5- Static: The belief that mathematics is static is unhealthy and should be challenged. The item testing for this belief was "Everything important about mathematics is already known by mathematicians." This belief had three significant relationships. First, it had a negative correlation with whether the participant communicated with a family member who majored in mathematics. Because the question was worded negatively, a negative correlation coefficient was desired. However, not much importance can be ascribed because very few students had family members who majored in mathematics. In future studies, the question would be more meaningful if it were rewritten to replace "major in mathematics" with "positive conversation about mathematics."

A second relationship was found with the number of mathematics method courses already taken by the participant. The correlation was positive with the static belief. This is problematic

and requires change in the methods courses to address the belief. It implies that currently methods courses are fostering this unhealthy belief.

The third significant relationship was found with whether the participant completed his/her student teaching. The correlation was negative indicating that if participants taught, they were less likely to believe in item 5.

Belief 6- Static: The item testing for this belief was "In mathematics you can be creative and discover things by yourself." This is a healthy belief that teachers as well as students should hold. The results showed that this belief had significant relationships with participation in math activities outside the classroom, participant's achievement level, and completion of student teaching.

The first relationship, between math activities and this belief, had a negative correlation coefficient (-0.211) significant at the 0.05 level. It indicates that the more activities a person participated in, the less likely he/she was to believe that he/she could be creative in mathematics. This relationship is a concern and requires further investigation. The negative correlation coefficient could mean that the activities' type needs to be changed. For example, pre-service teachers may be advised to join a math club which focuses on math exploration and curriculum instead of simple math competitions which is much more common. The negative relationship between this belief and whether the participants participated in math activities should be taken with a grain of salt, however, because only 14% of participants reported that they had participated in math activities outside the classroom (65 out 441).

The second significant relationship was with the participants' achievement level. It had a positive correlation coefficient of 0.131 (< 0.05) indicating that the higher the participants'

achievement level, the stronger their belief that they could be creative and discover things by themselves.

A significant relationship also existed between belief 6 and the characteristic of completion of student teaching. The relationship was negative and had a coefficient of -0.138 (< 0.05). Again, this finding may suggests that teaching in Jordan focuses on procedural concepts and on following a set of procedures to find answers to math problems. The belief that there is a room for creativity in mathematics requires that teacher preparation programs start focusing on conceptual knowledge more and procedural knowledge less.

Belief 7- Process vs. single right answer: Two variables had a significant relationship with belief 7, "Math problems can be done correctly in only one way." First, the number of mathematics content courses was significant at the 0.05 level. The correlation coefficient was (0.097) meaning that the more math content courses the participant completed, the stronger their belief in item 7. The second relationship existed with the number of mathematics methods courses already taken. The correlation was also positive and had a correlation coefficient of 0.137. Again, the positive correlation means that the more math methods courses the participants completed, the stronger their belief tended to be. This correlation was significant at the 0.01 level

The belief that "Math problems can be done correctly in only one way," is unhealthy and should be challenged. Interestingly, both mathematics content and methods had positive relationships with it which could be interpreted as the Jordanian educational system is reinforcing this belief. Ideally, the relationships should be negative meaning that as pre-service teachers complete their necessary math content and methods courses, they should start believing that math can be done in more than one way. However, the reliability of this finding for both

relationships is questionable because of the issue during the translation of the instrument from English to Arabic.

The questions in the instrument to collect data about the number of math content and methods courses were: “How many courses in math content (e.g., Calculus, Geometry, Algebra) did you take prior to enrolling in college?” and “How many courses in math teaching methods (e.g., mathematics curriculum design, learning and teaching in mathematics, elementary mathematics methods, secondary mathematics methods) did you take?”

However, the translated version (Arabic version) could be interpreted to ask for the number of “workshops” the participants had completed instead of courses. This is the most probable reason why almost 60% of participants reported zero for the completed courses. Because of this, it is recommended that the impact of mathematics content and methods courses on teachers’ beliefs be reinvestigated.

Belief 8- Process vs. single right answer: Belief 8, “To solve most math problems you have to be taught the correct procedure,” is another unhealthy belief. Again, the number of mathematics methods courses showed a significant relationship with this belief. The relationship was negative (-0.107) at the 0.05 level indicating that the more mathematics methods courses participants had completed, the weaker the belief was, which this is a desirable result. The problems with the questionnaire and with the translations require that the relationships be revalidated.

