The effect of interaction-with-students field experience on elementary mathematics teachers' beliefs and practices

Yi Jung Lee, University of Georgia, U.S.A.

Literature review and theoretical framework

Teaching is a complicated process because a teacher has to, almost every minute in class, make decisions about "what to teach, how to teach, who to call on, how fast the lesson should move, how to respond to a child, and so on" (Carpenter, Fennema, Franke, Levi, & Empson, 1999, p. 95).

The National Council of Teachers of Mathematics (NCTM, 2000) noted that "effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well" (p. 11) and incorporated it as one of the principles for school mathematics. In order to build a continuum to foster teachers' effective teaching, Feiman-Nemser (2001) suggested that teacher candidates need opportunities to "test the theories, use the knowledge, see and try out the practices advocated by the academy…. investigate problems and analyze situations that arise in the field" (p. 1024). Field experience is an opportunity for preservice teachers to practice their learned knowledge and skills directly with students (Mewborn & Stinson, 2007; Philipp et al., 2007).

There are different formats and purposes of field experiences in distinct teacher education programs. Nicol (1999) emphasized that introducing field-based opportunities can "provide prospective teachers with powerful and memorable experiences in ways which might make the professional course work more meaningful and relevant" (p. 49). Nicol considered the field experiences as a context through which prospective teachers could investigate, interpret, and discuss the situations they experienced within a collaborative setting. Mewborn and Stinson (2007) explored the influential field experience task of working one-on-one with a child and examined several activities preservice teachers conducted in their field experiences. Philipp et al. (2007) also conducted an experimental study to investigate the effects of different early field experience on prospective elementary school teachers' mathematical content knowledge and beliefs.

The results suggest that teachers who work with only one child could focus solely on the child's mathematical thinking and cannot avoid the challenges of grappling with that individual child's understanding and finding ways to support the child. Sawyer and Lee (2014) called the task of working one-on-one with a child as a Single Student Mathematical Field Experience (SSMFE).

Research questions

In this study, I sought to understand how the interaction-with-students field experience impacted two elementary mathematics teachers' beliefs and practices. Questions which guided my inquiry were: what do preservice teachers find problematic in their working

with children and what strategies do they employ to enhance their understanding of children?

Methodology

Participants

Two participant, Jayne and Alex (pseudonyms), were selected from a five-year research project (Mewborn & Stinson, 2007) because they entered the teacher education program with similar beliefs, but their teaching practices differed markedly by the end of their second year of teaching (Spangler, Sawyer, Kang, Kim, & Kim, 2012). In their SSMFE, Jayne worked with Ben, a first grader, and Alex worked with Chris, a third-grade student.

Procedures

This study began during the preservice teachers' first semester (junior year in college) in their teacher education program. Before this study, they had taken one mathematics content course for elementary education majors. During the study, they completed two mathematics methods courses, and SSMFE was one activity in their first methods course. During the second and third semesters they participated in 4-week field experience in local schools; the fourth semester was a traditional student teaching experience. After graduating, the participants were employed at elementary schools in the same district for at least two years.

Single Student Mathematical Field Experience (SSMFE)

During the first mathematics methods course, the participants assisted the mathematical learning of one elementary student once a week for 8 weeks focusing on understanding the student's thinking, explanations, and interpretation of mathematical problems the preservice teachers constructed. This interaction was designed to focus on the mathematics of the students, allowing preservice teachers to build confidence in their abilities to respond to students' problem-solving activities. In the SSMFE, the instructor of the mathematical methods course and her two teaching assistants assisted the preservice teachers by coaching them in real time with questioning, adjusting instructional pace, and paying attention to the student's mathematical thinking.

Data collection

The data in this study included the Integrating Mathematics and Pedagogy (IMAP) web-based beliefs survey, two methods courses assignments, eight interviews for each participant (one per semester for 4 years), 11 observations for each participant: once during an early field experience; twice during student teaching; and 4 times during each of the first two years of teaching.

Data analysis

In order to understand how the interaction-with-students field experience impacted two teachers' beliefs and practices, collected data were analyzed using the constant-comparative method (Strauss & Corbin, 1990) in which each incident in the data is compared with other incidents for similarities and differences. The author initially identified what the participants stated they learned from the SSMFE in their first methods course's final portfolio and then compared this with what they said about their teaching practices over the first two years of teaching.

