Chapter 5
Current Research on Prospective Secondary Mathematics Teachers' Field Experiences

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1 Introduction

In recent years, more attention has been placed on field experiences of prospective teachers. In fact, a *Report of the Blue Ribbon Panel on Clinical Preparation and Partnerships for Improved Student Learning* commissioned by the National Council for Accreditation of Teacher Education [NCATE] (2010) in the U.S. suggests a "*clinically based preparation* for prospective teachers, which fully integrates content, pedagogy, and professional coursework around a core of clinical experiences" (p. 8). The clinical experiences suggested here would allow prospective teachers to learn to enact pedagogical strategies for particular purposes in context (Ball and Forzani 2009). In addition, NCATE (2010) suggests that prospective teachers experience a clinical experience continuum in which a developmental sequence of teaching experiences during the teacher education program is delineated with experiences moving from the simplest, such as learning names, recording grades, and taking the lunch count, to the most complex, such as differentiating instruction, developing assessments, and designing and implementing unit plans. These experiences would begin in a pre-teaching experience (mainly observational), next a practicum (perhaps teaching a lesson or working with small groups of students) connected to a methods course, and then finally an internship/student teaching experience (gradually taking on teaching responsibilities until he/she is teaching a full load of classes and then gradually gives the classes back to the cooperating teacher.).

Furthermore, the National Research Council [NRC] (2010) posited that field experience along with content knowledge and the quality of the prospective teachers are the aspects of teacher preparation that are likely to have the strongest

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effects on outcomes for students. In addition, teachers feel that clinical experiences are beneficial to their professional development:

> Study after study shows that experienced and newly certified teachers alike see clinical experiences (including student teaching) as a powerful—sometimes the single most powerful—component of teacher preparation. Whether that power enhances the quality of teacher preparation, however, may depend on the specific characteristics of the field experience. (Wilson et al. 2001, p. 17)

This implies that, during clinical experiences, prospective secondary mathematics teachers (PSMTs) develop *the craft of teaching*—the ability to design lessons that involve important mathematical ideas, design tasks that will help students to access those ideas, and to successfully carry out the lesson. This may include effectively launching the lesson, facilitating student engagement with the task, orchestrating meaningful mathematical discussions, and helping to make explicit the mathematical understanding students are constructing (Leatham and Peterson 2010, p. 115).

However, even though we would like prospective teachers to develop the craft of teaching as described, teacher preparation programs in many countries find it difficult to place PSMTs with cooperating teachers who are prepared to foster their growth due to many cooperating teachers' lack of proficiency with this approach to teaching, which is in alignment with the National Council of Teachers of Mathematics [NCTM] (1989, 1991, 1995, 2000, 2014) standards documents and other calls for inquiry-based and problem- and student-centered instruction. The cooperating teachers' lack of proficiency in using an inquiry approach to teaching may be attributed to their beliefs systems or lack of professional development related to the approach, or a combination of these factors and others.

Moreover, a bidirectional relationship needs to exist between teacher preparation programs and school partners in which clinical experiences take place. This relationship should reflect a common vision and shared commitment to inquiry-based practices and other issues related to mathematics teaching and learning. Borko et al. (2000) asserted that compatibility of methods courses and student teaching experiences in which PSMTs participate on several key dimensions is essential for the settings to reinforce each other's messages, and thus work in conjunction, rather than in opposition, to prepare reform-minded teachers.

Even though there have been calls for more attention to field experiences, there has not been many large scale studies that have looked at field experiences in a comprehensive manner. For example, the TEDs-M study only focused on whether or not programs within and across countries had *extended teaching practice* (student teaching) or *introductory field experiences* (pre-teaching or practicum) (Tatto et al. 2012). What follows is a review of the literature related to clinical experiences for PSMTs. The studies provided show the complexities that exist around clinical experiences and learning to teach in general.

2 Methodology of the Survey

The author conducted the survey by searching for studies related to field experiences for PSMTs published in nine international research journals in mathematics education (see Chap. 1 of the topic survey for a list of the journals). The search was confined to the relevant literature from the period of 2005–2015. Several searches were conducted by combining the key words "prospective teacher" and "secondary" with the following key words related to clinical experiences: "student teaching", "field placements", "mentor teachers" and "cooperating teachers". For each search result the article's title and abstract were read. The study was selected if it were connected to secondary prospective mathematics teachers' clinical experiences. Thus, the search excluded several studies that addressed field experiences of elementary prospective teachers. Next, the full articles were read and analyzed with regard to their (1) focus, (2) theoretical perspective, (3) methodology, and (4) findings. Then, the articles were categorized based on their research purposes. This analysis allowed me to divide the set of studies into 6 groups: (1) field experiences related to methods courses, (2) video-based explorations connected to methods courses, (3) a single case study related to student teaching, (4) articles that focused on the roles of PSMTs, cooperating teachers, and university supervisors, (5) professors reflecting on how to improve clinical experiences for their programs' candidates, and (6) programs' organization of field experience. I examined a total of 17 articles. Most of the studies examined in this topic study are qualitative in nature, which is not surprising due to the nature of field placements and the number of PSMTs that are usually in a program. Even though the majority of the studies may not be generalizable, they provide the field with detailed descriptions about the context and the participants involved in the studies, which can provide the field with information about promising practices and challenges.

