Iranian Teachers' Professed Beliefs about Mathematics Education and the Efficacy on their Practice

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Abstract

This study examined Iranian mathematics teachers' beliefs about the nature of mathematics, teaching it and learning it within two theoretical frameworks: absolutist traditional beliefs and constructivist non-traditional beliefs. In contrast to previous research indicating that teachers in developing countries are more likely to support traditional mathematics education beliefs, this study of Iranian secondary teachers revealed that teachers expressed greater support for non-traditional mathematics education beliefs. Teachers with non-traditional views expressed more support for constructive teaching and learning in their classrooms than teachers with traditional views regarding mathematics education. Differences between the conclusions of this study and previous studies on teacher beliefs in developing countries were attributed to the historical, social and cultural features of Iranian educational policy and practice.

Key Words

Constructivism, curriculum, mathematics education, reform, teachers' beliefs.

Introduction on Teachers' Beliefs

Teacher beliefs about the nature of mathematics, teaching mathematics, and learning mathematics, matter because they encourage the implementation of changes and new strategies in teaching (Fluck &Dowden, 2010). Teacher beliefs about mathematics could discourage innovative programs and encourage a standards-based program. The centrality of beliefs in the enactment of teaching encourages professional development designers to focus on beliefs as a mechanism for changing the practice of experienced teachers and developing the pedagogical understanding of pre-service candidates (Uzuntiryaki & Boz, 2007). While a significant majority of research conducted on teachers' beliefs has been limited to developed nations, this article reports findings from the developing world and is the only study conducted on Iranian mathematics teachers' beliefs.

Theoretical Framework

Definitions of beliefs "travel in disguise and often under alias [as] attitudes, values,… perceptions, conceptions and perspectives" (Pajares, 1992, p. 302). The distinction between these words is not important for the results; therefore, in applying notions of beliefs and belief systems to teachers, the words 'conception,' 'view,' 'perspective,' and 'belief' will be used interchangeably throughout this study depending on which term comes most naturally.

Teacher Beliefs about the Nature of Mathematics

We define teachers' mathematics beliefs as "personal judgments about mathematics formulated from experiences in mathematics, including beliefs about the nature of mathematics, teaching mathematics, and learning mathematics" (Raymond, 1997, p. 552). Teachers construct beliefs about subject matter during their pre-service and professional periods. Their instructional behaviour will be influenced by their conception of mathematics as composed of facts, rules, and logic. Although we may act upon our beliefs with certainty at one time, we may question that same action in the future.

A disparity exists between traditional and non-traditional beliefs regarding the nature of mathematics. A traditional view emphasizes rules and procedures, while ignoring the processes of mathematics and how mathematical knowledge often emerges from real life situations. In contrast, a non-traditional view emphasizes problem solving, concepts, and rules that show how mathematics are constructed by humans. Both traditional and non-traditional conceptions of mathematics can be associated with absolutist and constructivist views of mathematics. Teachers with an absolutist conception of mathematics describe mathematics as a vast collection of fixed and perfect concepts and skills, or a useful but unrelated collection of facts and rules; mathematical knowledge constitutes certain and absolute truths. Teachers with a constructivist conception of mathematics, the more popular conception, consider mathematics a human construction that describes and interprets the world; mathematics is continuously constructed, revised and explored by learners with teachers as 'facilitators'.

In this study, the researcher distinguishes traditional from non-traditional conceptions of the nature of mathematics using three dichotomies: (1) mathematics defined as a set of operations versus tools for thought, (2) mathematics as accepted versus constructed knowledge, and (3) mathematics as an isolated versus an integrated discipline.

Teachers' Beliefs about Teaching and Learning Mathematics

The beliefs of teachers about the nature of mathematics, teaching it and learning it are considered to be an important aspect of classroom instruction (Beswick, 2007). Several distinctions in teacher beliefs about teaching and learning mathematics have been made. Kuhs and Ball (1986) identified the learner- and content-focused teaching approaches: the former focuses on the learner's construction of mathematical knowledge, and the latter focuses on conceptual understanding "[which] is driven by the content itself but emphasises conceptual understanding" (Kuhs and Ball, 1986, p. 2). Kuhs and Ball also note how a content-focused approach emphasizes student performance and mastery of mathematical rules and procedures. This approach positions the teacher as a transmitter of the knowledge, while students do drills and practice using prescribed procedures. This style of teaching is defined as 'drill theory' (Brownell, 1935) and can follow from teachers' traditional absolutist conception of mathematics.

Skemp (1978) suggested two teaching methods: Instrumental Mathematics Teaching and Relational Mathematics Teaching. Instrumental Mathematics Teaching involves no investigations and is based on a step-by-step procedure, in alignment with the absolutist view of mathematics. Relational Mathematics Teaching promotes students' investigations based on general principles to tackle a variety of problems and emphasizes teacher-student interaction, in alignment with a constructivist view of mathematics.

The researcher has distinguished three dichotomous sets of beliefs about teaching and learning mathematics, in correspondence with traditional and non-traditional beliefs about the nature of mathematics. For beliefs about teaching we contrasted (1) an emphasis on performance versus understanding, (2) teacher control versus student autonomy, and (3) relying on textbooks versus using tools and new concepts. For beliefs about learning we contrasted (1) instrumental versus relational learning, (2) abstract versus interactive learning, and (3) innate versus intellectual ability.