It is crucial to understand that just because a participant stated something does not necessarily mean it was enacted in their classroom practices. "For the purposes of investigation, beliefs must be inferred" (Pajares, 1992, p. 315). Individuals often are not aware of their beliefs, so the interpretation of the participants' understanding came from observation field notes of their teaching practice as well as self-description data to ensure an accurate representation or to find any the inconsistency (Leatham, 2006).

Results

Analysis shows that three salient effects stemmed from teachers' interaction with students.

Assumption contradiction

On many occasions the students' practical performance contradicted teachers' assumptions about students' learning.

Jayne had a strong belief in doing what was best for her student and strived to select appropriate mathematical tasks and to follow her student's thinking as much as possible. However, she misestimated Ben's ability to do math. For example, Jayne unexpectedly found that Ben struggled with basic subtraction while his being proficient in most topics in mathematics, but she learned how to help Ben overcome his struggles via breaking down the problem step-by-step and employing manipulatives in the SSMFE. In addition, Jayne had to frequently readjust her lesson plan and advocated that over planning is always beneficial. She stated, "There were times when I planned something that was too simplistic for Ben, so I needed to have a back up plan" and "the same held true for when I had an activity or problem that was too complex for him." In continuing working with Ben, Jayne learned to become more flexible with lessons and admitted "I just never realized kids could grasp that much, I mean they were at such an advanced level for how old they were. They're just like miniature adults." Jayne unexpectedly experienced Ben's persistence in solving problems, and that contradicted with what she original assumed was normal for children, that is giving up quickly. She said that "If something didn't work, he'd try another way, and he'd try another way…they're just so persistent."

Alex experienced a significant assumption contradiction about students' abilities to do math. Chris often solved problems differently or more quickly than Alex had anticipated, answered more things correctly and even showed him things he had not thought about. Alex said, "I do not remember asking Chris where he was stuck; rather I assumed." Alex reflected on that "Perhaps I made such assumptions in order to keep the lesson progressing or assuming that his difficulties were the same as ones I had encountered earlier in life." For example, when Alex posed the problem, 302-48, to Chris and intuitively assumed that he should be capable to solve it because of his proficiency on subtraction. However, Chris encountered difficulty due to the re-grouping with a 0 in the tens place, which was not anticipated by Alex. Hence, Alex advocated not to make assumptions as to what a student can do or to even how they might think as a result of the interaction-with-students.

Questioning techniques insufficiency

Often the teachers' questioning techniques were insufficient to elicit students' responses.

Jayne found that Ben had no ideas for how to solve several math tasks, which forced her to suspect that "the way a problem is phrased is the only thing keeping a child from solving it". Therefore, she started to learn how to ask better questions in SSMFE and stated, "If you just rearrange the wording of some questions, a child will understand it more clearly." However, when Jayne tried to inquire about Ben's thoughts, what frustrated her was that Ben only responded "I did it in my head." Although this triggered Jayne to ask more "definitional questions" (Hyman, 1979) during math tasks, such as "how do you know that [a particular shape] was a 'triangle'?" to elicit Ben's understanding of the definition of triangle, Jayne still found it difficult to use questions to elicit Ben's thoughts during the interaction.

Alex possessed a positive attitude toward applying questioning techniques in teaching and said that he learned to ask questions based on Chris's statements. Moreover, he allowed Chris to pose questions even though he could not immediately them. The application of questioning techniques became more multifaceted in Alex's two years formal teaching. In one of his self-reported successful lessons, he designed a lesson to teach bar graphing and required his students to ask yes or no questions at beginning of the class. After that, students had to use reasoning skills to demonstrate their answers to the yes or no questions. He recalled that one of his students questioned really well, and this prompted Alex to ask more "how" questions, such as "how did you solve this?" to cultivate students' reasoning skills. However, his questions mostly elicited "procedural knowledge", which was defined as action sequences for solving problems (Rittle-Johnson & Alibali, 1999), although Alex felt that he was asking a lot of questions.

Alternative ssessment

The teachers came to appreciate assessing students alternatively based on students' knowledge rather than through standardized examinations.

In Jayne's interaction-with-students, she learned that teachers should employ different ways to assess different children, especially those who might know how to solve the problem but because of the way it was worded they couldn't explain their thinking. Jayne worked with one little girl who did not even know the ABCs, so using a standardized test would use words that she does not even know to assess her and "that's not a true assessment." Furthermore, she pointed out the disadvantage of overvaluing standardized tests in teaching: failure on a standardized test will increase students' pressure to learn and teachers will teach the test.