Belief 9- Memorization: The belief that “The best way to do well in math is to memorize all the formulas,” is another unhealthy belief that should be targeted for change. It had a significant relationship only with the father’s educational level. The correlation was significant at the 0.05 level and negative (-0.095) indicating that the more educated the father, the less

emphasis the participant put on memorizing formulas, which is the desired direction. The finding suggests that the healthy form of this belief is more recognized or valued by the "better educated" in Jordanian families. Because most participants reported a low level of parental education, this relationship, too, is only mildly interesting or important.

Belief 10- Gender: the belief that "Males are better at math than females," had significant relationships with age and gender. The two relationships were both significant at 0.01 level, however, age had a positive correlation (0.191) and gender had negative correlation (-0.346). The positive correlation between age and this belief means that the older the participants are, the stronger they feel about belief 10. It would have been more desirable to have negative correlation between age and this belief. Probably the mathematics methods courses would be a good place to start discussing the importance of this belief. According to the 2011 results from the Trends in International Mathematics and Science Study (TIMSS), Jordanian female students outscored boys by 28 points on average. Since 1999 -the first time Jordan participated in TIMSS- girls have outperformed boys in every cycle (1999, 2003, 2007, and 2007). Table 30 shows achievement differences by gender among Jordanian students.

Table 30

Trends in Mathematics Achievement by Gender

	Girls	Boys
1999	431	425
2003	438	411
2007	438	417
2011	420	392

Additionally, the negative relationship between this belief and gender suggests that girls –the majority of the participants (more than 80%) - do not agree with the statement. The belief

that boys are better than girls in math is unhealthy and should be subject to change. The desirable belief is that there is no difference between abilities of males and females in mathematics.

Belief 11- Mathematical mind: The belief that some ethnic groups are better than others in mathematics is unhealthy and should be challenged wherever it exists. Participant's achievement level was the only characteristic that had a significant relationship with this belief. The relationship was negative (-0.119) and significant at the 0.05 level. It indicates that the higher the participant's achievement level, the less likely he/she is to believe that some ethnic groups are better than others. What is interesting about this finding is that while Jordanian pre-service teachers strongly believe that some people are better than others in mathematics, however, they are less likely to ascribe mathematical ability to a specific ethnic group.

Belief 12- Time: The belief that "To be good in math you must be able to solve problems quickly," is another unhealthy belief in mathematics. This belief did not have any significant relationships with any participant characteristics. It would be more desirable if a negative correlation with mathematics methods courses existed.

The relationships between the different beliefs and participants' characteristics showed interesting results which should be subjects for further investigation. Specifically, mathematics methods courses already completed by the participant, had more significant relationships with beliefs than any other characteristic. It had a significant relationship with beliefs 5 "Everything important about mathematics is already known by mathematicians," belief 7, "Math problems can be done correctly in only one way," and belief 8, "To solve most math problems you have to be taught the correct procedure." As mentioned earlier, these results should be interpreted carefully because of the issue regarding the translation of the question about mathematics methods courses.

Research Question 3: The third research question of this study was: How do the beliefs of Jordanian pre-service teachers compare to the beliefs of South Korean pre-service teachers?

Summary of results: The answer for this question was drawn from the descriptive statistics in two studies, the South Korean study by Kim in 2009 and this Jordanian study. The researchers in both studies used the same questionnaire, the Mathematics Belief Instrument. The means and standards deviations for each question in the instrument were calculated. For the complete comparison see table 10 in chapter 4.

Discussion: As was mentioned in chapter 4 and was evident in table 10, Jordanian pre-service teachers' means were stronger (either closer to 1 or closer to 4) in 10 out of the 12 items included in the Mathematics Belief Instrument. This suggests that Jordanian pre-service teachers' beliefs, whether healthy or unhealthy, are stronger than those of Korean pre-service teachers. The two items on which the Korean pre-service teachers had higher means were 3 and 10. Item 3 stated, "Good mathematics teachers show students lots of different ways to look at the same question," and item 10 read "Males are better at math than females."

