RELATIONSHIP BETWEEN PRE-SERVICE MATHEMATICS TEACHERS' TEACHING AND LEARNING BELIEFS AND THEIR PRACTICES

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The purpose of this study was to determine pre-service mathematics teachers' teaching and learning beliefs and examine the relationship between their beliefs and practices. Qualitative and quantitative research methods were designed for this study. Survey, semi-structured interviews, observations, and pre-service teachers' written documents such as school practice portfolios were used to collect the data. Under the developed theoretical framework, it was found that some of the pre-service mathematics teachers' beliefs were consistent with their practices; while some of them presented different practices from their beliefs.

INTRODUCTION

Teachers' beliefs related to instruction have direct effects on their classroom practice; therefore, they have been a focus of attention in a large amount of research (Block and Hazelip, 1995; Hoban, 2003; Kagan, 1990; McDiarmid, 1995; Peterman, 1993; Thompson, 1992; Woolley & Woolley, 1999). Stipek, Givven, Salmon & MacGyvers (2001) emphasize that influencing teachers' beliefs is important to be able to change their classroom practice. If the purpose is to shape teachers' practices, their beliefs should be examined at the earliest stages in their professional development especially during their pre-service teacher training. Therefore, this study attempts to determine pre-service mathematics teachers' teaching and learning beliefs and examine the relationship between their beliefs and practices.

BELIEF AND BELIEF SYSTEMS

Kagan (1990), defines teacher belief as "the highly personal ways in which a teacher understands classrooms, students, the nature of learning, the teacher's role in the classroom and the goals of education" (p.423). Richardson (as cited in Woolley & Wooley, 1999, p. 3) gives three sources of teacher belief: a) personal life experiences which shape a teacher's world view, b) experiences as a student with schooling and instruction, and c) formal knowledge including pedagogical content knowledge. Gates (2005) emphasized the social dimensions of the sources of teachers' belief.

Fishbein & Ajzen (1975) define hierarchy of beliefs as a belief system. Green (1971) categorizes belief system as the following three dimensions: primary and derivative beliefs (primary beliefs are independent from other beliefs while derivative beliefs are the consequences of primary beliefs), central and peripheral beliefs (central beliefs are the ones that are most strongly hold and peripheral beliefs are the ones that

are susceptible to change), and beliefs in clusters which might be isolated from each other.

According to Thompson (1992), belief systems are dynamic, permeable mental structures, susceptible to change in light of experience" (p. 149). In other words, "teacher beliefs and belief systems are grounded in their personal experiences and, hence, are highly resistant to change" (Block & Hazelip, 1995, p. 27). It can be derived from the literature that teaching and learning beliefs emerge from personal experiences and can be changed by having the related experiences.

RELATIONSHIPS BETWEEN BELIEF AND PRACTICE

There is ample research on the relationship between teachers' beliefs and practices (Kagan, 1992; Kane, Sandretto & Heath, 2002). Other research investigated pre-service and in-service teachers' mathematics related beliefs as they are central to the belief-practice relationship (Raymond, 1992; Andrews & Hatch, 2000). Research demonstrates the general inconsistency between pre-service teachers' pedagogical views of teaching and their classroom behaviour (Raymond, 1997). It is suggested that future studies should seek to elucidate the dialectic relationship between teachers' beliefs and practices (Thompson, 1992).

PURPOSE OF THE STUDY

The purpose of this study was to determine pre-service mathematics teachers' teaching and learning beliefs and examine the relationship between their beliefs and practices. Pre-service teachers' beliefs in relation to practice were investigated under the theoretical framework developed from the previous research.

THEORETICAL FRAMEWORK

In the literature, teachers' beliefs related to instruction are categorized mainly as traditional and constructivist. Traditional belief is "based on a theory of learning suggesting that students learn facts, concepts, and understandings by absorbing the content of their teacher's explanations or by reading an explanation from a text and answering related questions" (Ravitz, Becker & Wong, 2000, p.1). Constructivist belief, on the other hand, is "based on a theory of learning suggesting that understanding arises only through prolonged engagement of the learner in relating new ideas and explanations to the learner's prior knowledge" (Ravitz et al., 2000, p.1).

The theoretical framework of this study is based on the research done by Haney and McArthur (2002) where they investigated constructivist and behaviourist beliefs in relation to practice. They categorize constructivist beliefs as core beliefs which are enacted in the practice, and peripheral beliefs which are stated but not enacted in the practice due to external factors such as lack of resources in the schools. They present a further categorization of core beliefs as constructivist, conflict and emerging core beliefs. Constructivist core beliefs are the constructivist beliefs that are put into

practice. On the other hand, conflict constructivist beliefs are those beliefs that are enacted in the practice, but are in opposition to constructivist theory (e.g. believing in hands-on student inquiry but relying on heavy lecturing). Emerging core beliefs are the ones that are both stated and put into practice but are not directly related to the constructivist practice (e.g. believing that good teachers are caring). Our theoretical framework which was extended from Haney & McArthur's (2002) framework is summarized in Figure 1 below. A category called transitional was considered to investigate beliefs in which neither constructivist nor traditional beliefs are dominant.