In Alex's first two years of teaching, he tried to individualize the assessment formats. Alex's most important assessments come from having students work the board while he asked the questions that let to class discussion. If students had an understanding of the discussed concept, Alex expected that they could repeat back the concept and apply it in the same way that they had applied it during the instruction. If students were confused, Alex asked students to write the problem down and to explain each step in the process. Alex admitted that this means of assessment was very informal, but it did tell him that who did not know how to solve a particular problem. However, he despaired of the situation in which he found himself in which there was so much

assessment that had to be done that he was forced to ensure good results and records students' grades formally with written work.

Discussion

According to participants' personal learning experiences and apprenticeship of observation, preservice teachers might bring particular propensities when entering the teacher education program, but their beliefs about teaching and knowledge of students could change through appropriate math tasks with plenty of challenges and contradiction in the interaction-with-students.

Closely interacting with students affects teacher's beliefs about teaching

Nicol (1999) emphasized that working with pupils provides "opportunities for preservice teachers to frame and investigate their own problems of practice and to do so within a developing community of inquiry" (p. 63). When the participating teachers initially came into mathematics method course, they were looking forward to learning "how to teach math" to children with very practical expectation about "what, when, why, and how's." They experienced intense challenges due to their limited knowledge of students and pedagogy when closely interacting with students and admitted that this experience highlighted their confusion about teaching.

The SSMFE provided opportunities for preservice teachers to listen to students' thoughts, to see how creative students could to be, to build knowledge about what students already knew, to give better explanations, and to develop great patience. After being novice teachers, the participating teachers were confronted with more challenging problems from school districts and the larger educational system when they became teachers, and their beliefs about teaching kept changing due to the experience of closely interacting with students. Their focus on how students understand instead of merely focusing on getting answers shows that both teachers valued process over product. They planned lessons from day to day depending on what students needed instead of based on what was on the next page in the textbook. In particular Jayne used or followed the textbook in a very limited way. Alex's focus on students sharing thoughts and responding to others instead of focusing on individual activity in class demonstrates Alex's belief that the teachers' role is to promote knowledge sharing (Raymond, 1997).

Positive attitudes toward student-centered teaching and hands-on learning

In Alex 's SSMFE reflection reports, he realized that the beginning sessions in SSMFE consisted mostly of his talking, and he felt that their time together could be more interactive. Moreover, Alex found that "allowing him [Chris] time to speak helps him to instruct not only himself, but me [Alex] as well as to his thinking." Alex started to orient himself to a student-centered stance in SSMFE.

Unfortunately, Alex's student-centered teaching was suppressed when he had his own classroom by a system of accountability that centered on assessment and fidelity to a particular curriculum (Spangler et al., 2012). Alex could not resist the system in his teaching practice, but still maintained positive attitudes about student-centered teaching and hands-on learning. For example, he said that hands-on activities in teaching were something important he has learned in his methods course and emphasized that if the child understands its purpose, then the hands-on approach can be very beneficial. After accomplishing the required curriculum and assessment, Alex strived to have students

give problems from real life where they had to use mathematics ideas that they had done in class. Alex also respected the way his students preferred to do a problem and the reason they preferred to do it that way.

On the contrary, Jayne's student-centered teaching stance was further strengthened by her interaction-with-students. Jayne always made up her own lesson activity based on students' knowledge and insisted everything must be really hands-on, getting students involved and not being scared to make a mess. She was willing to challenge the external authority of the school system and pointed out that what the textbook says, what your schedule says, and even other experienced teachers' advice are not necessarily the best way to teach your students.

Implication

One implication of this study is that interaction-with-students can influence preservice teachers' beliefs about and perceptions of students' thinking and knowledge. However, this will come with some challenges and frustration for teachers. SSMFE in this teacher education program is in a short and condensed time frame in preservice teachers' learning. Teachers might not have sufficient time and opportunities to profoundly investigate and explore mathematical ideas and assumption they maintained. Furthermore, under the predetermined framework of the methods course, a gap between a college-based course and the school-based practicum setting could exist.

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Yi Jung Lee
University of Georgia
Athens, GA, 30602
yijung41@uga.edu