Participants from both countries believed strongly about the existence of the "mathematical mind" (Item 1: Some people are good at mathematics and some are not). Item 1 had the highest mean in the Jordanian sample (M=3.63) and the second highest in the Korean study (M=3.01). However, the difference in means (3.63 vs. 3.01) seems quite large since this is an unhealthy belief, and one than is not supported by research. It would seem that pre-service teachers in both countries could benefit from challenging it, but the differences suggest that Jordanian pre-service teachers have much more to gain by confronting this belief. Presumably, then, if this belief were to change, Jordanian pre-service teachers would work hard for all their students. This surely could result in TIMSS scores increasing for Jordanian students.

The biggest differences in means were found in items 7 and 9. In the Jordanian sample, item 7, “Math problems can be done correctly in only one way,” had a mean of 2.35. The mean for that item was only1.29 in the Korean study. In item 9 “The best way to do well in math is to memorize all the formulas” the Jordanian mean was 2.81 compared to 1.73 in the Korean sample.

These two items reveal interesting findings. First, the Korean pre-service teachers did not believe that memorization of formulas is important compared to mathematical reasoning and problem solving. On the other hand, nearly 65% of the participants in the Jordanian study (281 out 441) believed that in order to do well in mathematics, students need to memorize all formulas. This is a fundamental difference in the learning of mathematics. Korean students rely more on reasoning and understanding while Jordanian students rely on memory.

Perhaps one of the reasons the Korean ranking was so high in international comparisons - second in 2007 and first in 2011- was that Korean students were willing to attempt all of the problems while Jordanian students were hampered by not being able to remember the correct way to work certain problems.

Summary of important results

The study sought to investigate beliefs held by pre-service teachers in Jordan and compare them with the beliefs held by pre-service teachers in South Korea. The following are some of the most important findings:

Research question one: What are the Jordanian pre-service teachers’ beliefs about the teaching and learning of mathematics?

The majority of Jordanian pre-service teachers (93.4%) believed in the existence of a “mathematical mind.” If teachers view mathematics ability as fixed or stable, they might

unknowingly communicate that belief through their instructional practices. Another essential finding is about memorization. Nearly 65% of the participants believed that mathematics relies heavily on memorization. If for instance a teacher believes that the best way to learn mathematics is to memorize a set of rules or procedures, he/she might think that conceptual understanding is unimportant.

Finally, 70 % of the participants believed that neither gender was better than the other at mathematics.

Research question 2: What is the relationship between Jordanian pre-service teacher's beliefs and participant background characteristics?

The number of mathematics methods courses appears to be the most significant characteristic of all that were studied. It had the highest number of significant relationships, two positive and one negative. The first positive correlation was with the static belief, "Everything important about mathematics is already known by mathematicians." This is problematic and requires change in the methods courses to address the belief. It implies that currently methods courses are fostering this unhealthy belief. The second positive correlation was with the belief that "Math problems can be done correctly in only one way." The positive correlation means that the more math methods courses the participants have complete, the stronger their belief tended to be. Ideally, as pre-service teachers complete their necessary mathematics methods courses, they should start believing that math can be done in more than one way. Hence, this one is also problematic.

The negative correlation was with the belief about the mathematical mind. The negative relationship indicates that the fewer mathematics methods courses the participant had completed the stronger the belief. This is good because it suggests that the methods courses may be

effectively challenging this belief. In summary, methods courses appear to have the greatest impact on beliefs and they should be used to challenge beliefs about mathematics being static and about placing an emphasis on a single way or method of doing mathematics. They should also be used to foster the belief that all students can do mathematics.

The second important characteristic is the fathers' educational level. It had a positive relationship was with the belief that "Good mathematics teachers show students lots of different ways to look at the same question," and a negative correlation with the belief that "The best way to do well in math is to memorize all the formulas." Both of these correlation support healthy beliefs about the teaching and learning of mathematics. This suggests that more education - for parents and for pre-service teachers- will ultimately make an impact on the beliefs that are formed by primary and secondary students.

Research question 3: How do the beliefs of Jordanian pre-service teachers compare to the beliefs of South Korean pre-service teachers?

One of the biggest differences found between Jordanian pre-service teachers and Korean pre-service teachers' beliefs is the importance of memorization. Jordanian pre-service teachers believed that in order to do well in mathematics, students need to memorize all the formulas. On the other hand, Korean pre-service teachers did not believe that memorization of formulas is important compared to mathematical reasoning and problem solving. This could be a major difference in how students achieve because Korean students would be willing to attempt all problems, even those they had not seen before while Jordanian students might give up when presented with a problem for which they had not memorized a strategy or formula.

