BELIEFS ABOUT MATHEMATICS AND MATHEMATICS INSTRUCTION AMONG BASIC EDUCATION MATHEMATICS TEACHERS IN AL-BATINAH SOUTH, OMAN

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DEDICATION

For the greatest family:

My dear Mother and wife who fill my heart with love and life with beauty, and our beloved kids: AL-genan, Ouf and Al-juri, for being part of this amazing journey to get" our" master degree! And trust that they will see value in the pursuit of knowledge

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LIST OF ABBREVIATIONS

BAM	Beliefs About Mathematics
BAMI	Beliefs About Mathematics Instruction
HLM	Hierarchical Linear Modeling
NCTM	National Council of Teachers of Mathematics

KEPERCAYAAN TENTANG MATEMATIK DAN PENGAJARAN MATEMATIK DALAM KALANGAN GURU MATEMATIK PENDIDIKAN ASAS DI AL-BATINAH SELATAN, OMAN

ABSTRAK

Objektif kajian ini adalah untuk mengenal pasti kepercayaan tentang matematik dan pengajaran matematik dalam kalangan guru matematik pendidikan asas fasa pertama serta untuk menentukan sama ada terdapat perbezaan yang signifikan dalam kepercayaan mereka tentang matematik dan pengajaran matematik dari segi kelayakan akademik, bidang pengkhususan, pengalaman mengajar dan lokasi sekolah di daerah Al-Batinah Selatan, Oman. Di samping itu, kajian ini bertujuan untuk menentukan sama ada terdapat hubungan yang signifikan antara kepercayaan mereka tentang matematik dengan kepercayaan mereka tentang pengajaran matematik. Kajian ini menggunakan reka bentuk kajian tinjauan hirisan rentas dan sebanyak 27 buah sekolah pendidikan asas di daerah Al-Batinah Selatan, Oman dengan seramai 288 orang guru matematik dalam fasa pertama mengambil bahagian dalam kajian ini. Penyelidik menggunakan instrumen BAM dan BAMI Collier (1972) masing-masing untuk mengukur kepercayaan guru matematik tentang matematik dan pengajaran matematik. Daripada 288 soal selidik yang diedarkan, sebanyak 192 soal selidik telah diterima daripada responden dengan kadar respon sebanyak 66.67 peratus. Walau bagaimanapun, 28 soal selidik tersebut telah dikecualikan daripada analisis kerana respon yang tidak lengkap. Oleh itu, sebanyak 164 soal selidik yang lengkap telah digunakan untuk

analisis. Secara keseluruhan, guru matematik pendidikan asas fasa pertama Oman cenderung kepada kepercayaan formal tentang matematik dan pengajaran matematik. Dapatan kajian menunjukkan bahawa tidak terdapat perbezaan yang signifikan dalam kepercayaan mereka tentang matematik dari segi kelayakan akademik, bidang pengkhususan, pengalaman mengajar dan lokasi sekolah. Dapatan kajian juga menunjukkan bahawa tidak terdapat perbezaan yang signifikan dalam kepercayaan mereka tentang pengajaran matematik dari segi kelayakan akademik, bidang pengkhususan, pengalaman mengajar dan lokasi sekolah. Walau bagaimanapun, hasil ujian pekali korelasi susunan pangkat Spearman menunjukkan bahawa terdapat hubungan positif yang signifikan antara kepercayaan mereka tentang matematik dan pengajaran matematik, r (162) = 0 .27, p < .05. r^2 = 0.07. Pekali penentuan, r^2 menunjukkan bahawa kira-kira 7 % daripada varians dalam skor kepercayaan guru tentang matematik berkait dengan varians dalam skor kepercayaan mereka tentang pengajaran matematik.

BELIEFS ABOUT MATHEMATICS AND MATHEMATICS INSTRUCTION AMONG BASIC EDUCATION MATHEMATICS TEACHERS IN AL-BATINAH SOUTH, OMAN