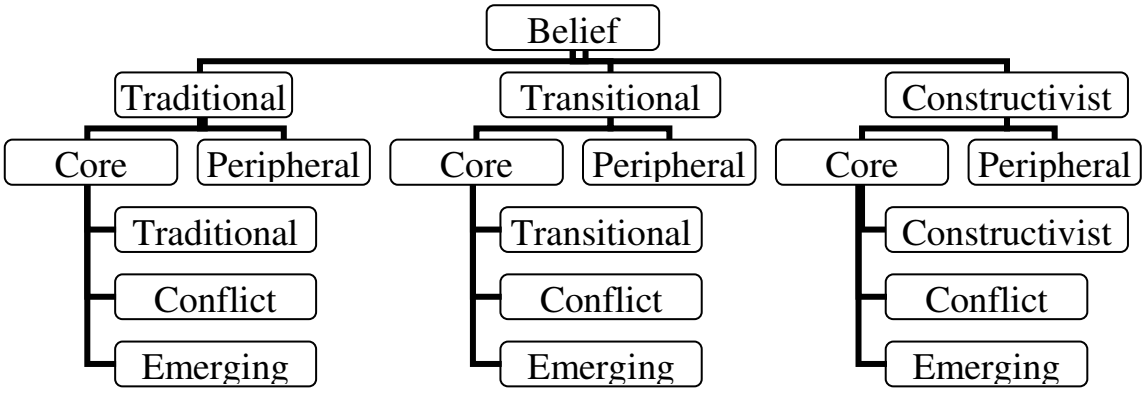

Figure 1. The categorization of beliefs in relation to practice

METHODOLOGY

Qualitative and quantitative research methods were designed for this study. The data was collected by using various instruments such as survey, semi-structured interviews, observations and pre-service teachers' written documents such as lesson plans and school practice portfolios.

Participants and setting

Participants of the study were 58 pre-service mathematics teachers attending the mathematics teacher education program. The age of the participants ranged from 20 to 25 and 45 % of them were female. Then, six pre-service teachers were selected to examine the belief-practice relationship deeply. The data was collected in "Instructional Methods in Mathematics-I" and "School Practice" courses.

Survey research

In order to examine pre-service teachers' beliefs, modified version of the TLC (Teaching, Learning, and Computing) survey developed by Becker & Anderson (1998) was used. As discussed in the literature review, teachers' beliefs are mainly categorized as traditional and constructivist. The new category called transitional beliefs was developed and pre-service teachers' beliefs were examined in five categories; traditional, close to traditional, transitional, close to constructivist and constructivist.

Interview

On the basis of the results of the survey, two participants from each belief category (constructivist, transitional and traditional) were randomly selected to be interviewed. The interviews were semi-structured and had two purposes. The first purpose was to examine pre-service teachers' beliefs. The second purpose was to discover how pre-service teachers prepared for their teaching practices in schools. Therefore the structure of the interviews had two parts. The first part consists of stimulated-recalls which required pre-service teachers to talk about their preparation and evaluation of the lessons in the school practice. The second part included questions about classroom environment, planning of teaching activities, assessment, the role of a teacher in the classroom and instructional goals to reveal participants' beliefs.

Observation and Written Documents

In order to evaluate pre-service teachers' teaching practices, six participants were observed in their method courses and school placements as they were teaching. To analyze the data from the observations, Greer et al.'s (1999) Constructivist Teaching Inventory was used. This inventory is composed of 44 items in four clusters: community of learners, teaching strategies, learning activities, and curriculum and assessment. The data from the observations was triangulated with the written documents and interviews.

RESULTS

The analysis of the data from the survey, interviews and observations were summarized in table 1 below. Letters were used to refer to the participants who were selected from different belief categories considering the results of the survey.

	Beliefs		Beliefs in relation to practice	
Participant	Survey	Interview	Method course	School setting
A1	Close to constructivist	Constructivist	Constructivist core	Constructivist core
A2	Close to constructivist	Constructivist	Constructivist core	Constructivist core
B1	Transitional	Transitional	Transitional core	Transitional core
B2	Transitional	Close to constructivist	Constructivist conflict	Constructivist conflict
C1	Close to traditional	Transitional	Transitional conflict	Transitional conflict
C2	Close to traditional	Close to traditional	Traditional core	Traditional core

Table 1. Comparison of the participants' teaching beliefs and practices

The columns named as method course and school setting represent the relationship between belief and practice based on our theoretical framework. Categories of beliefs in these columns were determined by comparing the participants' beliefs revealed from the interviews to their practices determined by observing practices in the method and school practice courses. For instance, C1 has transitional beliefs as determined from the interview and his practices were observed to be traditional; therefore, his belief in relation to practice both in the method course and school setting were determined as transitional conflict.