Jordanian pre-service teachers differ than Korean pre-service teachers regarding the belief that "Math problems can be done correctly in only one way." The majority of Korean pre-

service teachers disagreed with this statement while almost half of the participants in the Jordanian sample believed the statement was true or more true than false. Believing in multiple ways to solve problems provides a foundation for Korean students to think critically about all mathematics while Jordanian students would be more likely to rely on learned algorithms.

Limitations of the Study

The limitations of this study will be discussed in terms of participants, methodology, and the surveys.

One limitation of this study involves its validity because of what is called in the literature "social desirability" or "acquiescence bias." Social desirability is the tendency of participants to answer questions in a manner that presents a favorable image of themselves (Chung and Monroe, 2003). While the surveys were completely anonymous, there is always a concern that some participants may have answered in the way they thought was desired, rather than stating their true beliefs.

Acquiescence bias is the tendency that some respondents have a preference for agreeing or find it easier to agree with a statement than to disagree. In order to prevent this, the Mathematics Beliefs Instrument should be expanded to allow each belief to be addressed more than once, so that each belief could be worded in both a positive and a negative manner.

Another limitation of the study is the gender distribution in the sample. While 441 students participated in this study, 336 of them were females (81.6%).

A third limitation of this study is the reliability of the instrument used. While the instrument was used and validated in previous studies (Kim, 2009), based on the results of correlation analysis, Cronbach's Alpha was very low (0.41). Additionally, there were only weak

inter-relationships among the 12 items. Because of this limitation; a new instrument should be developed, validated, and used in future studies.

A fourth limitation involves the translation of the instruments. The official language in Jordan is Arabic; therefore, both parts of the instrument were translated into the Arabic language. A certified and licensed translator completed the translation process. However, during the translation process, the questions from the survey about the number of content courses and the number of mathematics methods courses completed by participants were almost certainly misunderstood. The questions in the survey were: "How many courses in math content (e.g., Calculus, Geometry, Algebra) did you take prior to enrolling in college?" and "How many courses in math teaching methods (e.g., mathematics curriculum design, learning and teaching in mathematics, elementary mathematics methods, secondary mathematics methods) did you take?" Unfortunately, the translated version (Arabic version) could be interpreted to ask for the number of "workshops" the participants completed instead of courses. This is the most probable explanation for the fact that almost 60% of participants reported zero for the number of completed courses. A more accurate translation might have produced very different results.

Suggestions for Future Research

The main goal of this study was to investigate and examine Jordanian pre-service teachers' beliefs about the learning and teaching of mathematics. Based on the results of this study, there are many areas that should be the focus of future research.

First, future research regarding the impact of the methods courses in teachers' preparation programs on pre-service teachers' beliefs will be valuable. Because of the limitation discussed in the previous section regarding the issue with translation, the interpretations about the results should be carefully examined. Specifically, the questions in the background instrument about

the number of mathematics methods and content courses are thought to have been mistranslated which could have impacted the results. Therefore, future research about the impact of mathematics methods and content courses on pre-service beliefs would provide additional information to those interested in mathematics education.

Second, in order to compare Jordanian pre-service teachers' beliefs with the Korean pre-service teachers, the researcher in this study used the same instrument that was used in the Korean study. However, the correlation coefficients between the items in the Mathematics Belief Instrument were very low. Additionally, many of the questions have proven to be ambiguous. Therefore, a new instrument with revised and validated items should be utilized to reinvestigate and explain Jordanian pre-service teachers' beliefs.

Third, future studies could follow prospective teachers through their first few years of their teaching careers. These studies could explore whether beliefs change with time based on the socialization with students and other mathematics teachers.

Having a teaching force with appropriate content and pedagogical knowledge and holding healthy beliefs about the learning and teaching of mathematics is the key to improving students' learning/achievement. Therefore, offering and investigating the impact of quality professional development for in-service teachers is another area for future research. It is critical to retaining and improving in-service teachers and is a valuable next step toward impacting student achievement in Jordan.