ABSTRACT

The objectives of this study were to identify Omani basic education first phase mathematics teachers' beliefs about mathematics and mathematics instruction and to determine whether there is a significant difference in their beliefs about mathematics and mathematics instruction in terms of academic qualification, field of specialization, teaching experience and school location in the Al-Batinah South county of Oman. In addition, this study aimed to determine whether there is a significant relationship between the mathematics teachers' beliefs about mathematics and mathematics instruction. This study used a cross-sectional survey research design and a total of 27 Basic Education schools in the Al-Batinah South county of Oman with 288 mathematics teachers in the first phase agreed to participate in the study. The researcher adopted the Collier's (1972) BAM and BAMI instruments to measure the mathematics teachers' beliefs about mathematics and mathematics instruction, respectively. Out of the 288 questionnaires distributed, 192 were received from the respondents which is equivalent to 66.67 percent response rate. However, 28 questionnaires were excluded from the analysis due to incomplete responses. Therefore, a total of 164 complete questionnaires were used for the analysis. Overall, the Omani basic education first phase mathematics teachers inclined towards formal beliefs about mathematics and mathematics instruction. The results indicated that there is no significant difference in their beliefs about

mathematics in terms of academic qualification, field of specialization, teaching experience, and school location. The results also indicated that there is no significant difference in their beliefs about mathematics instruction in terms of academic qualification, field of specialization, teaching experience, and school location. However, the results of the Spearman's rank-order correlation coefficient test showed that there is a significant positive relationship between the mathematics teachers' beliefs about mathematics and mathematics instruction, r (162) = 0 .27, $p < .05$. $r^2 = 0.07$. The coefficient of determination, r^2 shows that about 7% of the variance in the mathematics teachers' beliefs about mathematics scores are associated with the variance in their beliefs about mathematics instruction scores.

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

According to the Oman Ministry of Education (1999), before the year 1998 the general education system in Oman was teacher-centered which emphasized passive learning and high-stakes examinations. Beginning in 1998, the Oman Ministry of Education started a reform project to replace the general education system with a basic education system which emphasizes a student-centered, active learning pedagogy and formative continuous assessment. In the basic education system, activity-based learning is central and resources for hands-on activities are incorporated into the mathematics curriculum to provide for active learning in mathematics classrooms.

The 10-year basic education system in Oman is divided into two phases. The first phase is from the first grade to the fourth grade and the second phase is from the fifth grade to the tenth grade. The successful students will progress from one grade to another grade (Oman Ministry of Education, 1999).

According to the Oman Ministry of Education, Applied Sciences Curriculum Department (2005), the mathematics curriculum of the basic education system consists of six strands: Number and Number Theory; Number Operations; Geometry, Trigonometry, and Spatial Sense; Measurement; Pre-Algebra and Algebra; and Data Management and Probabilities.

In Number and Number Theory, the emphasis is on the understanding of the concepts of whole and rational numbers in the early grades. Integers, negative rational numbers, and irrational numbers are introduced in later grades. For Number Operations, the four basic operations of addition, subtraction, multiplication, and

division are introduced sequentially throughout the different grade levels for each of the number systems and specific operations are taught in an iterative manner reinforcing concepts developed in previous grades (Oman Ministry of Education, Applied Sciences Curriculum Department, 2005).

For Geometry, Trigonometry, and Spatial Sense, the development of geometrical and trigonometrical concepts and the cultivation of spatial awareness are best accomplished through the continuous integration of geometry in the curriculum. Students learn these concepts by actively manipulating, drawing, constructing, and creating geometric shapes and objects and making connections to the real world. In the strand of Measurement, the development of measurement sense is emphasized when students are actively engaged in the processes of comparing, estimating, and measuring (Oman Ministry of Education, Applied Sciences Curriculum Department, 2005).

In Pre-Algebra and Algebra, it is essential for students in the early grades to explore patterns in order to develop an understanding of the concept of variables and of algebraic thinking. This strand extends the study of operations and relationships of numbers to the use of variables and it provides the ability to represent mathematical rules using symbols. The emphasis is on developing an understanding of basic concepts rather than on the manipulation of symbols or the use of terminology (Oman Ministry of Education, Applied Sciences Curriculum Department, 2005).

Finally, for Data Management and Probabilities, students learn to manipulate data and the analysis of chance of occurrence for events. In this strand, the emphasis is on the use of graphs, tables, and lists related to numbers and statistics (Oman Ministry of Education, Applied Sciences Curriculum Department, 2005).

The school timetable in the basic education system is organized into a 40 period week, with each period lasting 40 minutes. The school year comprises 36 weeks, with approximately 32 weeks of instructional time (Oman Ministry of Education, Educational Evaluation Department, 2006). As the focus of this study is on the first phase of the basic education system, Table 1.1 summarizes the number of hours per week devoted to each subject area by grade for the first phase of the basic education system in Oman, including the subject of mathematics in particular.