3 The Selected Studies: What Has Been Studied in the Area?

3.1 Field Experiences Connected to Methods Courses

Four studies focused on field experiences connected to methods courses. Cavey and Berenson (2005) investigated a prospective teacher's understandings as she planned and exchanged ideas for teaching right triangle trigonometry in connection to concepts of ratio and proportion. They used Pirie–Kieren (1994) theory for growth in mathematical understanding as a lens for examining growth in the prospective teacher's understanding of mathematics within the context of learning to teach mathematics (as cited in Cavey and Berenson 2005). The researchers found that significant growth in understanding can occur when PSMTs have multiple opportunities to share and reflect on their images of teaching mathematics.

Nguyen et al. (2008) examined a case study of three Vietnamese student teachers working in groups in a methods course to explore Freudenthal's theory of realistic mathematics education (RME). The course emphasized students' knowledge construction in meaningful contexts. Qualitative methods were utilized. Transcripts of class discussions and group discussions, interviews, student teachers' lesson plans, and journal writings were the main data sources that were used to investigate the development of the student teachers' views on mathematics and mathematics education during the course. The deliberations about teaching strategies of the three subjects working in a group to design lesson plans were also analyzed. The findings showed that the three student teachers explored new meanings of mathematics teaching that caused them to shift from their traditional point of view to a student-centered one. Reflecting on their teaching and learning also impacted their decision to utilize the student-centered approach. It is noted that among the three subjects, there were two student teachers, who questioned the viability of the student-centered approach in the Vietnamese educational context where the social and political conditions were not favorable for teaching in this manner.

Ricks (2011) discussed a theoretical framework that divides teacher reflection into two broad categories: "The first and most common incident reflection occurs as specific incidents or episodes unconnected to future activity. The second process reflection—based on the work of John Dewey and Donald Schön—connects reflective incidents into a cyclic progression that refines ideas through experimental action" (p. 251). He examined the reflective activity of a group of prospective secondary mathematics teachers as they jointly planned a public school lesson to illustrate how incidents of reflection can be refined and linked into more powerful and purposeful progressions of ideas.

These studies provide evidence that it is important for PSMTs to connect what they are doing in their course work to what is happening in classrooms. The studies also helped reinforce the need for field experiences to be embedded throughout PSMTs' programs.

3.2 Using Video-Cases to Foster PSMTs Understanding of NCTM's Standards Based and Inquiry-Based Approaches

Studies in this section used videos as a means to help PSMTs understand what reform based teaching looks like, serving as a "virtual" field experience. This approach aids with the dilemma discussed in the introduction related to the number of secondary mathematics teachers who are strong reform mathematics teachers. Santagata et al. (2007) reported on two studies in which a video-based program on lesson analysis for pre-service mathematics teachers was implemented for two consecutive years as part of a teacher education program at the University of Lazio, Italy. The authors gave a rationale for using video cases to help PSMTs analyze

teaching and learning situations. They addressed two questions: What can prospective teachers learn from the analysis of videotaped lessons? How can prospective teachers' analysis ability, and its improvement, be measured? Two groups of prospective teachers (approximately 140 in total) participated in the program. A three-step lesson analysis framework was applied to three lesson videos: (1) goal(s) and parts of the lesson; (2) student learning; and, (3) teaching alternatives. Prospective teachers' ability to analyze lessons was measured through an open-ended pre- and post-assessment. In the assessment, prospective teachers were asked to mark and comment on events (in a lesson not included in the program) that they found interesting for: teachers' actions/decisions; students' behavior/learning; and, mathematical content. A coding system was developed based on five criteria: elaboration, mathematics content, student learning, critical approach, and alternative strategies. The researchers found that in a relatively short period of time, prospective teachers in both Study 1 and Study 2 improved their analyses of teaching by moving from simple descriptions of what they observed to analyses focused on the effects of teacher actions on student learning as observed in the video. These data suggest promising directions for the development of both an instrument to measure lesson analysis abilities and a model for teacher learning.

