

DESIGNING PROFESSIONAL LEARNING COMMUNITIES THROUGH UNDERSTANDING THE BELIEFS OF LEARNING

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ABSTRACT: This study was designed to initiate the process of building professional development learning communities for pre-service math teachers through revealing those teachers' conceptions/beliefs of students' learning and their own learning in China. It examines Chinese pre-service math teachers' conceptions of student learning and their related pedagogical beliefs with respect to the following four aspects: self-regulation, construction of knowledge, the social nature of learning, and a dynamic view of ability. A total of 129 middle-school and secondary pre-service math teachers from China participated in this study. The results indicated that the Chinese pre-service teachers' conceptions of student learning and their pedagogical beliefs are constructive, process-oriented, and progressive. In addition, the traditional Chinese socio-cultural values still have an impact on the pre-service teachers' conceptions of student learning. Implications and recommendations for designing meaningful and effective teacher professional development programs that not only incorporate teachers' beliefs of student learning but also are aligned with Chinese mathematics education reform are also discussed.

Keywords: Professional development, learning community, adult education, beliefs of learning, Chinese educational reform, mathematics education, teacher education

Background

The past decade has witnessed worldwide reforms in teaching math, science and technology. Studying how to improve teaching and learning of the teachers in related subjects in the fields, therefore, becomes a focus of attention in the field of adult education. Loucks-Horsley, Stile and Hewson (2009) summarized the trends in the academic community regarding teaching science and mathematics, one of which that related activities became more purposeful and teacher professional development was designed with a clear intention of improving students' learning. Loucks-Horsley, et. al also developed and expanded the idea of professional learning communities. According to the Professional Development Design Framework (Loucks-Horsley, Stile & Hewson, 2009), the first step of designing a teacher professional development program is to commit to vision and standards; and the first inputs designers acquire to achieve this are *knowledge* (solid facts and research) and *beliefs* (knowledge based on personal experience, observations and convictions).

China started the educational reform on mathematics in 2004. The Ministry of Education released its 2011 version of the curriculum standards, which is an update of its 2001 standards. The parallel documents were issued by the National Council for the Teachers of Mathematics (NCTM) of the United States about a decade ago (1989, 2000). Those documents set up the vision and standards for building professional development communities for math teachers in China. Now that the first step of the Loucks-Horsley et.

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al (2009)'s Professional Development Design Framework, committing to vision and standards, has been established, it is the next step to build professional development communities that acquire and acknowledge knowledge and beliefs of learning of both pre-service and in-service teachers in order to further the reform and improve the quality of teaching mathematics in China. With those inputs, professional development/training strategies can be devised to strengthen or modify these conceptions (Ogan-Bekiroglu & Akkoc, 2009).

Purpose of Study and Research Questions

This study was designed to jump-start the design process of professional development communities for mathematics teachers through revealing math pre-service teachers' conceptions/beliefs of students' learning and their own learning in China. The study also presents the current state of teaching and learning the subject of math in China and explores the desired state that is aligned with its national policy. The study hopes to fill the void in literature on designing an effective model of professional development for mathematics teachers in China.

The following questions guided the study:

1. How do math pre-service teachers view students' learning?
2. How do math pre-service teachers view their own learning?
3. How do their conceptions/beliefs influence their decisions on teaching strategies?
4. What factors do designers of professional development communities need to take into consideration based on the findings of pre-service teachers' beliefs on their learnings and their students' learning?

Literature Review

Teacher Professional Development and its Characteristics

Teacher professional development is "the professional growth a teacher achieves as a result of gaining increased experience and examining his or her teaching systematically" (Glatthorn, 1995, p. 41). According to Villegas-Reimers (2003), professional development is different from career development, and carries the following characteristics (pp. 11-13): a) it is based on constructivism rather than on a 'transmission-oriented model.' Teachers should be treated as active learners; b) it is perceived as a long-term process as it acknowledges the fact that teachers learn over time; c) it is perceived as a process that takes place within a particular context; d) many identify this process as one that is intimately linked to school reform, as professional development is a process of culture building and not of mere training which is affected by the coherence of the school programme; e) a teacher is conceived of as a reflective practitioner; f) professional development is conceived of as a collaborative process; and g) professional development may look and be very different in diverse settings, and even within a single setting. In order for a professional development program for teachers to be successful, the

program must be grounded in knowledge about teaching and model constructivist teaching (Corcoran, 1995).