Conclusion

This study investigated Jordanian pre-service teachers' beliefs about the learning and teaching of mathematics as they moved through their preparation programs. The aim of the study was the need to identify possible explanations for why Jordanian students score much lower than

many of their global counterparts on international mathematics tests. According to the 2007 results from the Trends in International Mathematics and Science Study (TIMSS), Jordanian eighth-graders scored 427 on average in mathematics, which is much lower than the TIMSS scale average of 500. Furthermore, Jordan ranked 31st out of 48 participating countries. Additionally, according to the most current data and last administered cycle of TIMSS, TIMSS 2011, Jordanian eighth-graders scored only 406 on average which is a 21- point decrease from their 2007 results. Jordan's overall ranking in 2011was 49th out of 56 participating countries and education systems.

Significant results found from this study, if addressed, could impact students' achievement in international assessment. First, nearly 95% of the participants believed in the existence of a mathematical mind. If this belief were to change, Jordanian pre-service teachers might work harder for all their students; this surely could cause TIMSS scores to go up. Second, nearly 65% of the participants believed that the best way to learn mathematics is to memorize all the formulas. If this belief were to change, Jordanian pre-service teachers might help students to see alternative ways to work problems –ways that might be generalizable.

Jordanian pre-service teachers seem to hold relatively strong beliefs, healthy or unhealthy. Ten out of the 12 beliefs in the Mathematics Beliefs Instrument were worded negatively (unhealthy), however, Jordanian pre-service teachers showed strong feelings on many of them, the strength of these feelings was much stronger than the feelings of their Korean counterparts. At the same time, they showed strong feelings about the healthy beliefs as well. Additionally, it was evident that the characteristic, the number of mathematics methods courses completed by participant, had the most significant relationships with Jordanian pre-service teachers' beliefs.

The comparison between Jordanian and Korean pre-service teachers produced significant results. Specifically, Korean beliefs are much less "absolute." The strong beliefs of Jordanian pre-service teachers if tempered more like the beliefs in Korea, might help to improve Jordan's standing in international mathematics comparisons.

The findings of the study provide many ideas for future research in the areas of pre-service teachers' beliefs. Further research regarding the impact of teacher preparation programs on beliefs is warranted. Knowledge gained through such studies will provide mathematics teacher educators in Jordan with the necessary information to better prepare mathematics teachers and, as a result, with a better way of learning mathematics for Jordanian students.

Appendix A

Part 1: Mathematics Beliefs Instrument

	Item	False	More false than true	More true than false	True
1	Some people are good at mathematics and some are not.				
2	In mathematics something is either right or it is wrong.				
3	Good mathematics teachers show students lots of different ways to look at the same question.				
4	Good math teachers show you the exact way to answer the math question you will be tested on.				
5	Everything important about mathematics is already known by mathematicians.				
6	In mathematics you can be creative and discover things by yourself.				
7	Math problems can be done correctly in only one way.				
8	To solve most math problems you have to be taught the correct procedure.				
9	The best way to do well in math is to memorize all the formulas				
10	Males are better at math than females.				
11	Some ethnic groups are better at math than others.				
12	To be good in math you must be able to solve problems quickly.				

Appendix B

Part 2: Background Information

1. Age ( )
2. Gender Male ( ) Female ( )
3. Parents' Educational Level:

   Father:

   ( ) Below High School Education

   ( ) Graduated High School

   ( ) Graduated 2-year College

   ( ) graduated 4-year College

   ( ) graduated graduate School

   Mother:

   ( ) Below High School Education

   ( ) Graduated High School

   ( ) Graduated 2-year College

   ( ) graduated 4-year College

   ( ) graduated graduate School

4. Describe your parents attitude about mathematics

   Very negative ( ) negative ( ) Uncertain ( ) Positive ( ) very Positive ( )

5. I have had a chance to communicate with family member who majored in Mathematics
6. I participated in math activities outside the classroom setting (for example: mathematics workshops) before entering college

Yes ( ) No ( )

7. What was the level of your mathematics achievment

   Low (20%) ( )

   Below Average (40-60%) ( )

   Average (40-60%) ( )

   Above Average (60-80%) ( )

   High (Greater than 80%) ( )

8. How many courses in math content (e.g., Calculus, Geometery, Algebra) did you take prior to enroll in college?

   ( ) courses.

9. How many courses in math teaching methods (e.g., mathematics curriculum design, learning and teaching in mathematics, elementary mathematics methods, secondary mathematics methods) did you take?

   ( ) courses.