Beliefs of Teachers in Developing Countries

Research regarding teachers' beliefs about the nature of mathematics, teaching it and learning it has been predominately conducted in developed countries, especially Western nations, while limited research has been conducted in developing countries. More research should be done cross-culturally to explore how diverse cultures and curriculums construct teachers' mathematic beliefs. It has been documented that in some developing countries transmission teaching dominates the classroom, mathematics is represented as a body of fixed knowledge defined by textbooks, student autonomy is rare, and teacher control dictates the classroom (Zamani, 1997). These teaching approaches and beliefs are influenced by the steering effect of standardized university entrance exams, the predominate perception that mathematical ability is an innate trait rather than a developed capacity, and the common belief that memorizing procedures is worthwhile (Author, 2005).

Research Purposes

Given the paucity of information regarding teacher beliefs about the nature of mathematics, learning it and teaching it in developing countries, the researcher conducted a descriptive study in Iran to discover (1) whether teacher beliefs in a developing country were more traditionalist than non-traditionalist, (2) whether teachers' non-traditional beliefs about the nature of mathematics were correlated to their non-traditional beliefs about mathematics teaching and learning , and (3) whether teachers perceived that their beliefs influenced their practice.

Education System in Iran

Two Iranian ministries are responsible for the Iranian education system: the Ministry of Culture and Higher Education for university education, and the Ministry of Education and Training for pre-university education. The Supreme Council of Education is responsible for approving all policies, standards, and regulation for all schools.

The Schools' Structures

During 1979-1990 all schools were public, and the government supplied more than 90 percent of the education funds. All schools received public allocations for materials and maintenance on a per student basis from the Ministry; however, the allowance was not sufficient for desired teaching

materials and maintenance. During 1980-1990, the number of students enrolled in all levels of school combined nearly doubled, resulting in the introduction of non-profit (private) schools in Iran. Both schools must follow the same curricula and extra-curricular programs; however, the private schools charge high tuition fees and provide more facilities than public schools.

The educational system in Iran is highly centralized since the Ministry of Education and Training administers and finances schools at the primary and secondary levels. The structure of the educational system is divided into four cycles: pre-school, primary school, middle or guidance school, and secondary school. The pre-school education cycle is a one-year program for children five years old in which they receive the basic notions needed to enter primary schools. There is no exam at the end of this cycle and children proceed automatically to the following cycle. The primary education cycle is a five-year program covering grades one to five for children six to eleven years old. This phase is free and compulsory. Students take exams at the end of each year, which determines whether they will be promoted to the next grade. At the end of grade 5, students take a nation-wide examination and only those who pass are qualified to proceed to the next cycle. The middle or guidance cycle covers grades six to eight for children eleven to thirteen years old. Like the preceding cycle, this cycle also provides students with general education while recognizing the abilities and interests of students in preparation to decide which branch (academic or technical / vocational) they intend to pursue next. At the end of guidance cycle, students take a regional examination under the supervision of provincial boards of education and only those who pass are eligible to proceed to the secondary cycle. The secondary education cycle is a four-year program that covers grades nine to eleven and pre-college for fourteen to seventeen year olds. The secondary education is divided into two main branches: academic/general and technical/vocational. Students choose which branch to pursue and national examinations are conducted at the end of each grade.

Educational Reform

The reform started in 1989-1991 when the Ministry of Education and Training suggested the inclusion of a computer course for grade 11 students in the mathematics-physics focus of the secondary education cycle. The suggestion was made since there were no specific guidelines for using technology, but computer use was spreading in Iranian society and some private schools in 1988. The project started in the major cities of 25 Iranian provinces. The government intended to narrow the gap between the Iranian education system and that of industrialized nations, which had already moved rapidly towards computer use in the classroom. The government also invited several Iranian educators with Western education to suggest teaching and learning strategies for the new curriculum. For example, in 1995, the Iranian Ministry worked with UNISCO to hold workshops for teachers, educational reformer and officials to promote active learning (Kamyab, 2004). The goal was to change the current teaching method in the schools by promoting a "one-way process in which the teacher directly presents information and skills dictated by a textbook. Students remain passive throughout a lesson" (Kamyab, 2004, p. 57).

The Ministry of Education and Training also integrated the "KAD" (the initial letters of two Persian/Farsi words for work and knowledge) apprenticeship program into the secondary school curriculum in order to prepare students for the job market with a focus on students' productivity in real life situations. According to the Ministry of Education and Training (1993):

> …high school students have to participate in a work place or profession, one day a week (the schools are based on 6 days a week), for the first three years of their secondary schooling. They take part in this program about 30 days during the school year, and their apprenticeship is under the joint supervision of work place and school authorities. (p. 125)

Some of the main objectives of the educational reform movement were to: (1) develop students' logical thinking, problem solving skills, and creativity, (2) integrate schools and professions, and (3) rapidly increase technology use in the classroom. The Ministry paid special attention to developing and enhancing scientific, educational, and cultural ties with neighbouring nations (Ministry of Education and Training, 2005).

Methodology

This study investigates Iranian secondary school teachers' beliefs regarding mathematical education and reports Iranian teachers' self-described beliefs about the nature of mathematics, teaching it and learning it for the first time. Furthermore, it discusses whether the teachers believe that their educational views affect their practice.

Since the study involves beliefs that cannot be observed in a large population, the survey research method was used to gather data on teachers' beliefs in a developing country, Iran. A quantitative analysis was used in which scaling of the questionnaire items were applied. This application is recommended in studying social phenomena or events, such as education, where quantitative analysis (Pandey, 2009; Patton, 1990) is preferred.