The Impact of Professional Development on Teachers, Students' Learning and Educational Reform

Numerous research studies around the globe have found that successful professional development experiences have a noticeable impact on teachers, in and out of classroom (Ball, 2000; Henning, 2000; Kallestad & Olweus, 1998). Furthermore, Villegas-Reimers (2003) summarized many research studies on the effect of teachers' professional development on students' learning and concluded that the more professional knowledge teachers have, the higher the levels of student achievement are. Borko and Putnam (1995), in particular, pointed out that professional development plays an important role in changing teachers' teaching methods, which in turn have a positive impact on students' learning. As to the impact of professional development on education reform, many countries, such as Finland, provided a good case where professional development of teachers successfully transformed the country's educational systems (Darling-Hammond, 2010; Jamil, 2014; Sahlberg, 2010). In conclusion, professional development of teachers plays a key role in ensuring the effectiveness of an educational reform at all levels, if any (Villegas-Reimers, 2003).

Teachers' Beliefs about Student Learning and the Related Pedagogy

This study used Bolhuis and Voeten's (2004) study as the conceptual framework for the following reasons. First, it treats teacher beliefs as a complex, multidimensional construct and reflects the interconnectedness of teacher beliefs as discussed in the research literature (Cooney, Shealy, & Arvold, 1998). Second, Bolhuis and Voeten's Learning Inventory is closely aligned with a student-centered, inquiry-oriented pedagogy which is the underpinning of the current mathematics education reform movements in China. In addition, Bolhuis and Voeten's framework is the only one the researchers have found that examines teachers' implicit beliefs of students' intelligence or ability, in addition to their beliefs about student learning. Examining and comparing such implicit beliefs are relevant and meaningful in the contexts of US and Chinese mathematics education. In particular, students and teachers in China and other Confucian Heritage Cultures (CHC) have a tendency to attribute success to effort and persistence. With such a philosophical orientation, Chinese students are less likely to adopt the "helpless learner" syndrome than American students (Moy & Peverly, 2005). Bolhuis and Voeten (2004) identified five dimensions of teacher beliefs about student learning: self-regulation of learning, the construct-character of knowledge, the social nature of learning, a dynamic model of intelligence, and tolerance of uncertainty.

Self-regulation of learning. Mathematics teachers' beliefs about students' self-regulated learning are closely tied to their knowledge of how students learn and think about mathematics, which in turn influence their perceptions of the teacher's roles (Fennema, Carpenter, Franke, Jacob, & Empson, 1996). The authors categorize teacher beliefs regarding students' abilities to self-regulate into four levels ranging from the

belief that students learn best by being told how to do math to the belief that students can solve problems on their own without the needs of direct instruction. They also observed that although teachers' beliefs and practices are not always categorized at the same level, there was a clear relationship between beliefs and instruction. This result suggests that studying pre-service teachers' beliefs about students' self-regulated learning may help to predict the type of instructors they will eventually become.

Student-centeredness is one of the leading themes of China's mathematics education reform movement. For instance, the Ministry of Education's standards (2011) made the explicit recommendation that "instruction should actively involve teachers and students into a process of interactions and mutual development. Effective instruction is a union of teaching and learning. Students are centers of learning. The teacher is the organizer, guide, and collaborator" (p. 2).

Studying Chinese pre-service teachers' conceptions of student self-regulated learning is likely to reveal interesting results also because of the culture's emphasis of balance over extreme positions. Such a cultural value seems to be consistent with Eshel and Kobavi's (2003) more balanced view of student self-regulation: classroom control is not necessarily a zero-sum game and students' control is not always at the expense of teacher's control.

The construct-character of knowledge and the social nature of learning

These two dimensions in the Bolhuis and Voeten's (2004) framework reflect the basic tenet of constructivism in that "knowledge is not passively received but is actively built up by the cognizing subject" (von Glasersfeld, 1989, p.162). Although we do acknowledge that constructivism as an epistemology does not always dictate how one teaches, we also take the stance that there are models of teaching that could be legitimately called "constructivist" (Steffe & D'Ambrosio, 1995). Teachers might build their own legitimate models of "constructivist teaching" depending on how they interpret constructivism (Steffe & D'Ambrosio, 1995, p. 146). However, there are common elements across these models that are generally accepted as the central characteristics of "constructivist teaching" such as student-led inquiry and social learning. The constructivist-oriented teaching model serves as the underpinning of the mathematics education reform in China. For instance, the Ministry of Education's curriculum standards (2001, 2011) stress, on multiple occasions, the importance of students making conjectures through observations and experience, as well as reasoning about mathematics and making generalizations.

Two common and interrelated features of "constructivist teaching" are student-led inquiry and social learning. Vygotsky's (1987) original notion of zone of proximal development refers to what students cannot achieve by themselves but can accomplish with the aid of the teacher. Drawing from Vygotsky's initial conception of the zone of proximal development, Steffe and D'Ambrasio (1995) extend the zone to what they call the "zone of potential construction," which encompasses various mathematically meaningful contexts that stimulate rich "interactive mathematical communications"

including those among the learners themselves (p. 154). Although we have noted that “constructivist teaching” does not always lead to social learning, we do believe that when students develop mathematical understanding through collaborative problem solving, they produce the deepest and most powerful form of knowledge. If social learning results in a truly profound understanding of mathematics, then we believe that it is consistent with the social constructivist theory of teaching and learning (Wood, Cobb, & Yackel, 1991). In addition, we agree with Bolhuis and Voeten (2004) that if a teacher conceptualizes learning as a social process, she/he is also likely to value the process of learning rather than give attention only to the end results, and thus, is a process-oriented teacher.