Table 1.1

Classes per Week for the First Phase of the Basic Education System (Grades 1 to 4)

	Grade and number of periods per week				
Subject	G1	G2	G3	G4	Total
Islamic Education	6	6	6	5	23
Arabic Language	12	12	10	7	41
English	5	5	5	5	20
Mathematics	7	7	7	7	28
Science	3	3	3	5	14
Social Studies	0	0	2	3	5
Physical Education	2	2	2	2	8
Art Education	2	2	2	2	8
Music Education	1	1	1	1	4
Environment Life's Skills	1	1	1	1	4
Information Technology	1	1	1	2	5
Total number of lessons	40	40	40	40	160

Note: G1, G2, G3, G4 refer to Grades 1, 2, 3 and 4 respectively.

Source: Oman Ministry of Education (2001)

1.2 Statement of the Problem

Official reports such as the National Council for Teachers of Mathematics (NCTM) (2000) Agenda for Action recommends the adoption of a problem solving approach to the teaching of mathematics. This depends fundamentally on the teacher's system of beliefs, and in particular, on the teacher's conception of the nature of mathematics. NCTM concluded that key elements of the practice of teaching mathematics depends on particularly the system of beliefs concerning mathematics and its teaching and learning and teacher's level of thought process and reflection.

Knowledge is important, but it alone is not enough to account for the difference between mathematics teachers. Two teachers can have similar knowledge, but while one teaches mathematics with a problem solving orientation, the other has a more didactic approach. The key belief components of the mathematics teacher are view or conception of the nature of mathematics, view of the nature of mathematics teaching as well as views about the process of learning mathematics. Mathematics teachers' beliefs have a powerful impact on the practice of teaching (Ernest, 1989).

The Oman Ministry of Education mentioned that early stages of student's education are very important. Better development of students during their early stages can be achieved if the teachers have positive beliefs about the subject and the extent of their passion and faith in teaching. As far as the distribution of mathematics teachers about learning and teaching mathematics is concerned, there are teachers who really love mathematics and have a strong desire for teaching. However most of them have chosen mathematics as their specialty subject for teaching without really having a strong liking for it. In such cases mathematics achievement results of the students were low in both school level examinations and when compared to

international standards (Oman Ministry of Education, Educational Evaluation Department, 2006).

Both the government and business sectors need employees with good skills, especially in mathematics as stated in the documentation of Oman Vision 2020 Conference. These goals require a high degree of adaptability and a strong background in mathematics in order to independently apply the rapidly changing technologies to match the needs of Oman (Albelushi, AlAdawi, & AlKetani, 1999; Oman Ministry of Education, 2005-2006).

Another study conducted by the Department of Curriculum Evaluation at the Oman Ministry of Education in the academic year 2008/2009 found that there was a sharp decline in the level and performance of the students transferring from fourth grade (the first phase of the basic education system) to the fifth grade (the beginning of the second phase of the basic education system). The most important reason stated was difference in the mathematics instruction methods. There are differences in teachers' beliefs about mathematics and mathematics instruction in terms of qualification, specialization, teaching experience and school location (Al Maamari, Hafez bin Mohammed & Al-Oufi Mohammed bin Khamis, 2009).

Most of the teachers at the first phase of the basic education system are females. They are with different academic qualifications: some of them hold Intermediate Diploma Qualification (two years after the high school), some of them have a Bachelor of Education (four years after high school), and some of them hold Master's and Doctoral degrees. Also, these teachers who teach mathematics differ in their field of specialization: some of them are specialized in mathematics and others specialized in mathematics and science. With regard to teaching experience, there are some teachers who have more than twenty years of teaching experience and most of

them with Diploma Qualification and they often complain about lack of job satisfaction and lack of training programs during their long service (Al Maamari, Hafez bin Mohammed & Al-Oufi Mohammed bin Khamis, 2009).

Geographical location of the school has a significant role in facilitating student learning. As in the urban sites, the helping environment, the necessary and advanced tools for learning such as technology and other materials are available and all of these are lacking in the remote locations. As well as the distribution policy of teachers to schools are based on their level of qualification in the learning phase. So, the teachers who graduated with good level are posted to urban locations while the teachers who graduated with low level are posted to the remote locations (Al Maamari, Hafez bin Mohammed & Al-Oufi Mohammed bin Khamis, 2009).

