Self-Study in Mathematics Teacher Education

Olive Chapman
University of Calgary

Over the lifetime of ICMI, belief has evolved as a powerful notion in mathematics teacher education. Social psychologists studied the nature of beliefs and their influences on people's actions in the early 1900s. But it was the advent of cognitive science in the 1970s and the resulting shift in research on teaching to a focus on teacher thinking that influenced interest in the study of teachers' beliefs. A review of research reports presented at PME in its first 30 years (Ponte & Chapman, 2006) show that while there was little attention on beliefs in the 1980s, there has been a significant increase in their use from the early 1990s. These studies reflect the cognitive science influence and focus on: teachers' beliefs of mathematics and its teaching and learning, the relationships between these beliefs and instructional practice, and changing beliefs. Self-study in mathematics teacher education emerged and evolved in relation to this evolution of research on beliefs. In this paper, I discuss the nature and role of self-study in mathematics teacher education. In particular, I consider the relationship between beliefs and self-study, role of reflection in self-study and instructional approaches used to facilitate self-study in preservice mathematics teacher education. In these contexts, beliefs are viewed as a form of knowledge influencing mathematics teaching practice and self-study as an opportunity for acquiring more powerful beliefs in relation to both content and pedagogical knowledge.

Self-study refers to the study of oneself, in particular, one's thinking and actions. Self-study in teacher education is related to personal or practical knowledge and in particular, notions of beliefs as a basis of what teachers know and do and why they do it. In the next section, I discuss these notions followed by a section on the goals of self-study resulting from these notions.

Beliefs and Self-Study

There is no agreed definition of belief, but what is implied in studies in mathematics education indicates that it refers to anything that an individual regards as true and is derived from experience, real or imagined. In this paper, belief is being used in this broad sense that includes one's conceptions and knowledge from experience. There are several conceptions or notions about beliefs based on theory and findings of studies of mathematics teachers that have implications for self-study. These notions deal with the role of beliefs in determining what, how and why teachers come to be who they are as practitioners. The following are five related notions relevant to self-study.

1. *Belief as a basis of knowledge*: In the context of teaching, belief is associated with teachers' personal knowledge, practical knowledge or practical wisdom about their roles, their students, mathematics, and context. Thus, teachers' beliefs provide a basis of the knowledge used to organize and run the mathematics classroom. This implies that teachers need to hold appropriate beliefs to hold appropriate knowledge for teaching mathematics.
2. *Belief as a basis of dispositions*: According to Dewey, dispositions deal with "habits of mind". Dispositions are guided by teachers' beliefs related to values such as caring, fairness, responsibility, and social justice. For example, they might include a belief that all students can learn mathematics or learn to think mathematically, a vision of high and challenging standards, or a commitment to a safe and supportive learning environment.
3. *Belief as a basis of action*: Beliefs are considered to be a key determinant of what teachers do in their classrooms. According to Nespor (1987), this includes task definition and dealing with ill-structured problems and entangled domains that characterizes teaching. This suggests that changes to mathematics teaching are dependent on changes of teacher's beliefs.
4. *Belief as a basis of change*: Altering beliefs is associated with bringing about change. Beliefs can be

altered or transformed by shown to be unreasonable and alternative or new beliefs are available to replace the old.

5. *Belief as a basis of learning*: Beliefs are important influences on the ways teachers conceptualize and learn from experience. Acquiring new beliefs or changing old beliefs constitutes learning, thus, preservice teachers' learning can be evidenced by changes in their beliefs.

Goals of Self-Study

The preceding five views of beliefs provide a basis for the goals of self-study in mathematics teacher education. They suggest that instructional approaches in teacher education must be tailored to consider preservice teachers' beliefs. Self-study provides an instructional tool for educators and a means of learning for preservice teachers that takes into consideration these five notions of beliefs. The goal of instruction should include helping preservice teachers to understand or become aware of their own initial beliefs and to change, extend or develop beliefs in a specified direction. Self-study places the spotlight on the beliefs that enable or hinder learning and growth of the preservice teachers into proficient mathematics teachers. One particular issue that helps to contribute to the usefulness of self-study is the nature and role of preservice teachers' initial beliefs.

