# Pre-service teachers' beliefs about mathematics in China and Thailand

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## Introduction

Teachers' beliefs play important roles in their teaching. Liljedahl (2009) proposed that a teacher with the belief of mathematics as a toolbox would teach mathematics with an emphasis on rules, formula and procedures with an abundance of practice to enforce memorization and mastery, and s/he would guide the students to follow her/his procedures. The major sources of teacher beliefs could come from personal experience, experience with schooling and instruction, and experience with formal knowledge (Richardson, 1996). As pre-service teachers (PSTs) start their teaching career and begin struggling to develop their teaching practice, they rely on and reveal much about their beliefs (Raymond, 1997), which were developed based on their previous school (including teacher education programme) experiences. Therefore, knowing pre-service teachers' existed beliefs becomes crucial to teacher educators and researchers.

With the Asian students' outstanding performance on mathematics in the international assessments (e.g., PISA and TIMMS), researchers have paid more attention on mathematics education in Asian countries (Leung, Graf, & Lopez-Real, 2006). However, there is a lack of research studying the beliefs PSTs hold among these countries. Different teachers' beliefs about mathematics can be related to differences in their mathematics teaching, which in turn reflect the difference of students' mathematics learning. The study aimed to compare PSTs' beliefs about mathematics in China and Thailand. The main research question we explored asks, what is the status and difference of PSTs' beliefs about mathematics in China and Thailand? Beliefs are often context-independent and the beliefs related to mathematics education may also vary in different regions.

The study will have some contributions to teacher education. Knowing the initial beliefs can promote pre-service teachers' willingness to develop their beliefs in their teacher preparation program, and also can benefit teacher educators' work.

## Literature review

### *Beliefs about mathematics*

Mathematical beliefs are the "primary regulators" of teachers' classroom behavior (Ernest, 1989, p. 252). They are also regarded as "personal judgments about mathematics formulated from experiences in mathematics" (Raymond, 1997, p.552). McLeod (1992) described four differentiations: beliefs about mathematics, beliefs about mathematics teaching, about self, and about the contexts in which mathematics education take place. Differences in teachers' beliefs about mathematics appear to be related to differences in their mathematics teaching, which in turn reflect their different views of how to learn mathematics and of students' mathematics learning (Beswick, 2007). Among the four categories, beliefs about mathematics are more important, which refer to beliefs about the nature of mathematics. They reflect teacher's views of the

philosophy of mathematics (Ernest, 1989). There are three schools of philosophies of mathematics: the instrumentalist view, the Platonist view, and the problem solving view. The instrumentalist believes mathematics is useful and collects unrelated facts, rules and skills. The Platonist views mathematics as a consistent, connected and objective structure, which means mathematics is a unified body of knowledge that is discovered, not created. The problem solving view sees mathematics as a dynamically organized structure located in a social and cultural context (Ernest, 1989, p. 251).

*Pre-service teachers' beliefs*

Aside from the various studies on the beliefs among practicing teachers, the beliefs of PSTs are worth even more attention. "Most pre-service teachers have an unrealistic optimism and a self-serving bias that account for their believing that the attributes most important for successful teaching are the ones they perceive as their own" (Pajares, 1992, p. 323). Changing and influencing PSTs' existing beliefs is one of the goals of teacher preparation programs. However, studies showed that teacher preparation programs had little impact on PSTs' initial beliefs (Vacc & Bright, 1999). While learning in the teacher preparation program, PSTs are expected to develop, modify, and challenge their beliefs. Some of them modified their existing beliefs to fit their new experiences, while others resisted changing them (Vacc & Bright, 1999; Stuart, & Thurlow, 2000).

This study explored PSTs' existing beliefs about mathematics in two teacher preparation programs in China and Thailand respectively. We found that studies we reviewed in literature were mainly done in Western countries. Shanghai (a big city in the east of China) students were found to do better in mathematics than Thailand students in recent PISA, ranking top and fiftieth, respectively. Beliefs are often context-independent and the beliefs related to mathematics education may also vary in different regions. There is still a lack of studies on PSTs' mathematical beliefs in Eastern countries. It is relevant to know what kind of mathematical beliefs PSTs hold in the eastern regions, not only because this is precisely the theme of the current studies in the field, but also because of its critical contribution to teacher education. Studies have indicated that being aware of and understanding teacher candidates' existing beliefs is the starting point as well as the basis for teacher educators (Ernest, 1989), and is one motivation for PSTs to feel the need to change (Stuart & Thurlow, 2000). Thus, this study provides empirical evidence of PSTs' beliefs about mathematics for both teacher preparation programs and PSTs themselves, so as to make both of them more aware of teacher candidates' initial beliefs. The main research question is: What are the characteristics and differences of PSTs' beliefs about mathematics in China and Thailand, particularly their beliefs about the nature of mathematics and mathematics teaching and learning?