However, not much is known about basic education first phase mathematics teachers' beliefs about mathematics and mathematics instruction in Oman. Also, not much is known about whether there is any significant differences in basic education first phase mathematics teachers' beliefs about mathematics and mathematics instruction in terms of academic qualification, field of specialization, teaching experience and school location. In addition, there is a lack of research on the relationship between teachers' beliefs about mathematics and mathematics instruction in Oman. Hence, there is a need to investigate basic education first phase mathematics teachers' beliefs about mathematics and mathematics instruction and whether there is any significant differences in their beliefs about mathematics and mathematics instruction in terms of the demographic variables in Oman. Further, there is a need to investigate the relationship between teachers' beliefs about mathematics and mathematics instruction in Oman.

1.3 Objectives of the Study

The objectives of this study are as follows:

1. To identify Omani basic education first phase mathematics teachers' beliefs about mathematics.
2. To identify Omani basic education first phase mathematics teachers' beliefs about mathematics instruction.
3. To determine whether there is a significant difference in the mathematics teachers' beliefs about mathematics in terms of:
    a) academic qualification
    b) field of specialization
    c) teaching experience
    d) school location
4. To determine whether there is a significant difference in the mathematics teachers' beliefs about mathematics instruction in terms of:
    a) academic qualification
    b) field of specialization
    c) teaching experience
    d) school location
5. To determine whether there is a significant relationship between the mathematics teachers' beliefs about mathematics and mathematics instruction.

1.4 Research Questions

Specifically, this study aims to answer the following research questions:

1. What are Omani basic education first phase mathematics teachers' beliefs about mathematics?

2. What are Omani basic education first phase mathematics teachers' beliefs about mathematics instruction?
3. Is there a significant difference in the mathematics teachers' beliefs about mathematics in terms of:
    a) academic qualification?
    b) field of specialization?
    c) teaching experience?
    d) school location?
4. Is there a significant difference in the mathematics teachers' beliefs about mathematics instruction in terms of:
    a) academic qualification?
    b) field of specialization?
    c) teaching experience?
    d) school location?
5. Is there a significant relationship between the mathematics teachers' beliefs about mathematics and mathematics instruction?

1.5 Null Hypotheses

The following null hypotheses are formulated to answer Research Questions 3, 4 and 5:

Ho1a: There is no significant difference in the mathematics teachers' beliefs about mathematics in terms of academic qualification.

Ho1b: There is no significant difference in the mathematics teachers' beliefs about mathematics in terms of field of specialization.

Ho1c: There is no significant difference in the mathematics teachers' beliefs about mathematics in terms of teaching experience.

Ho1d: There is no significant difference in the mathematics teachers' beliefs about mathematics in terms of school location.

Ho2a: There is no significant difference in the mathematics teachers' beliefs about mathematics instruction in terms of academic qualification.

Ho2b: There is no significant difference in the mathematics teachers' beliefs about mathematics instruction in terms of field of specialization.

Ho2c: There is no significant difference in the mathematics teachers' beliefs about mathematics instruction in terms of teaching experience.

Ho2d: There is no significant difference in the mathematics teachers' beliefs about mathematics instruction in terms of school location.

Ho3: There is no significant relationship between the mathematics teachers' beliefs about mathematics and mathematics instruction.

1.6 Significance of the Study

This study is one of the first studies in the Sultanate of Oman dealing with mathematics teachers' beliefs about mathematics and mathematics instruction. This study will help teacher educators in the colleges of education to train and prepare basic education first phase mathematics teachers. The results of this study can be used in mathematics training programs at these colleges. Also teacher educators should focus on the significance of these beliefs in the performance of basic education first phase mathematics teachers in the classroom.

The study of teachers' beliefs is a gateway to understand the nature and quality of their teaching performance. Therefore the study of these beliefs reflects the nature of their educational practices and contributes in finding some evidence that could be used in the development of educational programs designed for basic education first phase mathematics teachers in the Sultanate of Oman and the educational syllabus of teachers of basic education. This study provides an Arabic translation of mathematics teachers' beliefs about mathematics and mathematics instruction questionnaires furthermore, how other studies can benefit from it. They also confirm the importance of basic education teacher training on those beliefs. Finally, the search for ways to develop basic education teacher training may contribute to the development of the curriculum designed for training teachers at the colleges of education.

The valid and reliable instruments will be useful for the Ministry of Education as well as mathematics educators and researchers in Oman to assess mathematics teachers' beliefs about mathematics and mathematics instruction. The results of the study will help the Ministry of Education to establish a baseline data of basic education first phase mathematics teachers' beliefs about mathematics and mathematics instruction in Oman.