Preservice mathematics teachers generally have well-developed personal and practical theories about teaching and views about the nature of mathematics. They come to teacher education programs with strong beliefs of teaching acquired during many years of being a student. These beliefs provide a basis of their sense making and influence the way they approach teacher education and what they learn from it. But these beliefs could lack depth and be in conflict with alternative views of mathematics education promoted in the programs. Thus, in order to strengthen teacher education programs, it is necessary to include a focus on prospective teachers' initial beliefs and background knowledge about teaching and mathematics. Self-study provides a way of achieving this.

Self-study allows preservice teachers to inquire about their thinking, learning and instructional practices. They can inquire about initial beliefs to become aware of them, to make them explicit, to confront them, to clarify and extend them by articulating and by subjecting them to the challenge of others or alternative theories. They can inquire about their emerging beliefs. Based on studies on the mathematics teacher, the inquiry should deal with beliefs about mathematics, mathematics concepts and procedures, mathematics learning and learners, mathematics teaching and self as teacher. Self-study paves the way for understanding, deepening, and/or restructuring of the preservice teachers' thinking and consequently their practice. It also engages them in ways that can help them to become reflexive and self-conscious of their beliefs and to become reflective practitioners.

Reflection and Self-Study

Self-study can take different forms, but its key characteristic is reflection. Self-study involves reflection on self – one's thinking or behaviors. In this context, reflection is intended to lead to new understandings of action situations, of self-as-teacher in terms of the cultural milieu of teaching, and of taken-for-granted assumptions about teaching. The reflective process has a long history as a basis of learning. It is widely accepted as a key factor in facilitating teacher education and professional development. Research with mathematics teachers has established that reflection often stimulates them to analyze their own teaching practices in more detail. However, the effectiveness of the reflective process in teacher education may be dependent on how it is conceptualized and how the student teachers are engaged in it.

There are many ways of viewing reflection. For example, Dewey (1933) defined it as an active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusion to which it tends. It is often initiated when the individual student encounters some problematic aspect of learning and attempts to make sense of it (Dewey, 1933). This suggests that simply telling preservice teachers to reflect will not necessarily lead

to reflection. They should be involved in an active, conscious process of reviewing their thinking, actions, or experiences in order to describe, analyze, evaluate and so inform learning about practice. This process requires situations in which they can experience conflicts, challenges or tensions for learning and, in particular, change to occur. In the case of reflecting on one's own actions, an interactive or dialogical process in which others observe, criticize, and offer counter-views is important in helping to achieve such situations.

Another issue with reflection and self-study is accessing implicit or tacit beliefs. The initial beliefs preservice teachers hold about mathematics and pedagogy that form a basis for their sense-making are likely to be mainly tacit, i.e., they are embedded in who they are but not directly accessible to talk about. As Polanyi (1958) explained, since we are not consciously aware of our tacit beliefs or their influence on our thinking and actions, they are not adequately exposed through direct expression/telling of what we believe or think. But, he suggests, we can communicate this knowledge indirectly if we are given adequate means for expressing ourselves. This implies that the reflective process could be enhanced if educators incorporate means of going beyond what the preservice teachers offer as a direct response to a question about their thinking.

In general, then, self-study needs to include some systematic approaches to facilitate the preservice teachers' reflection and inquiry of themselves. Examples of such approaches used in my work and reported in other studies of mathematics teacher education are discussed next.

Instructional Approaches for Self-Study

(A) Literature Review

I conducted a review of recent studies in which mathematics teacher educators researched instructional approaches they used with preservice teachers. Most of the instructional approaches in these studies involved some form of self-study. A few studies focused explicitly on the preservice teachers' self-study of their thinking independent of their actual practice. Most of the approaches focused on their thinking and behaviors in relation to practice. Examples of these approaches are:
(i) *Pre-Post-lesson Model*: Artzt (1999) created a model to facilitate preservice teachers' reflection as a basis of their learning during student teaching. It involved pre- and post-lesson reflective activities in which the preservice teachers' analyzed their thinking and instructional practices before, during, and after their lessons. They wrote lesson plans and a paper of their pre-lesson thoughts and concerns, engaged in a post-lesson conference with the supervisor and cooperating teacher that included a self-assessment of their teaching, then wrote a paper describing their post-lesson thoughts. (ii) *Case Inquiry:* Masingila and Doer (2002) used a multimedia case of an experienced teacher. The goal for the preservice teachers was to use the case study teacher's practice to support their analysis and reflection on their own emerging practices. (iii) *Concept maps:* Bolte (1999) used concept maps and the writing of interpretive essays. Preservice teachers actively participated in developing connections between related concepts, reflected on their thinking and engaged in mathematical discourse. (iv) *Lesson Study*: Fernández (2005) used "micro-teaching lesson study" that engaged the preservice teachers in three cycles of planning, teaching, analysing and revising a mathematics lesson. This included documenting pre-lesson thoughts, analysis of the lesson and revisions to the lesson plan, the second teaching analysis and revisions, and the third teaching analysis and final revisions. Lee (2005) also involved her preservice teachers in an iterative planning–experience–reflection cycle to allow them to critically reflect upon and improve their practice. (v) *Journals:* Many of the studies included writing about one's own experience or recording interpretations and sharing this with peers. All of these approaches were shown to have positive outcomes on the preservice teachers' learning.