Location of the Study

The survey research took place among secondary mathematics teachers in Tehran, where the population is 6,758,845. Tehran is the capital and most populated city in Iran. Over eleven percent of the student population in upper secondary school resides in Tehran, with fifty four percent females and forty six percent males. The upper secondary school includes grades nine to twelve. The schools are segregated by gender for both teachers and students; however, the insufficient number of female mathematics teachers in Tehran has forced some schools to employ male mathematics teachers in female upper secondary schools.

The significance of single-gender schools may have a bearing on the way teachers construct their beliefs and teaching strategies about mathematics, especially in comparison to a society with co-ed schooling. There are over 2000 upper secondary schools in Tehran (SCI, 1996). Each school has at least two mathematics teachers for teaching four mathematics courses in mathematics: Algebra, Analysis, Calculus, and Geometry. Therefore, there are over 4000 mathematics teachers employed in Tehran's upper secondary schools.

The Subjects of the Study

The subjects were mathematics teachers in private and public secondary schools in Tehran. They were well distributed across the demographic variables of gender, teaching grade(s), years of experience, and school of employment. The teachers were employed as teachers in Tehran and granted their teaching certificate by the Ministry of Education and Training. Three hundred thirty teachers have participated in the survey, 42% female and 58% male. The teachers were teaching mathematics either in a single or multiples grades, and their teaching experience varied between one to more than 16 years.

Data Collection

A Teachers' Beliefs Questionnaire (TBQ) was developed as a data collection instrument. The questionnaires were self-administered and delivered through the mail. To minimize the risk of more than one questionnaire being completed by a single teacher, only one questionnaire was sent to the

principal office of each school, along with a letter asking that the questionnaire be submitted to one mathematics teacher in that school.

Teachers' beliefs questionnaire

The questionnaire was constructed to reveal information on teachers' educational beliefs regarding traditional absolutist views and non-traditional constructivist views, and if teachers believe that their views affect their teaching practice.

Table 1 lists the dichotomous sets of traditional versus non-traditional conceptions of the nature of mathematics, teaching and learning mathematics included in the questionnaire.

Table 1.The dichotomous sets of traditional and non-traditional conceptions.

Non-Traditional	Conception of	Traditional
Math as tools for thought (e.g., Mathematics is about reasoning in solving problems)	Nature of Mathematics	**Math as operations** (e.g., In mathematics, answers are either right or wrong)
Math to be constructed (e.g., Mathematics is a creation of human mind)		**Math to be accepted** (e.g., Mathematics involves mostly facts and procedures that have to be learned or simply accepted as true)
Math as integrated subject (e.g., Mathematics involves technology)		**Math as isolated subject** (e.g., Mathematics is an abstract and solitary subject)
Emphasis on understanding (e.g., Discussing students' mathematical understanding should be a major consideration when teaching math)	Teaching Mathematics	**Emphasis on performance** (e.g., Mathematics teaching should always involve clear, step-by-step demonstrations of procedures)
Student autonomy (e.g., Students should be taught how to explain their mathematics ideas)		**Teacher control** (e.g., Mathematics class is only for teachers to teach)
Using tools and concepts (e.g., Instruction is presenting new math concepts regardless of the existing standardized exams)		**Relying on textbooks** (e.g., Teachers should rely on mathematics textbooks when planning lessons)
Relational learning (e.g., Students learn mathematics when they construct new problems)	Learning Mathematics	**Instrumental learning** (e.g., Students learn math as a result of repeated practice and reinforcement)
Interactive learning (e.g., Students learn mathematics best when they can play mathematical games together)		**Abstract learning** (e.g., Students who produce correct answers have learned the mathematical concepts)
Intellectual ability (e.g., All students learn mathematics if they worked at it)		**Innate ability** (e.g., Learning mathematics requires mostly strong students)

For example, understanding 'math as tools for thought' is associated with a non-traditional conception, while understanding 'math as operation' is associated with a traditional conception. Two criteria were considered in selecting the survey questions for each conception in this study: (1) that the questions reveal Iranian secondary school mathematics teachers' beliefs related to mathematics as a subject, mathematics instruction, and learning mathematics, and (2) that the questions were in accordance with the Iranian social context. This cross-cultural study presented unique challenges since translating or adapting a test or questionnaire item from one language to another does not necessarily assume the equivalency of the test or item in the alternate language (Muller, 2007). To increase the study's validity and reliability, special attention was give to the translation and adaptation of the questionnaire items as guided by Hambleton and Patsula (1999).

Measuring beliefs

In order to examine the teachers' overall strength of agreement or disagreement with traditional and non-traditional beliefs about mathematics, teaching it, and learning it, each respondent's ratings were obtained in each set of mathematical beliefs on a Likert-type scale of 1 to 6. The strength of their agreement in all three parts was measured from strongly disagree to strongly agree on a six

point Likert-type scale. The analytical and statistical procedures of the data were carried out using a statistical computer software.

The Result of the Study

Teachers' answers to the questionnaire (TBQ) revealed the overall strength of their agreement or disagreement with traditional and non-traditional beliefs about mathematics, teaching mathematics, and learning mathematics. The score mean and standard deviation in Table 2 show overall agreement with the traditional and non-traditional beliefs. The score mean closer to 1 indicated stronger disagreement, while a score mean closer to 6 indicated a stronger agreement. In addition, the score mean in the middle range (3 to 4) indicated that either the respondents were generally 'neutral' on those questions or that respondents were split into two camps (agree and disagree), which 'neutralized' each other when combined. Table 2 also shows a comparison of traditional and non-traditional beliefs about mathematics, math teaching and math learning. The convention for describing the strength of Effect Size is small= 0.2, medium= 0.5, and large= 0.8 (Cohen, 1988).