Fixed versus dynamic ability. Dweck and her colleagues conducted research to solve the puzzling phenomenon, i.e., why individuals of equal abilities respond to challenges with marked differences that eventually lead to quite different levels of achievement (e.g., Dweck & Leggett, 1988). They formed, tested, and verified a couple of hypotheses: (a) People who pursue performance goals (concerned with gaining favorable evaluation of their performance) are likely to develop the “helpless” learner pattern and show vulnerability when facing learning challenges; while people who seek learning goals (concerned with increasing skills or competence) are likely to seek challenge and be persistent in their efforts, (b) The views of intelligence as fixed versus incremental (implicit theories of intelligence) predict adoption of different learning goals. In particular, people who view one’s intelligence as fixed (entity theorists) tend to adopt performance goals; while those who view one’s intelligence as malleable (incremental theorists) tend to adopt mastery goals. Traditional beliefs about mathematics teaching and learning may be associated with the entity theory of intelligence and ability because of their shared emphasis on the product of learning or the end results (Stipek, Givvin, & MacGyvers, 2001). Teachers who view intelligence and ability as fixed entities may not be persistent in their efforts to help the students that they deem as possessing low abilities. On the other hand, constructivist teaching and learning are aligned with the incremental theory of intelligence and ability because both theories emphasize the process of knowledge construction (Bolhuis & Voeten, 2004). When facing challenges, teachers who view intelligence and ability as incremental are likely to examine and modify their teaching process in order to bring out maximized learning outcomes from their students.

Methodology

The study adopted the learning inventory developed by Bolhuis and Voeten (2004), which contains two parts. The first part includes 24 items on student learning and the second part consists of 22 items on the teachers’ own learning. Each item consists of two contrasting statements, a more constructivist-oriented statement and a more traditional statement. Bolhuis and Voeten identified five dimensions of teacher beliefs about student learning: self-regulation of learning, the construct-character of knowledge, the social nature of learning, a dynamic model of intelligence, and tolerance of uncertainty. Bolhuis and Voeten’s Learning Inventory is closely aligned with a student-centered, inquiry-

oriented pedagogy, which is the underpinning of the current mathematics education reform movements in China. Convenience sampling was used in the survey study.

Participants

A total of 129 pre-service math teachers from China participated. The Chinese sample included grade 7-12 pre-service math teachers who were respectively enrolled in two 4-year teacher preparation programs at two universities, one in the southeast coast of China and the other in central China. Among the 129 Chinese pre-service teachers, 74 were female; 35 were male; 20 did not identify their gender on the returned questionnaires.

Data Analysis and Results

There were a few missing values (less than 0.1%) in the sample. These missing values were replaced with the score of the highest frequency for that particular item. In addition to descriptive statistics (e.g., means, standard deviations), Pearson correlation, exploratory factor analysis (EFA) and Confirmatory Factor Analysis (CFA) were conducted to analyze the data. In order to correlate the factors of student learning with those of their own learning, mean scale scores (i.e., the mean of the observed item means, with equal weighting of all items belong to that factor) were computed for all the pre-service teachers. The criteria specified by Cohen (1988) to interpret the strength of the correlation coefficients, specifically, $0.10 < r < 0.30$ is interpreted as a weak correlation, $0.30 < r < 0.50$ as a moderate correlation, and $r > 0.50$ as a strong correlation.

The overall reliability alpha was .69, which met Nunnally's (1978) minimum criterion ($> .60$) for early-stage, exploratory study such as this one. The factor structure extracted from the EFA was validated by CFA with the maximum likelihood method of estimation. Satisfactory goodness of fit indices were found for both conceptions of student learning in terms of CFI (comparative fit index), RMSEA (root mean square error of approximation, and SRMR (standardized root mean square residual) (CFI: .93, RMSEA: .04, SRMR: .06) and conceptions of own learning (CFI: .93, RMSEA: .04, SRMR: .06). The resulting factor structure also supported Bulhuis and Voeten's (2004) conclusion that conceptions of student learning and own learning are multi-dimensional constructs. However, the factor structure found by Bolhuis and Voeten was not replicable in this study. In EFA, only three instead of five factors were extracted for the conception of student learning: Individual versus Social Learning (4 items), External versus Internal Regulation of Knowledge Construction (5 items), and Fixed versus Dynamic Ability (4 items). The conception of own learning is also comprised of three factors: Social and Lifelong Learning versus Individual and Limited Learning (6 items), Externally versus Internally Regulated Learning (6 items), and Knowledge as Fixed versus Actively Constructed (4 items). The three factors extracted for conceptions of own learning were not parallel to the three factors for conceptions of student learning, which is inconsistent with the findings of Bolhuis and Voeten (2004).