10. Did you experience student teaching yet?

    Yes ( ) No ( )

Appendix C

Yarmouk University Results on Mathematics Beliefs Instrument (N=156)

	Mean	SD
Some people are good at mathematics and some are not.	3.77	0.55
In mathematics something is either right or it is wrong.	2.83	1.10
Good mathematics teachers show students lots of different ways to look at the same question.	3.47	0.80
Good math teachers show you the exact way to answer the math question you will be tested on.	3.42	0.83
Everything important about mathematics is already known by mathematicians.	2.55	1.06
In mathematics you can be creative and discover things by yourself.	2.95	0.94
Math problems can be done correctly in only one way.	2.58	1.14
To solve most math problems you have to be taught the correct procedure.	3.67	0.55
The best way to do well in math is to memorize all the formulas.	2.97	1.01
Males are better at math than females.	1.78	0.91
Some ethnic groups are better at math than others.	2.57	0.97
To be good in math you must be able to solve problems quickly.	2.73	1.06

Appendix D

Mu'tah University Results on Mathematics Beliefs Instrument (N=73)

	Mean	SD
Some people are good at mathematics and some are not.	3.60	0.70
In mathematics something is either right or it is wrong.	2.67	1.18
Good mathematics teachers show students lots of different ways to look at the same question.	3.36	0.93
Good math teachers show you the exact way to answer the math question you will be tested on.	3.22	0.87
Everything important about mathematics is already known by mathematicians.	2.48	1.09
In mathematics you can be creative and discover things by yourself.	2.93	0.99
Math problems can be done correctly in only one way.	2.53	1.01
To solve most math problems you have to be taught the correct procedure.	3.44	0.71
The best way to do well in math is to memorize all the formulas.	2.99	1.09
Males are better at math than females.	1.68	0.86
Some ethnic groups are better at math than others.	2.52	0.96
To be good in math you must be able to solve problems quickly.	2.67	1.08

Appendix E

Al-Bayt University Results on Mathematics Beliefs Instrument (N=82)

	Mean	SD
Some people are good at mathematics and some are not.	3.41	0.85
In mathematics something is either right or it is wrong.	2.62	1.11
Good mathematics teachers show students lots of different ways to look at the same question.	3.39	0.89
Good math teachers show you the exact way to answer the math question you will be tested on.	3.37	0.82
Everything important about mathematics is already known by mathematicians.	2.45	1.09
In mathematics you can be creative and discover things by yourself.	3.15	0.89
Math problems can be done correctly in only one way.	2.28	1.20
To solve most math problems you have to be taught the correct procedure.	3.28	0.95
The best way to do well in math is to memorize all the formulas.	2.62	1.12
Males are better at math than females.	2.13	1.16
Some ethnic groups are better at math than others.	2.39	1.07
To be good in math you must be able to solve problems quickly.	2.49	1.11

Appendix F

Jordan University Results on Mathematics Beliefs Instrument (N=49)

	Mean	SD
Some people are good at mathematics and some are not.	3.59	0.61
In mathematics something is either right or it is wrong.	3.06	1.01
Good mathematics teachers show students lots of different ways to look at the same question.	3.43	0.87
Good math teachers show you the exact way to answer the math question you will be tested on.	2.82	1.09
Everything important about mathematics is already known by mathematicians.	2.67	1.05
In mathematics you can be creative and discover things by yourself.	2.92	0.93
Math problems can be done correctly in only one way.	1.98	1.01
To solve most math problems you have to be taught the correct procedure.	3.39	0.86
The best way to do well in math is to memorize all the formulas.	2.35	1.03
Males are better at math than females.	1.84	0.99
Some ethnic groups are better at math than others.	2.22	0.98
To be good in math you must be able to solve problems quickly.	2.14	0.94

Appendix G

Jadara University Results on Mathematics Beliefs Instrument (N=81)

	Mean	SD
Some people are good at mathematics and some are not.	3.63	0.66
In mathematics something is either right or it is wrong.	3.04	0.97
Good mathematics teachers show students lots of different ways to look at the same question.	3.28	0.95
Good math teachers show you the exact way to answer the math question you will be tested on.	3.16	0.89
Everything important about mathematics is already known by mathematicians.	2.68	1.09
In mathematics you can be creative and discover things by yourself.	2.93	0.98
Math problems can be done correctly in only one way.	2.07	1.10
To solve most math problems you have to be taught the correct procedure.	3.53	0.74
The best way to do well in math is to memorize all the formulas.	2.84	1.05
Males are better at math than females.	2.73	1.26
Some ethnic groups are better at math than others.	2.48	1.14
To be good in math you must be able to solve problems quickly.	2.94	1.05