Table 2. Overall statistics of traditional and non-traditional beliefs about mathematics, mathematics teaching and mathematics learning.

Beliefs	Mean	SD	Comparison of Mean	Effect Size
Mathematics			t(287)=13.86, p=0.001	0.41
Traditional	3.53	0.64		
Non-traditional	4.12	0.68		
Teaching Mathematics			t(314)=25.03, p=0.001	0.76
Traditional	3.08	0.59		
Non-traditional	4.70	0.83		
Learning Mathematics			t(298)=21.27, p=0.001	0.62
Traditional	3.38	0.68		
Non-traditional	4.58	0.84		

Notes. Possible range of mean is 1 to 6. 1=strongly disagree, 6=strongly agree

The score mean of Iranian teachers' traditional beliefs about the nature of mathematics was in the middle range. The score mean of 4.12 showed that the teachers had stronger agreement with non-traditional beliefs than traditional beliefs about mathematics. The mean difference between traditional beliefs and non-traditional beliefs about mathematics was statistically significant which shows that Iranian teachers are non-traditional in their overall professed beliefs about mathematics. The score mean of 4.70 showed that teachers agreed more strongly with non-traditional beliefs than traditional beliefs about teaching mathematics. The medium size difference, ES=0.76, demonstrates that Iranian teachers are supportive of non-traditional beliefs about teaching mathematics.

The same pattern was found for learning mathematics. The score mean of 4.58 showed stronger agreement with non-traditional than traditional beliefs about learning mathematics. There was significantly greater support for non-traditional learning. The difference was of medium size, ES=0.62, which demonstrates that Iranian teachers are supportive of non-traditional beliefs about learning mathematics.

The mean scores as presented in Table 2 can be misleading if viewed in isolation of the three dichotomous sets of beliefs about the nature mathematics, teaching mathematics, and learning mathematics. As shown in Table 3, overall agreement with each set of contrasts related to traditional

and non-traditional beliefs was indicated by a score mean closer to 6 and disagreement was indicated by a score mean closer to 1; however, since there were some overlap agreements with both traditional and non-traditional belief questions, agreement with the questions related to the traditional/non-traditional views did not necessarily indicate disagreement with the questions related to the non-traditional/traditional views. In addition, the standard deviations (SD) presented in Table 3 indicate how teachers' beliefs about each contrast were clustered around the mean; however, the larger standard deviation, the less the data is concentrated around the mean.

Table3. Means and standard deviations of the dichotomous set of contrasts in traditional and non-traditional beliefs.

Traditional Belief Dimensions	Mean(SD)		Non-Traditional Belief Dimensions	Mean(SD)
Mathematics				
Math as a set of operations	3.46(0.90)	vs.	Math as tools for thought	3.88(0.70)
Math to be accepted	4.88(0.92)	vs.	Math to be constructed	3.89(0.90)
Math as an isolated subject	3.03(0.85)	vs.	Math as an integrated subject	4.68(1.02)
Teaching Mathematics				
Emphasis on performance	3.56(0.85)	vs.	Emphasis on understanding	4.69(0.88)
Teacher control	2.98(0.75)	vs.	Student autonomy	4.75(0.90)
Relying on textbook	2.55(0.99)	vs.	Using tools and new concept	4.61(0.99)
Learning Mathematics				
Instrumental learning	3.43(0.67)	vs.	Relational learning	4.72(1.31)
Abstract learning	3.23(0.77)	vs.	Interactive learning	4.47(0.84)
Innate ability	3.43(1.85)	vs.	Intellectual ability	4.57(0.93)

Notes. Possible range of mean is 1 to 6. 1=strongly disagree, 6=strongly agree

The score means for the conceptions of 'math as a set of operations' in the traditional beliefs about mathematics and 'math as tools for thought' in the non-traditional beliefs about mathematics were in the middle range. Inspection of the standard deviation for the conception of 'math to be accepted' versus 'math to be constructed' revealed almost the same cluster of agreements around the mean; however, the level of agreement with the questions in the conception of 'math to be accepted' in traditional beliefs about mathematics was higher than the questions in the conception of 'math to be constructed' in non-traditional beliefs about mathematics. A high level of agreement was detected in the conception of 'math as an integrated subject' in the non-traditional beliefs about mathematics, whereas the level of agreement with the questions in the conception of 'math as an isolated subject' in the traditional beliefs about mathematics was in the middle range. The differences between the means of the conceptions in the traditional and non-traditional beliefs about mathematics contributed to the result that there was a general tendency to agree with the non-traditional constructivist perspective about the nature of mathematics presented in Table 3, despite the teachers' agreement with the conception of 'math to be accepted' in the traditional beliefs about mathematics.