(B) My work

I use self-study in several ways with preservice teachers. These approaches include the use of narrative inquiry, metaphor inquiry, and questions/prompts. Narrative inquiry involves the use of

stories of personal experiences. As Bruner (1986) noted, "narrative is concerned with the explication of human intentions in the context of action" (p. 100). It is a way of making sense of human actions or a "scheme by means of which human beings give meaning to their experience … a framework for understanding the past events of one's life and for planning future actions" (Polkinghorne 1988, p.11). Since the stories we tell reflect who we are and what we may become, they provide a basis for meaning recovery and meaning construction of our actions. They facilitate interpretation and understanding of our experiences. Thus, story can be used as the object of reflection or a process of reflection in self-study (Chapman, 1999). Related to narrative inquiry is metaphor inquiry, i.e., using metaphors or similes instead of stories. As Schon (1979) explained, metaphors are viewed "as central to the task of accounting for our perspectives on the world: how we think about things, make sense of reality, and set the problems we later try to solve" (p. 254). Similarly, Lakoff and Johnson (1980) argued that metaphors are conceptual in nature, are among one's principal vehicles of understanding, and play a central role in the construction of one's reality. From their perspective, its primary function is understanding. Metaphor, then, can be used as a tool for reflection because it serves as representation of a particular context and reveals connections. According to Dewey (1933), reflection occurs when one thing signifies or indicates another. Regarding questions and prompts, a combination of the two that offers one relevant situations he or she had not considered before can create the problematic encounter necessary to initiate reflection. In addition, instead of a single question or prompt, a sequence of several of them aimed at promoting reflection about the same concept in different ways is more likely to get one to delve deeper into his or her beliefs.

I have used these approaches as individual activities or in combination. For example, to inquire into beliefs about teaching mathematics, the preservice teachers wrote stories based on an actual mathematics lesson and/or an imagined lesson, which were then unpacked (e.g., Chapman, 1999). The written stories became a basis for inquiring into the meaning of specific themes embodied in them. In order to allow the preservice teachers to delve deeper into the stories, I facilitated a process to unpack the stories, e.g., investigating the view of mathematics conveyed by the story, the teachers' role, the students' role, discourse, and treatment of content. Similarly, I have used metaphors to unpack problem solving (e.g., Chapman, 1998). This included metaphors for mathematics, problem solving, teacher intervention during students' problem solving, and teaching problem solving. The preservice teachers created and used the metaphors to inquire into the meaning of specific themes embodied in them.

The following, more detailed, example of my work with self-study involves the use of all three approaches, i.e., narrative inquiry, metaphor inquiry and questions/prompts. This example is based on a study of an approach to help preservice teachers to understand problem solving as a mathematical and pedagogical process, i.e., as mathematical thinking and a method of instruction, respectively. The participants were 29 preservice secondary mathematics teachers in the second semester of their 2-year post-degree education program. This was their first course in mathematics education, so they had no instruction or theory on problem solving prior to this experience. They also were not taking any other mathematics education course in this semester. The activities were organized in three stages. The first stage focused on individual reflection on problems and problem solving guided by questions, prompts, and metaphors, which included: What is a problem? Choose a grade and create a mathematics problem that could be a problem for those students. What did you think of to create the problem? Why is it a problem? Is it a 'good' mathematics problem? Why? What is problem solving? Problem solving is (like) … because…. What is the goal of problem solving in the school curriculum? What process do you go through when you solve a problem? If possible, represent the process with a flowchart.