1.7 Limitations of the Study

This study was limited to basic education first phase mathematics teachers specialized in the second area and mathematics in the Batinah South county of the Sultanate of Oman. As such, the results of this study cannot be generalized to all basic education first phase mathematics teachers in Oman. Another limitation of the study was that the data on the mathematics teachers' beliefs about mathematics and

mathematics instruction were obtained through self-reported questionnaires. Thus, the results of this study are dependent on the honesty and accuracy of the mathematics teachers' responses to the items of the questionnaires. Further, the response rate was only 56.9% and this was also a limitation of the study The research design used in this study was also a limitation of the study because the cross-sectional survey research design only captured mathematics teachers' beliefs about mathematics and mathematics instruction based on their answers to the questionnaires at only one point in time and hence the results of the study might not indicate the mathematics teachers' beliefs about mathematics and mathematics instruction throughout their teaching of basic education first phase mathematics in the classrooms.

1.8 Definition of Terms

1.8.1 Omani basic education first phase mathematics teachers

Omani basic education first phase mathematics teachers are graduates of the College of Education who are working in government basic education first phase schools supervised by the Ministry of Education Oman and are distributed by the Ministry of Education to the Directorates which in turn are distributed to schools.

1.8.2 Beliefs about mathematics

The researcher adopted a general and dualistic framework for the study of beliefs about mathematics which was first used by Collier (1972) and followed by Seaman et al. (2005) as well as Roscoe and Sriraman (2011). The framework describes an individual’s beliefs about mathematics on a scale that ranges from formal beliefs on one end to informal beliefs on the other. Formal beliefs about mathematics identify the subject as one of procedures. An individual sees

mathematics as consisting of rules, algorithms, and formulas which are hierarchically organized according to various strands such as arithmetic, algebra and geometry. Informal beliefs about mathematics identify the subject as one of creative and investigative processes. An individual sees mathematics as consisting of the processes of problem-solving, proof and reasoning, communication, connection and representation (NCTM, 2000) among others. Understanding mathematics is evidenced through active and successful engagement in these processes (Roscoe & Sriraman, 2011; Seaman et al., 2005).

In this study, the basic education first phase mathematics teachers' beliefs about mathematics (BAM) were measured using Collier's (1972) BAM instrument which was also used by Seaman et al. (2005) as well as Roscoe and Sriraman (2011).

1.8.3 Beliefs about mathematics instruction

Similarly, the researcher adopted a general and dualistic framework for the study of beliefs about mathematics instruction which was first used by Collier (1972) and followed by Seaman et al. (2005) as well as Roscoe and Sriraman (2011). The framework describes an individual's beliefs about mathematics instruction on a scale that reaches from formal convictions toward one side to casual convictions on the other. Formal beliefs about mathematics instruction is considered as an educator focused action. An individual sees mathematics instruction as the teacher providing a clear presentation of procedures and encouraging students to acquire these skills through individual drill and practice. Informal beliefs about mathematics instruction is conceived as a student-centered activity. An individual sees mathematics instruction as the teacher facilitating understudy development of scientific

information through exercises that are characteristically exploratory and open-finished (Roscoe & Sriraman, 2011; Seaman et al., 2005).

In this study, the basic education first phase mathematics teachers' beliefs about mathematics instruction (BAMI) were measured utilizing Collier's (1972) BAMI instrument which was also used by Seaman et al. (2005) as well as Roscoe and Sriraman (2011).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses theories related to the study and research identified with instructors' convictions about mathematics and mathematics instruction. Moreover, the conceptual framework of the study is also explained and illustrated in this chapter.

2.2 Related Theories

Teaching, learning, and the nature of mathematics are categories of beliefs commonly identified as having an influence on a teacher's practice (Thompson, 1992). Sometimes beliefs about students' feelings towards school or particular subjects are placed within the student or learning belief categories. Mathematics education dealt with many different categories of instructors' convictions about learning and educating arithmetic. The first category has classified these beliefs according to a behavioral framework (traditional trend) based on the transmission of information in contrast to the constructivist framework (non-traditional) as stated in many studies (e.g., Barkatsas & Malone, 2005; Gales & Yan, 2001; Shahvarani & Savizi, 2007).