In the non-traditional teaching mathematics, the conception of 'emphasis on understanding' achieved a higher level of agreement than the conception of 'emphasis on performance' in traditional teaching mathematics, with a middle range mean. The significant differences between the score mean (2.98) of the conception of 'teacher control' and score mean (4.75) of the conception of 'student autonomy' showed teachers' disagreement with the questions in the second conception in traditional beliefs about teaching and their agreement with the questions in the second conception in

non-traditional belief about teaching. Similarly, the considerable differences between the score mean (4.61) of the conception of 'using tools and new concept' and score mean (2.55) of the conception of 'relying on textbooks' indicated that teachers were in favour of the last conception in teaching mathematics non-traditionally. The differences between the means of the set of dichotomies in the traditional and non-traditional beliefs about teaching confirm the result that there is a general tendency to agree with the non-traditional constructivist perspective about teaching mathematics presented in Table 2.

Table 3 shows that all three conceptions in the traditional learning have score means in the middle range, while their corresponding conceptions in the non-traditional belief have a high level of agreements among Iranian mathematics teachers; therefore, the teachers' general tendency to agree with a non-traditional constructivist perspective about learning mathematics, presented in Table 2, stemmed from the differences between the means of the dichotomies in the traditional and non-traditional beliefs about learning mathematics.

Table 4 shows the comparison of the means of the conceptions in traditional and non-traditional beliefs using multiple t-tests. Multiple t-tests exaggerate Type I error because they ignore correlations among the dependent variables, which is a minor limitation of this study.

Table 4. Comparison of the dichotomous set of conceptions in traditional and non-traditional beliefs.

Traditional Mathematics		Non-traditional	Comparison of Means	Effect Size
Math as a set of operations	vs.	Math as tools for thought	t(307) = 7.35, p=.001	0.25
Math to be accepted	vs.	Math to be constructed	t(320)= -3.13, p=.002	0.10
Math as an isolated subject	vs.	Math as an integrated subject	t(315) = 21.75, p=.001	0.66
Teaching Mathematics				
Emphasis on performance	vs.	Emphasis on understanding	t(327)=16.91, p=.001	0.55
Teacher control	vs.	Student autonomy	t(321)= 24.05, p=.001	0.73
Relying on textbooks	vs.	Using tools and new concept	t(326)= 24.55, p=.001	0.72
Learning Mathematics				
Instrumental learning	vs.	Relational learning	t(314)= 15.95, p=.001	0.53
Abstract learning	vs.	Interactive learning	t(314)= 20.23, p=.001	0.61
Innate ability	vs.	Intellectual ability	t(316)= 9.79, p=.001	0.34

Notes. Possible range of mean is 1 to 6. 1=strongly disagree, 6=strongly agree

Table 4 elaborates the results shown in Tables 2 and 3. Table 4 examines the conceptions in matching pairs. In each pair a traditional belief or practice is matched against the closest opposite non-traditional belief or practice in mathematics, teaching mathematics and learning mathematics. Table 4 shows that for 8 of the 9 matching pairs teachers expressed greater support for the non-traditional beliefs than for the traditional beliefs (the means and standard deviations for each conception are in Table 3). The one expectation showed teachers' greater support for a conception in the traditional beliefs about mathematics. In all comparisons the differences were statistically significant. The size

of the difference ranged from very small (ES=0.10 for the conception of 'math is to be accepted/constructed') to medium (ES=0.73 for the subscales measuring teaching mathematics emphasizes teacher control/student autonomy).

The results of the ratings of the teachers' agreement with each conception related to mathematics suggest that Iranian teachers have non-traditional views about mathematics except for the conception of 'math to be accepted' in the traditional beliefs. In contrast, the results for the ratings of the teachers' agreement with each conception related to teaching and learning mathematics indicated that Iranian teachers agree with the non-traditional views and disagree with the traditional views.

Correlations among Iranian Teachers' Beliefs

The study also examined whether there were associations among teachers' beliefs about the nature of mathematics, teaching and learning mathematics. Pearson correlations among the conceptions in the teachers' traditional beliefs and non-traditional beliefs were used to determine such associations, which are presented in Table 5 and Table 6 respectively.

In Table 5, correlations were computed among teachers' traditional mathematical beliefs. The top part of the table correlates beliefs about mathematics with beliefs about teaching. The middle part correlates beliefs about mathematics with beliefs about learning. The bottom part correlates beliefs about teaching mathematics with beliefs about learning mathematics.

Table 5. Correlations among teachers' traditional mathematical beliefs.

Correlations between mathematics as a subject and its teaching and learning			
Mathematics	Set of operations	To be accepted	Isolated subject
Teaching			
Emphasis on performance	0.44**	0.20**	0.20**
Teacher control	0.25**	0.07	0.30**
Rely on textbooks	0.23**	0.06	0.24**
Learning			
Instrumental learning	0.45**	0.14*	0.18**
Abstract learning	0.35**	0.13*	0.30**
Innate ability	0.43**	0.26**	0.18**

Correlations between teacher's beliefs about teaching and learning mathematics			
Teaching	Emphasis on performance	Teacher control	Rely on textbooks
Learning			
Instrumental learning	0.38**	0.29**	0.30**
Abstract learning	0.38**	0.17**	0.26**
Innate ability	0.19**	0.10	0.20**

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

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

All but three of the 27 correlations are statistically significant. The beliefs about 'mathematics as a set of operations' and 'mathematics as an isolated subject' were positively correlated with r ranging from a low of 0.18 to a high of 0.45 with the six conceptions in teaching and learning mathematics.