As seen in table 1, two of the pre-service teachers (A1 and A2) who were selected as being constructivist on the basis of survey results were also constructivist in the interview. They stated the following:

> A1: I'd choose which method to use according to the topic. I would apply discovery, and computer assisted methods and use concept maps. Some topics are more appropriate for these methods such as functions and absolute value, but not polynomials and logarithmic functions…teacher's role in the classroom shouldn't be the leading one, he is like a secret hero.
>
> A2: A teacher should be the facilitator when it's a suitable topic for students to discover for themselves… knowing why rules work is important…students should be active and investigate.

Both of them were also constructivist in their teaching practices. To illustrate why the practice of A1 was considered as constructivist, a brief account for his practice in the school setting will be given here. He taught absolute value in one of his lessons in the schools. He started his lesson by reminding prior knowledge such as number line and being non-negative. He tried to draw students' attention to the difference between the terms distance and length. He helped students to relate these to being non-negative. After giving the definition, he illustrated examples by asking students to express the algebraic expressions of absolute values in the colloquial language. He also encouraged students to express the algebraic expression on the number line.

The practice of A2 was also considered as constructivist. In one of her school placements she taught induction. She started her lesson with the story of Gauss and explained how he found out the sum of the numbers up to 100. She noted that generalization from specific cases may not always be true. She gave the example of Fermat's prime numbers as $F_n = 2^{2^n} + 1$ and mentioned that the induction method was needed to prove such statements. While explaining the method of induction, she gave the example of dominos. In her reflection report of the lesson, she wrote that:

> A2: I had two choices to teach induction. One like the way the textbooks do with the definitions in formal notation, secondly by using colloquial language to give meaning to the notation. I chose the second way because if I had chosen the first way then it would have been too abstract.

Practices of these two pre-service teachers were constructivist which reflected their beliefs; thus, they were considered in the category of constructivist core.

B1 was selected as having transitional beliefs based on the survey results. Her beliefs were also considered as transitional based on the interview transcripts. For instance, in terms of classroom environment, she stated that:

> B1: Students should listen and understand what is taught…they should participate and they can correct my mistakes.

Her practices in the method course and school practice reflected her transitional beliefs; hence, her beliefs in relation to practice were considered as transitional core.

Although B2 was selected as having transitional beliefs based on the survey results, his beliefs were analyzed as close to constructivist. In the interview, he stated that:

> B2: I would choose the teaching method according to the topic and the students' level. I would use group work, experiments, demonstration boards…I wouldn't teach directly. Students should try for themselves.

However, his practices both in the method course and school setting were not constructivist. For instance, in the school setting he heavily relied on giving definitions and rules followed by examples which aimed instrumental understanding as pointed out by Skemp (1978). Although, he tried to relate mathematics to real life, he did not assess whether students could make this relationship. Consequently, his beliefs in relation to practice were considered as constructivist conflicting.

Although C1 was selected as having traditional beliefs based on the survey results, his beliefs were determined as transitional in the interview:

> C1: I wouldn't want students be so quite or so noisy. I want them to participate….One to one interaction is important in the classroom….I want to share their problem…I would choose questions at different levels.

However, his practice was traditional. For instance, in the school setting, when he was teaching probability, he mostly relied on using rules. When students asked the reason why they multiplied the probabilities instead of adding, he mentioned that it was because there were rules for this. In the interview, when he was asked the reason for his answer to the students, he explained that he did not know the answer.

C2's belief was considered as traditional. In the interview she said that:

> C2: The teacher should teach thoroughly, not quickly…Group work becomes chatting…Meaningful learning is important but curriculum should also be followed.

Her practices reflected her traditional beliefs. For instance, when she was teaching probability in her school placement, she heavily relied on applying rules without reasons in the sense of instrumental understanding of Skemp (1978). She reacted negatively towards the different solutions from the students as she deleted a student's solution on the board and wrote her solution instead.

CONCLUSIONS

The following conclusions can be drawn from this research. First, results showed some inconsistencies between pre-service teachers' teaching and learning beliefs and

practices. In this paper, these inconsistencies were described on the basis of our theoretical framework developed from Haney & Mc Arthur (2002). The data indicated that declared beliefs might not be enacted due to the various reasons such as lack of subject knowledge and the complexity of classroom environment. For example, one of the participants who believed in active participation of students could not put his beliefs into practice. This might be because surviving in a chaotic classroom environment requires pedagogical skills and experience.

As a second conclusion, pre-service teachers believe that teaching approach should be determined on the basis of the nature of the mathematical topic. As one of the pre-service teachers who held constructivist beliefs stated that functions and absolute-value could be taught using discovery methods and in a technology-rich environment while polynomials and logarithmic functions could only be taught by heavy-lecturing. More research is needed to investigate topic specific beliefs.

Finally, constructivist or traditional beliefs tend to be more consistent with practice. In other words, pre-service teachers who held constructivist or traditional beliefs have core beliefs in their practice.

The data revealed more comprehensive categories than the ones in the theoretical framework developed by Haney & McArthur (2002). Similar to the research done by Ogan & Akkoç (2005), this study observed some of the categories (such as traditional core, transitional conflict and transitional peripheral) in our extended theoretical framework. Further studies need to be conducted for other categories which were not observed in this study. The theoretical framework might have significance for other studies which aim to change teachers' beliefs.

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