This behavioral framework focuses on the acquisition of a set of algorithms and certain values which are the main objectives of teaching and learning mathematics. It means that, the teacher's role is a hub of the process of teaching and learning mathematics.

The constructivist framework, on the other hand, focuses on the learner himself. He is an active and effective element in the construction of meaning and understanding of mathematics. The learner, therefore, relies on realistic models and his understanding and abilities to analyze the mathematical theories and to link them with his previous experience.

The constructivist framework dealt with mathematics teachers' beliefs according to a problem-solving procedure. In contrast to the behavioral framework, the constructivist framework considers problem-solving as the essence and the way to learn mathematics. It focuses on symbolic work and the use of interesting questions to motivate learners' reasoning skills in mathematics and the development of their abilities to solve problems. In the constructivist framework mathematics teachers facilitate students' learning and give them enough opportunities to justify and explain their mathematical ideas and solutions and to build their mathematical understanding and to maximize their skills to solve problems (Benken &Wilson, 1998; Beswisk, 2005).

But, the behavioral framework focuses on individuals and their typical questions in addition to the syllabus. Problem-solving comes at a second position. In this behavioral framework learners should first be able to master certain facts and skills in mathematics before they are able to solve problems (Anderson et al., 2005).

Kuhs and Ball (1986) have classified teachers' beliefs about teaching and learning mathematics into three kinds:

1.The central beliefs of the learner, where the focus is on the personality of the learner and his role in building knowledge in mathematics through active interaction with mathematics activities, and teacher's role is mainly to facilitate learning.

2.Students-centralized content, which has two dimensions: The first concerning the learner especially when the practices of their teachers is moving towards focusing on their comprehension of the ideas, and logical connections involved in mathematics building. The second dimension is related to the teacher whose practices move towards the focus on performance, through the mastery of procedures and generalizations in mathematics.

3. Centralized class, where the focus is on organizing classroom activities effectively. The teacher's role is defined mainly in presenting educational material clearly and providing individual practice opportunities for learners to do some activities (Speer, 2005).

Researchers have documented the role of beliefs in mathematics education (Cooney, 1985; Hart, 2002; Philipp, 2007; Schommer-Aikins, Duell, & Hunter, 2005; Seaman, 2005; Thompson, 1992). Although, much has been disputed about the part of beliefs in mathematics education, as Mewborn and Cross (2007) have pointed out, beliefs can be seen as attitudes and knowledge. Tann (1993) offers personal theories as ways of thinking about a man's arrangement of convictions, qualities, comprehension, and presumptions. Hart (2002) describes beliefs as being formed through experience over time. Howse (2006) defines beliefs as one's personal notions, perceptions, and conceptions of truth and reality. For the purpose of this study, beliefs should be understood in these terms.

In understanding how some researchers view mathematics, Mewborn and Cross (2007) contrasted two differing beliefs. One way to dichotomize these beliefs is to see mathematics as fixed and the other view is to see mathematics as fluid. The fixed view would include the beliefs that: (a) mathematics is calculation, (b) science issues ought to be tackled in under five minutes, or else there is a major issue with

either the issue or the understudy, (c) the objective of doing an arithmetic issue is to acquire the right reply; and (d) in the educating and learning process, the understudy is latent and the educator is dynamic.

Van de Walle (2007) describes this fixed belief of mathematics as the traditional view. Furthermore, it is believed from this perspective that "mathematics is a collection of rules to be mastered, arithmetic computations, mysterious algebraic equations and geometric proofs" (p. 12). He continues that the fixed view of mathematics believes that "mathematics is a series of arbitrary rules, handed down by the teacher, who in turn got them from some very smart source" (p. 12). When mathematics is believed to be fixed, doing mathematics is following some rules, knowing mathematics is applying the correct rule, and determining the correct answer is held by the expert, that is some teacher or book.

In contrast to the fixed beliefs of mathematics, according to Mewborn and Cross (2007), the fluid view (which corresponds to the position of the National Council of Teachers of Mathematics) would include the belief that: (a) mathematics is problem solving; (b) mathematical problems come in different types, some can be solved quickly by recall and others require a significant amount of time to understand the problems, experience with possible solution methods, reach an answer, and check to see that the answer makes sense. The goal of doing a mathematical problem is to make sense of the problem, the solution process, and the answer. In the teaching and learning process, the students and teacher are both active in making sense of the mathematics and of solving the problems.