The teachers' conception of 'mathematics to be accepted' had higher association with teachers' emphasis on 'performance in mathematics teaching' (r=0.20) and 'innate ability in mathematics learning' (r=0.26) than with 'instrumental learning' (r=0.14) and 'abstract learning' (r=0.13). The lowest and non-sufficient correlations were found between the conceptions of 'mathematics to be accepted,' 'teacher control,' (r=0.07) and 'rely on textbooks' (r=0.06). In addition, Table 5 presents correlations between the three conceptions that concern the traditional teaching and learning mathematics. Except for the association between the conceptions of 'teacher control' in teaching and 'innate ability' in learning, all other beliefs in the traditional teaching and learning mathematics were significantly associated with r ranging from a low of 0.17 to a high of 0.38. The convention for describing the strength of correlations is: small=0.10, medium=0.25 and large=0.40 (Cohen, 1988).

In Table 6, correlations were computed between the three conceptions that concern the non-traditional teaching and nature of mathematics. The top part of the table correlates beliefs about mathematics with beliefs about teaching math. The middle part correlates beliefs about mathematics with beliefs about learning math. The bottom part correlates beliefs about teaching with beliefs about learning math.

Table 6. Correlations among teachers' non-traditional mathematical beliefs.

Correlations between mathematics as a subject and its teaching and learning			
Mathematics	Tools for thought	To be constructed	Integrated subject
Teaching			
Emphasis on understanding	0.22**	0.35**	0.58**
Student autonomy	0.22**	0.28**	0.61**
Using tools and new concept	0.28**	0.36**	0.61**
Learning			
Relational learning	0.29**	0.24**	0.45**
Interactive learning	0.38**	0.41**	0.58**
Intellectual ability	0.27**	0.28**	0.47**
Correlations between teacher's beliefs about teaching and learning mathematics			
Teaching	Emphasis on understanding	Student autonomy	Using tools and new concept
Learning			
Relational learning	0.48**	0.50**	0.50**
Interactive learning	0.55**	0.60**	0.65**
Intellectual ability	0.57**	0.58**	0.55**

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

All nine conceptions are positively and significantly correlated with r ranging from a low of 0.21 to a high of 0.65. The highest correlations were between the conceptions of 'integrated subject' with all six conceptions in the non-traditional teaching and learning math. Similarly, the associations between all the conceptions in the non-traditional teaching and learning were strong with r ranging from a low of 0.48 to a high of 0.65. The correlations among the non-traditional conceptions were higher than the correlations among the contrasts in traditional beliefs.

The study also examined if teachers' traditional and non-traditional beliefs were related to the beliefs that their views are affecting their practices. To investigate the relationship, statements were added to the Teachers Beliefs Questionnaire. The statements were constructed to elicit if the teachers agree or disagree that (a) there is no relation between beliefs and teaching or (b) teachers' beliefs about mathematics education influence their instructional practice.

In Table 7, the correlations between teachers' traditional and non-traditional mathematical beliefs with the statements (a) and (b) revealed that teachers' non-traditional beliefs were positively and significantly correlated with statement (b) about beliefs influence teaching.

Table 7. Correlations between teachers' beliefs and statements (a) and (b).

Statements	No relation between beliefs and teaching	Teachers' beliefs influence teaching
Mathematics		
Traditional	0.00	0.10
Non-traditional	0.05	0.28**
Teaching Mathematics		
Traditional	0.23**	-0.22**
Non-traditional	-0.33**	0.64**
Learning Mathematics		
Traditional	0.10	-0.03
Non-traditional	-0.28**	0.49**

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

The correlations ranged from a low of 0.28 to a high of 0.64. Non-traditional beliefs were either not correlated or negatively correlated with statement (a) revealing that there is no relation between beliefs and teaching, with r ranging from -0.33 to 0.05. In contrast, teachers' traditional beliefs were either not correlated or negatively correlated with statement (b), and not correlated or positively correlated with statement (a). This suggests that teachers with non-traditional beliefs are more likely to believe that their beliefs influence their teaching than those holding traditional beliefs.

Discussion of the Results

The discussion is focused on describing not only Iranian teachers' beliefs about mathematics as a subject, teaching and learning mathematics as they practice in the classroom and the consistency or inconsistency among their beliefs but also the possible derivation of such beliefs.

Iranian Teachers' Beliefs about Mathematics

The first major findings in this study responded to the question: what Iranian secondary school mathematics teachers' beliefs about the nature of mathematics? The results demonstrate that teachers held multiple, conflicting conceptions about mathematics. For example, many teachers believed that mathematics involves fact and rules that should simply be accepted and learned, in adherence with traditional views about mathematics. At the same time, teachers stated that mathematics is a subject that should be constructed, in adherence with non-traditional beliefs about mathematics. Some studies show that these mixed views usually occur when a reform movement is fairly new and the "teachers are trying to assimilate new practices to their more traditional beliefs

about mathematics" (Stipek et al., 2001, p. 214). This explanation aligns with the findings of this study because teachers were found to with both traditional and non-traditional beliefs about mathematics. These conflicting beliefs can be attributed to the short period since the reform movement was instigated, which did not allow sufficient time for a complete shift in teachers' beliefs about the nature of mathematics. If the reform objectives are successfully implemented in the future, the transition of teacher beliefs from traditional to non-traditional will be likely completed. If this does not occur, traditional beliefs about mathematics are likely to stay.

An interesting result in the study was the participants' agreement with the conception of 'math as an integrated subject' from the non-traditional belief system. This differed somewhat from the research literature's reports of the pervasiveness of traditional views among teachers (Stipek et al., 2001). Teachers' agreement with this conception could be because most teachers were encouraged or mandated to choose courses in another field while completing university course requirements.