## Research design

*Participants*

Quantitative method was used in the study. 183 PSTs (58% female, 42% male) in Shanghai and 189 PSTs (80% female, 20% male) in Thailand whose ages ranged from 20 to 22 were invited to complete a questionnaire, which takes about 20 minutes. These PSTs were all senior students and were enrolled in mathematics teacher education programme in their universities.

*Instrument*

The whole questionnaire used in this study was previously used in Chan, Wong and Leu (2012), which included teachers' beliefs about the nature of mathematics and about mathematics teaching and learning.

Teachers' beliefs about the nature of mathematics were measured in 54 items by five subscales. The subscales include (1) Mathematics is a subject of ***calculables*** (13 items; e.g., "Mathematics is just mechanical computation."), (2) Mathematics involves ***thinking*** (13 items; e.g., "Mathematics is a subject that uses the brain"), (3) Mathematics is ***useful*** (11 items, e.g., "There are plenty of daily life applications of mathematics."), (4) Mathematics is ***precise*** (10 items; e.g., "Mathematics is composed by accurate results and correct steps. "), and (5) Mathematics is ***logical*** (8 items; e.g., "Mathematics is a rigorous logical system"). Participants were asked to rate how much they agree or disagree with each of the statement using a 5-point Likert scale, ranging from 1 (disagree) to 5 (agree).

Teachers' beliefs about mathematics teaching and learning were further measured by Capraro (2001, 2005)'s *Teacher's Mathematic Beliefs Scale*. The scale includes three factors with six items each, which were named *Students' learning*, *Teacher's role*, and *Teaching practice* respectively. The factor of Students learning means how students learn mathematics (e.g., "Time should be spent practicing computational procedures before students are expected to understand the procedures"). Teachers' role means the role of teacher in sequencing of teaching computational and application skills (e.g., "Students need explicit instruction on how to solve word problems"). Teaching practice means relationships between teaching computational skills and problem solving skills (6 items; e.g., "Teachers should allow their students to figure out their own ways to solve word problems"). Participants were asked to rate how much they agree or disagree with each of the statement using a 5-point Likert scale, ranging from 1 (disagree) to 5 (agree). The mean score on these 18 items was less than 2.5, which is referred as "low constructivist," while a mean score higher than 3.5 is considered "constructivist" who believes and explicitly lets students construct their own knowledge through investigation and dialogue (Capraro, 2005, p. 3).

**Results**

Preliminary analyses showed that there were similarities and differences in terms of teachers' beliefs about the nature of mathematics in the two countries. Overall, mathematics is believed to be more about thinking, logic, and usefulness, rather than a subject of calculableness and preciseness. PSTs in China rated significantly higher on thinking and usefulness than PSTs in Thailand, whereas PSTs in Thailand (vs. China) rated significantly higher on calculableness, preciseness and logic ($p < .001$). Details can be found in table 1.

Among the five subscales, the emphases on the nature of mathematics appeared to be different within the two countries. PSTs in China rated highest on usefulness ($M$ = 4.34), followed by thinking, logic, preciseness, and calculableness, with the mean differences being significant among the subscales. PSTs in Thailand, on the other hand, rated highest on logic ($M$ = 3.96), followed by usefulness, thinking, calculableness, and preciseness, with all the mean differences being significant except usefulness and

thinking. Regarding mathematic teaching, we found that the overall mean of beliefs about mathematics teaching was 3.48 in China and 2.77 in Thailand (see table 2). PSTs in China (vs. Thailand) were more likely to expect students to find their own solutions, to do more computational practices and consider themselves as a facilitator in students learning.

*Table 1.Descriptive statistics for teacher's beliefs on mathematics by country*

| | China | | Thailand | | |
|---|---|---|---|---|---|
| Subscales | *M* | *SD* | *M* | *SD* | *t*-test |
| Calculableness | 2.17 | 0.46 | 3.59 | 0.59 | -26.08** |
| Thinking | 4.23 | 0.47 | 3.77 | 0.57 | 8.51** |
| Usefulness | 4.34 | 0.63 | 3.81 | 0.57 | 8.53** |
| Preciseness | 2.32 | 0.65 | 3.35 | 0.59 | -15.68** |
| Logic | 3.37 | 0.54 | 3.96 | 0.62 | -9.71** |

** $p < .001$.

*Table 2.Descriptive statistics for Capraro's Mathematic Beliefs Scale by country*

| | China | | Thailand | | |
|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *t*-test |
| Overall | **3.48** | 0.45 | 2.77 | 0.29 | 18.12** |
| Students' learning | **3.10** | 0.94 | 2.18 | 0.71 | 10.52** |
| Teacher's Role | **3.19** | 0.60 | 2.43 | 0.44 | 13.90** |
| Teaching practice | **4.06** | 0.65 | 3.60 | 0.57 | 7.34** |

** $p < .001$.

**Discussion and conclusion**

This study explored the characteristics of PSTs' beliefs about mathematics between China and Thailand by the use of a questionnaire. The results showed that there were similarities and differences in terms of PSTs' beliefs about the nature of mathematics and beliefs about mathematics teaching and learning.