APPENDIX H

RESEARCHERS AND RESEARCHED BELIEFS

Barger, 1999

Belief	Description
Male Domain	Students' beliefs about mathematics being a male domain, i.e., more appropriate for males
Memorizing	Students' beliefs about the importance of memorizing in mathematics
Math Mind	Students' beliefs about the existence of "math mind" that is only possessed by those who do well in mathematics
Single Answer	Students' beliefs concerning whether mathematics problems always have a single correct answer
Process	Students' beliefs with respect to the importance of process over product (answer) in mathematics
Rule driven	Strength of students' beliefs that mathematics is driven by rules
Static	Students' beliefs that mathematics is static as opposed to creative, i. e., everything important in mathematics is already known
Time	Students' beliefs about the amount of time they should spend working on a mathematics problem
Expert	Students' beliefs that mathematics must be learned from an expert rather than their peers or figured out on their own

Garofalo, 1989

1. Almost all mathematics problems can be solved by the direct application of the facts, rules, formulas, and procedures shown by the teacher or given in the textbook.

2. Mathematical thinking consists of being able to learn, remember, and apply facts, rules, formulas, and procedures.

3. Mathematics textbook exercises can be solved only by the methods presented in the textbook; moreover, such exercises must be solved by the methods presented in the section of the textbook in which they appear.

4. Only the mathematics to be tested is important and worth knowing.

5. Formulas are important, but their derivations are not.

6. Mathematics is created only by very prodigious and creative people; other people just try to learn what is handed to them.

Kogelman and Warren, 1978

1. Some people have a math mind and some don't.
2. Math requires logic, not intuition.
3. You must always know how you got the answers.
4. Math requires a good memory.
5. There is a best way to do a math problem.
6. Math is done by working intensely until the problem is solved.
7. Men are better in math than women.
8. It's always important to get the answer exactly right.
9. Mathematicians do problem quickly, in their heads.
10. There is a magic key to doing math.
11. Math is not creative.
12. It's bad to count on your fingers.

Frank, 1988

1. Math is computation.
2. Doing math means following rules.
3. Learning math is mostly memorizing.
4. Mathematics problems should be done quickly solvable in just a few steps.
5. Something is wrong either with the problem solver or with the problem itself if it takes "too long" (more than 5 to 10 minutes) to solve.

6. The goal of doing mathematics is to obtain “right answer.”
7. Only the teacher can tell when an answer is right or wrong.
8. The role of the math student is to receive mathematical knowledge and to demonstrate that it has been received.
9. The role of the math teacher is to transmit mathematical knowledge and to verify that students have received this knowledge.

Buerk, 1985

1. Math is a collection of right answers and correct methods.
2. Math is cold and logical.
3. Math is not intuitive or creative.
4. Math is learned by memorization.
5. Math is learned by those with a mathematical mind.

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VITA

Adeeb Mohmad Jarrah was born on December 5, 1968 Jordan. He attended elementary, middle, and high school in a small town in the north of Jordan called Almazar. He graduated high school in 1986. He traveled to former Yugoslavia to attend college. Due to financial circumstances, he left that country and moved to the United States in 1990. He settled in Kansas City, where he got married, was a business owner, and has raised a family.

Mr. Jarrah has a Bachelor of Arts degree in Computer Science and an MBA with a concentration in Management Information Systems. In 2008, Mr. Jarrah began working towards his Interdisciplinary Ph.D. at the University of Missouri-Kansas City in Mathematics Education and with a co-discipline in Telecommunication and Computer Networking. While working towards this degree, he has had the opportunity to teach at the University of Missouri-Kansas City. He taught a variety of courses for pre-service teachers as well as general studies mathematics courses.

Upon completion of degree requirements, Mr. Jarrah plans to continue his career as a mathematics teacher educator and to pursue his research interests which include pre-service teachers' beliefs about mathematics, quality teacher preparation, and learning and teaching mathematics in the Middle East. Mr. Jarrah is a member of the National Council of Teachers of Mathematics, Missouri Council of Teachers of Mathematics, and the Kansas City Area Teachers of Mathematics. He is a current board member and conference co-chair within the Kansas City Area Teachers of Mathematics.