On the other hand, there was also agreement among teachers concerning the conception 'math is to be accepted' from the non-traditional belief system. This could be the result of their Iranian college or university mathematics education, which relies on the axiomatic nature of mathematics. All secondary mathematics teachers in Iran have a Bachelor's degree in mathematics, and all upper-division mathematics courses at the university level strongly reflect axiomatic views of mathematics that should be accepted as facts and absolute truth. Another explanation for teachers' agreement with the conception that mathematics facts and rules should be accepted is related to the teachers' efforts to prepare students for the university entrance exam. The Ministry of Higher Education mandates that this exam is compulsory. Preparing students for the exam demands rote learning, instrumental teaching and drill practices. It seems that regardless of whether the teachers' beliefs are traditional or non- traditional, they have to assume the responsibility of training students for the university entrance exam.

Although the teachers expressed agreement with the conception 'math is to be accepted,' the teachers did not express their disagreement with the conception 'math' to be constructed; instead, they took a neutral stance about the latter conception. The teachers' responses regarding whether mathematics is accepted or constructed could reveal an unresolved perception about mathematics as some facts and rules to be discovered and accepted, or a subject created and constructed by humans through experience and need. This unresolved perception regarding the nature of mathematics could mean that teachers are not aware of their beliefs or the effects of their beliefs on their practice. In fact, even "professional mathematicians think little about the nature of their subject as they work within it" (Dossey, 1993, p.42).

Iranian Teachers' Beliefs about Teaching and Learning Mathematics

Other findings responded to the question: what are Iranian secondary school mathematics teachers' beliefs about the natures of teaching and learning mathematics? In the traditional teaching belief system, teachers disagreed with the two conceptions 'teacher control' and 'relying on textbooks,' but gave a neutral response to the conception 'emphasis on performance.' This neutral stance should be understood in the context which Iranian teachers work—Iranian teachers must cover a heavy and prescribed curriculum in a system which places great emphasis on preparing students to pass the university entrance exam.

One of the Iranian reform objectives was to introduce computers into the education system, which incited changes in teachers' styles of teaching. Zamani (1997) found that by implementing computers in the classrooms, teachers had to alter their teaching method by taking on the role of a

facilitator, thus giving students the freedom to work collaboratively. This appears to be supported by this study since teachers expressed agreement with the conceptions of 'student autonomy' and 'interactive learning,' rather than 'teacher control' and 'abstract learning.' It is likely that because of the wide-spread growth of computer technology in mathematics education over the past decade, teachers generally fostered non-traditional beliefs regarding teaching and learning mathematics, especially in terms of their preferred reliance on tools and new concepts while teaching, instead of textbook. While there was similarity in beliefs among the participants concerning mathematics teaching, there were unresolved and contradictory beliefs about mathematics learning. A close inspection of individual responses to the questions related to each concept in traditional mathematics learning revealed variations in responses to different questions within the same conception. For example, most teachers had conflicting responses to the questions related to the conceptions 'instrumental learning,' 'abstract learning,' and ' innate ability' in the traditional belief system. These neutral or unresolved beliefs about traditional mathematics learning alongside agreement with non-traditional mathematics learning could be due to the inconsistency between what the curriculum demands and what the reform objectives are. For example, working with a heavy syllabus and prescribed textbook to prepare students for standardized exams requires the adoption of a traditional mode of teaching and learning—where the teacher simply lectures—with insufficient time left to implement reform objectives. It seems that even though the reform movement may promote and influence the teachers' beliefs about the use of technology in mathematics teaching and learning, encourage the adoption of a student-centred system, and reconstruct theories, many teachers do not have the opportunity to exercise these altered beliefs.

Consistency/Inconsistency among Iranian Teachers' Mathematical Beliefs

It is the premise of this study that teachers' beliefs are manifested in their instructional practices. The beliefs this study examined were those that secondary mathematics teachers hold towards the nature of mathematics, teaching it and learning it. It follows logically to ask: Is there any consistency/inconsistency among teachers' beliefs about the nature of mathematics, mathematics teaching, and mathematics learning?

Correlations were computed between three sets of conceptions in the traditional views about the nature of mathematics and the sets of conceptions in the traditional beliefs about mathematics teaching and learning. The results revealed that the three conceptions that 'math is a set of operations,' 'math rules should be accepted,' and 'math is an isolated subject' were significantly associated with the conceptions that 'the math teacher should emphasize student performance,' 'the math teacher should be in complete control,' 'the math teacher should rely on textbooks,' 'math learning is instrumental,' 'math learning is abstract,' and 'math learning is dependent on the student's innate ability.' These results indicate that the stronger the teachers' traditional beliefs regarding the nature of mathematics, the stronger the teachers' traditional beliefs regarding teaching and learning mathematics, which may also be reflected in their teaching method. For example, teachers who considered mathematics to be an isolated subject or set of operations that should be accepted put more emphasis on mathematical performance than understanding.

Only weak relationships were found between the conception 'math to be accepted' and the conceptions 'teacher control' and 'rely on the textbook.' Interestingly, throughout the analysis, 'math to be accepted' was treated by teachers as a conception related to non-traditional beliefs, showing positive correlation to all sets of conceptions in the non-traditional belief system. One possible explanation is that teachers who believe mathematics is a set of facts to be accepted by students assume only the responsibility of transmitting mathematical facts to students for the purpose of

passing standardized exams, and believe students' discoveries may not be relevant in passing such tests. The conflicting responses to these conceptions can be understood as indicating that the conception 'math to be accepted' should be expected to evoke teachers' traditional views more precisely. It may also mean that it is possible for teachers to hold conflicting sets of beliefs.