In general, PSTs in both regions believed mathematics is more about thinking, usefulness and logic, rather than calculable and precise. There are also some subtle differences between two countries. The majority of Chinese PSTs' beliefs are quite related to the problem solving view, which views mathematics as "a process of enquiry and coming to know" (Ernest, 1989, p. 250). The PSTs in Thailand mainly focus on the usefulness and logic of mathematics, which are close to the Platonist views which views mathematics as a "unified body of certain knowledge" that is "discovered, not created" (p. 250). Only a small proportion of these two group viewed mathematics as a collection of *calculables* and is precise, which is close to the instrumental view. As for beliefs about mathematics teaching and learning, the results showed that Chinese PSTs' beliefs are more like constructivist. Their overall mean was higher than Thailand. Thailand PSTs' beliefs are close to low constructivist.

Why do these PSTs hold such beliefs? Richardson (1996) pointed out that there are three possible sources for teachers' beliefs. They are personal experience, experience

with schooling and formal knowledge. In 2000, China has initiated new curriculum reform, in which constructivism was advocated (Ministry of Education of PRC, 2001). As mentioned before, these PSTs' ages ranged from 20-22. Tracking them back to their secondary school experiences, they learned mathematics under the latest curriculum reform period. Therefore, it is reasonable to think that these PSTs brought in the view that mathematics is useful and involves thinking, and they tended to believe in the constructivist teaching and learning approach. On the other hand, influenced by the traditional views that emphasized the basic knowledge and basic skills in teaching and learning mathematics (Zhang & Dai, 2004), it is not strange that these PSTs still hold the beliefs about the mastery of mathematical rules, facts, skills, and procedures, even though these beliefs are not the most important or core.

Almost at the same time, in Thailand, the new mathematics curriculum was implemented in 2002. This new curriculum was based on the principles of curricular development of the NCTM (2000). Mathematical thinking was emphasized in the new curriculum (Ministry of Education of Thailand, 2001). However, even though the curriculum reform was implemented, the definition of mathematical thinking remained a perplexing matter that the teachers found difficult to comprehend. Worse still, most mathematics teachers regarded mathematical thinking something essentially related to computation and emphasized the ability to solve problems in the styles they preferred. They still used traditional teaching emphasizing on the contents by using textbooks as major material for instructional organization and overlooking the importance of the students' learning process and attitudes toward learning with understanding (Inprasitha & Loipha, 2007, p. 258). Our Thailand PSTs also learned their school mathematics during the curriculum reform period. Therefore, it is not strange that, according to their teachers, these students who are capable of doing mathematical thinking are the same as those who make high scores on mathematics learning achievement tests. Teachers' judgments are clearly based on the way the students do on the close-ended tests as fast and as correctly as possible.

We realized that our samples were not enough and did not represent these two countries. However, the findings could open a window and let us know the status of PSTs' mathematical beliefs in different cultural contexts. Since belief is complex in nature and internal to each individual, PSTs might not realize or might be unclear about their own beliefs. This study, on the one hand, can help them to be aware of their mathematical-related beliefs. By noticing the coherence of their existing beliefs and the expected goals of their teacher preparation programme, the study also helped PSTs view their teacher preparation programme more positively and be willing to incorporate into their practice. On the other hand, different mathematically related beliefs as well as the rationale of forming those beliefs offered opportunities for PSTs to rethink their own beliefs and get to know more about teaching practices. Viewing mathematics and mathematics teaching from various perspectives can provide PSTs with flexibility in meeting challenges when they start their teaching career. However, there are still challenges for teacher preparation programmes. For example, how should flexible courses for PSTs be designed so as to prepare them for both the needs of practical schools and the calls for curriculum reform? How long will it take them to hold the mathematical beliefs that were gained from their teacher preparation program? Whether their mathematical-related beliefs are consistent with their teaching practices or not, what will happen to their mathematical beliefs when pre-service teachers become

teachers? By knowing the PSTs' existing beliefs, the teacher preparation programme can design, develop, and adjust courses so as to fit better with PSTs. A further study could be done on this, to explore the relationship of their beliefs and their teaching practices and professional development.

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