This fluid belief sees mathematics as a science of patterns and orders (Mathematics Sciences Education Board, 1989). Essentially, mathematics is ever

living and expanding. It can be discovered and explored where predictions and conjectures are made. Mathematics is a noun, but it is more than that. It includes the verbs (conjecture, discover, explore, investigate, predict, etc.) that conceive mathematics as well. In short, the nature of mathematics can be seen as two poles. One belief is that mathematics is static that is mathematics is an arbitrary set of rules that are unchanging and uncompromising. The other belief is that mathematics is dynamic, that is mathematics is an ever-growing, ever-changing body of flux. Imitation or regurgitation is how mathematics can be seen in the static belief about mathematics. However, for those who see mathematics through the dynamic beliefs, it undertakes an active dimension of assimilation and creation of mathematical ideas.

Green's (1971) portrayal of conviction frameworks to comprehend courses in which an individual's numerous convictions can associate. Green portrayed how specific convictions differentially impact conduct as indicated by their centrality or the number and quality of associations between a given conviction and others. The all the more midway held a conviction the all the more beyond a reasonable doubt it is held and the more troublesome it is to change. Green likewise recognized that the relative centrality of convictions shifts with connection.

This is steady with Ajzen and Fishbein's (1980) affirmation that convictions are particular to all of setting, which they characterized as containing spot, activity or conduct, time, and subject. This implies an instructor's conviction about the limit of an understudy to learn would rely on the specific physical classroom and school (place), the behaviour that the understudy would be relied upon to take part in both to learn and to exhibit learning (activities), the date and length of the lesson (time), the nature of the thoughts or topics being considered, and qualities of the understudy (subjects).

Green (1971) additionally depicted how convictions can be held in groups basically disconnected from different convictions and consequently potentially in disagreement of them. Such a circumstance can emerge when convictions create in divergent settings. A third part of Green's depiction concerns the essential or subsidiary nature of convictions and recognizes that a few convictions are held in light of the fact that they are legitimate results of different convictions. It takes after that changing a subsidiary conviction may require rebuilding of an individual's convictions framework such that the essential conviction that is a definitive explanation behind the subordinate conviction is modified or so that the consistent connections between convictions are changed. Imperatively for those inspired by advancing change in convictions, convictions might possibly be hung on the premise of proof. This is a critical refinement, for convictions in the last class are held for reasons, for example, the power of the wellspring of the data, or in light of the fact that they bolster existing, halfway held convictions. They are likewise more probable than evidentially held convictions to be held in segregated bunches, and are, by definition, impenetrable to change even in the light of unmistakably conflicting proof (Green 1971).

2.3 Related Studies

2.3.1 The Cycle of Mathematical Beliefs of Teachers

The teachers obtain the mathematical beliefs symbiotically from their previous mathematics teachers at school after perceiving the teaching for long hours during their schooling (Carroll, 1995; Thompson, 1984). This procedure parallels in several regards the discipleship model of learning that happens while learning a trade. In fact, business people learn by perceiving a master throughout a specified

task (Buchmann, 1987; Lortie, 1975). In the procedure of schooling, pupils learn not only content-based cognition but also educational programs besides other characters. When they are engaged in a teaching and learning activity, the beliefs of how to educate what's more, realize are profoundly established in the pupils, and frequently are strengthened by the conventional nature of several teacher training establishments which may have no beneficial impacts on pre-service mathematical beliefs of the teachers (Kagan, 1992; Kleinsasser & Foss, 1996; McGinnis & Parker, 2001).

There is proof that, in several instances, teacher education activities are so much engaged in focusing on transmitting pedagogic cognition that less deliberation is given to changing these beliefs. Therefore, teacher training activities could have less impact in generating teachers with beliefs consecutive with syllabus transformation and study (Kennedy, 1991). For instance, Marland (2002) discovered the causes given by in-service teachers concerning their classroom principles were not linked with what was in fact taught in their education in the college. There is one more proof acknowledging that resolution making of teachers does not depend only on their pedagogic cognition but on what they believe the content-based is and how they have to educate (Baird & Brown, 2003).

In the later years, it is assumed that it can be individually considered beliefs of mathematics teachers for practicing mathematics and teaching in general (Rösken & Rolka, 2007). Dion and Ernest (2000) distinguish beliefs of traditional formalist and constructivist which aimed at building self-knowledge. The authors introduced the concept of orientation in teaching mathematics and two orientations were identified: (a) a concept in which the orientation mainly focuses on the system of ideas and styles of thinking and the methods of their development, and (b)