All the correlations, except one, were tested positive. The correlations varied between -.07 and .41. Almost all the correlations between a factor of conceptions of student

learning and a factor of conceptions of own learning were moderate to high. This finding suggests that the pre-service teachers' conceptions of student learning and their conceptions of own learning tend to be consistent with each other.

Discussions

In general, the Chinese pre-service teachers in our study showed a strong preference and support for constructivist conceptions of learning over traditional conceptions of learning. It is surprising to see the overwhelming support for student self-regulation expressed by the Chinese pre-service teachers. Bolhuis and Voeten (2004) found that Dutch teachers strongly endorsed the notions that knowledge should be actively constructed and learning is a social process. However, Dutch teachers' support for internal regulation was relatively low.

It was also found that Chinese pre-service teachers did not perceive strong preference over students' social learning, which echoed the findings of Chan, Tan & Khoo, (2007). In terms of conceptions of own learning, the Chinese pre-service teachers strongly believed that they were capable of learning from others and continuing to grow as learners throughout their teaching careers.

As to whether pre-service teachers' conceptions of student learning were in agreement with the conceptions of their own learning, the researchers found a moderate to moderately strong agreement between the two, which supports the coherence theory of conceptions (Correa, Perry, Sims, Miller & Fang, 2008).

The results also suggest that Chinese pre-service teachers' conceptions of learning are complex and likely to be influenced by multiple theoretical and social-cultural perspectives. Confucianism, together with other traditional educational values and practices, may be too narrow a focus for understanding Chinese pre-service teachers' conceptions of learning (Chan & Elliott, 2004). Our findings suggest that while paying attention to the impact of traditional cultural and social norms, we should not overly stereotype.

Recommendations and Conclusions

Comparing the findings of the study and the national guidelines for reforming mathematics education in China, the researchers identified some gaps although alignments do exist.

The national standards promote a constructivist epistemology toward the nature of mathematical knowledge; and emphasize conceptual understanding over memorization and the connected nature of knowledge. In the Ministry of Education of China's standards (2011), it is stated: "Mastery of mathematics knowledge is not achieved through memorization and rote learning, but based on conceptual understanding" and "the teacher should emphasize the connection between mathematics and students' lived experiences, and the relation between mathematics and other school subjects" (p. 45). In

addition, the national guidelines stress the importance for the teacher to provide worthwhile tasks and a nurturing learning environment for students to “make conjectures, experiment with alternative approaches to solving problems, and construct and respond to others' mathematical arguments” (Martin, 2007, p. 40). The Ministry of Education of China's standards (2011) stated: “Students should be given time and space to observe, experiment, make conjectures, compute, reason, and verify in mathematics learning” (pp. 2-3).

Based on the findings, the training of pre-service math teachers should be focused on; first, creating opportunities to make pre-service teachers' conceptions of learning more explicit to them; second, encouraging pre-service teachers to take a more critical view of their conceptions through discussions and reflections. Finally, in light of our finding that there is a moderate to moderately strong correlation between pre-service teachers' conceptions of own learning and their conceptions of student learning, positive conceptions of student learning may be brought about through affecting teachers' conceptions of own learning. It is, therefore, believed that a professional learning community should provide an environment to train teachers to take more responsibilities for their own learning and help them deliver pedagogy that develops their students' self-regulatory abilities (Loucks-Horsley, Stile & Hewson, 2009; Tang et al., 2012; Villegas-Reimers, 2003).

Significance of Study and Limitations

This is an indigenous study in the context of Chinese math education reform, which presented the mixed and conflicted thoughts on math teaching and learning during the math education reform in China. This research helped us understand the nature of developing professional learning in the context of Chinese culture, and proposed strategies to build a learning community for teachers' professional development. These proposed strategies are intended to make fundamental changes instead of incremental changes to the field of math education in China by understanding pre-service teachers' beliefs of their students' learning and their own learning.

Several limitations of this study need to be acknowledged. First, the samples were relatively small and were drawn from two universities in China. The samples did not necessarily represent the variety of pre-service teacher education programs in China. Second and the most important, the results of this study were based on self-reported data. Respondents may tend to provide socially desirable answers with self-reported measures. This may have skewed the results from both samples toward a more constructivist view. Future investigations of pre-service teachers' conceptions are needed to solicit multiple sources of data such as observations, interviews, and artifacts, and correlate these sources with self-reports.

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