The second stage consisted of the following inquiry activities intended to extend the preservice teachers' initial beliefs: (i) They were provided with a list consisting of a non-verbal, algebraic exercise; a simple translation algebraic word problem; a complex translation algebraic word problem; a process (non-routine) word problem; an applied (open) problem, and a puzzle problem. (These labels were not included in the list.) They were asked: Without solving them, how are these problems similar

and different? What conclusions can you make about problems? (ii) They wrote narratives of their experiences solving a problem that was assigned to them. The narratives had to be temporal accounts not only the mental and physical activities that they engaged in to resolve the problem, but the emotional aspects of the experience. They later unpacked the narratives. (iii) They solved an assigned problem and made notes of their thought processes. They worked in pairs, and took turns to observe each other solve the same problem while thinking aloud. They compared their thought processes. (iv) They selected a process problem appropriate for a secondary school student, made predications about how the student would attack it, and used it to observe the student solving it while thinking aloud.

Stage three of the approach included activities that required the preservice teachers to compare their post-stage two thinking with their pre-stage two thinking, to compare their problem-solving models and flowcharts with those from theory provided to them (e.g., Mason, Burton, and Stacey, 1982), and to relate their problem-solving models to an inquiry instructional model.

Each of the three stages involved group reflections. This included: (i) Sharing and comparing their individual reflections and their findings from the inquiry activities, preparing summaries of key words of the group thinking to correspond with the questions in stage one and a flowchart of the problem-solving process. (ii) Discussing, summarizing, and creating a model of how they would teach problem solving. (iii) Whole-class sharing and discussion of the findings of the small-groups.

The study indicated that this approach was effective to facilitate the participants' self-study, awareness of initial beliefs and construction of useful knowledge about problem solving. There was significant evidence of changes in their beliefs and that their knowledge was expanded and deepened.

Conclusion

Self-study, then, can lead to the necessity for preservice teachers to be aware of their initial and alternative ways of thinking and patterns of behavior. In general, it can play an important role in mathematics teacher education in order to help to transform preservice teachers in ways more desirable for the teaching of mathematics.

References

Artzt, A. (1999). A structure to enable preservice teachers of mathematics to reflect on their teaching. *Journal of Mathematics Teacher Education, 2*(2), 143-166.

Bolte, L. (1999). Enhancing and assessing preservice teachers' integration and expression of mathematical knowledge. *Journal of Mathematics Teacher Education, 2*(2), 167-185.

Bruner, J. (1986). *Actual minds, possible worlds.* Cambridge, MA: Harvard University Press.

Chapman, O. (1999). Reflection in mathematics teacher education: The storying approach. In N. Ellerton (Ed.) Mathematics *teacher development: International perspectives.* West Perth, Australia: Meridan Press. 32-57

Chapman, O. (1998). Metaphors as a tool in facilitating preservice teacher development in mathematical problem solving. In A. Oliver & K. Newstead (eds.) *Proceedings of the 22nd PME International Conference*. Stellenbosch, South Africa: University of Stellenbosch, (2) 176-183

Dewey, J. (1933). *How we think.* Chicago: Henrey Regney

Fernández, M. L. (2005). Exploring "lesson study" in teacher preparation. In H. L. Chick & J. L. Vincent (Eds.), *Proceedings of the 29th PME International Conference* (Vol. 2, pp. 305-310). Melbourne.

Lakoff, G. & Johnson, M. (1980). *Metaphors we live by*. Chicago: University of Chicago.

Lee, H.S. (2005). Facilitating students' problem solving in a technological context: Prospective teachers' learning trajectory. *Journal of Mathematics Teacher Education*, 8, 223-254.

Mason, J., Burton, L., and Stacey, K. (1982). *Thinking mathematically*. New York: Addison-Wesley.

Masingila, J. O., & Doerr, H. M. (2002). Understanding pre-service teachers' emerging practices through their analysis of a multimedia case study of practice. *Journal of Mathematics Teacher Education*, 235.

Nespor, J. (1987). The role of beliefs in the practice of teaching. *Curriculum Studies,* 19(4), 317-328.

Polanyi, M. (1958). *Personal knowledge.* Chicago: the University of Chicago Press.

Polkinghorne, D. (1988). *Narrative knowing and the human science.* Albany: State University of New York.

Ponte, J. P. & Chapman, O. (2006). Mathematics teachers' knowledge and practices. In A. Gutierrez & P. Boero (Eds), *Handbook of research on the psychology of mathematics education: Past, present and future* (pp. 461-494). Rotterdam: Sense.

Schön, D. (1979). Generative metaphor: A perspective on problem solving in social policy. In A. Ortony (Ed.) *Metaphor and thought* (pp. 284-324). New York: Cambridge University.