Correlations were computed between three conceptions in the traditional beliefs about mathematics teaching and the set of conceptions in the traditional beliefs about mathematics learning. The results revealed that the three conceptions in mathematics teaching that 'the math teacher should emphasize student performance,' 'the math teachers should control the classroom,' and 'the math teachers should rely on textbooks' were significantly associated with the conceptions in math learning that 'math learning is instrumental,' 'math learning is abstract,' and 'math learning is dependent on student's innate ability.' These results indicate that the stronger the teachers' traditional belief regarding mathematics teaching, the stronger the teachers' traditional belief regarding mathematics learning, which may be reflected in their teaching method. For example, teachers who emphasized performance in teaching mathematics, look for innate ability in students' learning process. Consequently, such teachers are likely to predominately focus their teaching on students' overall mathematical skill level (Stipek, et.al. 2001) instead of paying attention to students' understanding or misconceptions.

The result supports Stipek's (2001) proposition that "a focus on individual students' differences in ability will undermine teachers' attention to students' subject-matter learning, interpretations and understandings of particular math concepts" (p. 223). Yet only weak relationships were found between the conceptions of 'teacher control' and 'innate ability.' The result indicates that teachers who believe that students' ability is fairly fixed and limits their learning also believe that neither 'student autonomy' nor 'teacher control' is relevant; these teachers assume that students who are low in mathematical ability will never thoroughly comprehend the contents regardless of the teachers' actions. The disparity of responses to these conceptions can also be understood as indicative of Rokeach's (1968) assumption that different beliefs have different intensity; perhaps the intensity of teachers' beliefs about students' innate ability is fairly strong.

Correlations were computed among teachers' non-traditional mathematical beliefs. These results indicate that the stronger the teachers' non-traditional beliefs regarding the nature of mathematics, the stronger the teachers' non-traditional beliefs regarding learning mathematics, which may be reflected in their teaching method. For example, teachers who emphasize students' understanding while teaching mathematics seem to look for intellectual abilities in the students' learning process and will provide instructional input that enhances those abilities. The result revealed that all conceptions in non-traditional beliefs about the nature of mathematics, teaching it, and learning it were strongly associated. To some extent, such strong relationships could be due to the implementation of reform objectives like technology in education and that many reform objectives or proposed new methods and programs were congruent with the teachers' beliefs, or teacher training programs were fairly successful in changing teachers' beliefs to align with reform objectives.

The correlations between teachers' traditional and non-traditional mathematical beliefs with statements (b) and (a), if there is/not a relation between beliefs and teaching, revealed interesting results. Teachers with non-traditional mathematical beliefs showed some awareness of the influence of their beliefs on their instructional practices; however, most teachers with traditional mathematical beliefs indicated that their beliefs had no influence on their teaching practice. A close inspection reveals that there is no disparity between the beliefs among teachers with traditional views and

teachers with non-traditional views regarding the impact of their beliefs on their instructional practice. They both teach according to their beliefs. The apparent disparity can perhaps be attributed to the teachers' experiences as learners and how those experiences correspond to their belief systems.

Over the years, Iranian teachers have experienced didactic models for teaching mathematics as learners of mathematics, and they have been exposed to the lecture system in teachers colleges. The aforementioned apparent disparity may be due to the teachers' difficulties reconciling their own instructional model, which has been influenced by their traditional beliefs, with the non-traditional teaching style prescribed by officials. If the instructional models correspond to the central-peripheral dimension of the teachers' beliefs systems, they resist change (Rokeach,1968); therefore, a teacher with traditional mathematical beliefs is more likely to teach according to the prescribed model believing that her/his beliefs have no influence on instructional methods, without recognizing that the model is, in fact, in accordance with their beliefs. Conversely, teachers with non-traditional beliefs are more likely to believe their beliefs influence their teaching because they will alter the prescribed teaching method, despite also having been exposed to the prescribed teaching styles in teachers colleges.

Concluding Remarks

Overall, Iranian secondary school mathematics teachers hold mixed beliefs regarding the nature of mathematics; however, because the questions provided the participants with a set of statements, they could have incited views that the teachers would otherwise not have thought of as applying to their conceptions of mathematics.

While Iranian teachers had mixed views about mathematics, their agreement with two of the three conceptions in non-traditional mathematics demonstrated that teachers were moderately leaning toward a constructivist view regarding the nature of mathematics, teaching it, and learning it.

There are consistencies among teachers' beliefs about the nature of mathematics, mathematics teaching, and mathematics learning. The consistencies among teachers' non-traditional beliefs were stronger than the consistencies among teachers' traditional beliefs. This also suggests that Iranian math teachers moderately favour constructivist views.

The teachers' awareness about the effects of their beliefs on their teaching practice has shown an interesting result. Although the teachers with traditional views have reported that their beliefs do not influence their teaching method, they are actually implementing teaching methods according to their beliefs; however, since their teaching methods are aligned with the prescribed methods of teaching, they are likely unconscious of their own beliefs and their influence on instructional practices.

Ultimately, reformers and policy makers in any nation may envision certain learning experiences for students or particular teaching methods for teachers through a reform movement, "they cannot fully anticipate how particular students will interact with the mathematical activities" (Lloyd, 2002, p. 9) or how particular teachers will modify the reform curriculum according to their educational beliefs.

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