In addition, Stockero (2008) employed mixed methods to investigate the effects of using a coherent video-case curriculum in a university mathematics methods course to determine: (1) how the use of a video-case curriculum affects the reflective stance of PSMTs; and (2) the extent to which a reflective stance developed while reflecting on other teachers' practice transfers to reflecting on one's own practice. 21 third-year PSMTs who were enrolled in a middle school (grades 6–8) mathematics methods course participated in the study. Stockero (2008) cited and Sherins' (2008) and Manouchehri's (2002) studies, which focus on levels of reflection as the basis for her theoretical framework. According to Stockero (2008), a key component of the course was a field experience with an intensive reflection component, which consisted of three visits to local middle school mathematics classrooms immediately following the completion of the video-case curriculum. The PSMTs all visited one or two classrooms at the same time; each PSMT facilitated a small group of students as they worked to solve a mathematics problem that was taken directly from the video-case materials. Stockero (2008) found that the PSMTs in the study showed changes in their level of reflection, their tendency to ground their analyses in evidence, and their focus on student thinking. She asserted that they began to analyze how teaching affects student thinking, to consider multiple interpretations of student thinking, and to develop a more tentative stance of inquiry. She also stated that the reflective stance developed via the video curriculum transferred to the PSMTs' self-reflection in the course's field experience.

Alsawaie and Alghazo (2010) used an experimental design, which involved mathematics PSMTs in analyzing video-based lessons and tested the effect of this experience on the PSMTs' ability to analyze mathematics teaching. They cited the learning to notice framework developed by van Es and Sherin (2002) and elaborated on in van Es and Sherin (2008) as their theoretical underpinning. Twenty-six

PSMTs who were enrolled in a mathematics methods course participated in the study. Half were in a control group. The students in the experimental group watched the videos on their own time at home. The authors believe that the intervention described in the study helped the PSMTs learn to pay attention to noteworthy events in classroom interactions; also, they developed the ability to pay attention to student learning when watching and analyzing a lesson.

Two of the studies in this session used similar theoretical frameworks related to reflecting on practice. All three of the studies showed that video-based instruction can be helpful in increasing PSMTs ability to analyze teaching and learning situations with a focus on learning.

3.3 Single Case Study Related to the Student Teaching Experience

Lloyd (2005) presented a case study of a PSMT, which focused on the teacher's beliefs about his role as mathematics teacher. Data were collected over the final 5 months of the teacher's university teacher education program through interviews, written course assignments, and observations of student-teaching. Findings indicated that the prospective teacher valued classroom roles in which students, rather than the teacher, explained traditional mathematics content. As his student-teaching internship progressed, the teacher began to develop new roles and engaged students in additional mathematical processes. These results emphasize the need for prospective teachers to recognize how teacher and student roles impact interrelationships between understanding and mathematical activity, and illustrate the nature of teacher learning that can occur during an internship. Lloyd (2005) suggested that activities that require the PSMTs to critically examine the roles of teacher and students, and related development of mathematics, in diverse representations of classroom instruction such as videotaped lessons or written classroom cases may move them in this direction.

3.4 Studies Related to the Roles of PSMTs, Cooperating Teachers, and University Supervisors During the Student Teaching Experience

These studies show the importance of placing student teachers in classrooms with teachers' whose practices are in alignment with program goals and who understand that the student teaching experience should be one of growth mathematically for all stakeholders including the PSMT, cooperating teacher, students, and the university supervisor.

Peterson and Williams (2008) shared two contrasting case studies of student teachers and their cooperating teachers that illustrated very different experiences with mathematical knowledge during student teaching. The researchers cited the work of Ball et al. (2005) as the framework for the knowledge that PSMTs need for teaching. The data for this study is taken from a study of eight student teacher/cooperating teacher pairs, and the core themes that emerged from their conversations. Peterson and Williams (2008) focused on two pairs for whom the core conversational themes represented disparate approaches to mathematics in and for teaching. One pair, Blake and Mr. B., focused on controlling student behavior and rarely talked about mathematics for teaching. The other pair, Tara and Mr. T., focused on having students actively participating in the lesson and on mathematics from the students' point of view. These contrasting experiences suggested that student teaching can have a profound effect on prospective teachers' understanding of mathematics in and for teaching. One finding from the study highlighted by the authors was "the consonance between the cooperating teachers' stated beliefs about mathematics teaching and what they wanted student teachers to learn, their mentoring style, and the focus of conversations with student teachers" (Peterson and Williams 2008, p. 475.).

Fernandez and Erbilgin (2009) conducted a qualitative study of post-lesson conferences led by supervisors (classroom cooperating teachers and a university supervisor) working with mathematics student teachers. They examined the issue through a sociocultural lens. They found that cooperating teachers focused more on evaluative supervision that lacked attention to the mathematics of the lessons, while the university supervisor focused more on educative supervision, guiding student teachers to reflect on and learn from their own classroom experiences including the mathematics of their lessons.

Leatham and Peterson (2010) reported on the results of a survey of 45 secondary mathematics cooperating teachers' perceptions of the primary purposes of student teaching and their roles in accomplishing those purposes. The three most common categories (teacher interaction, real classroom, and classroom management) made up more than 70 % of the total number of responses. Based on their results, the researchers asserted that for the cooperating teachers who mentor their PSMTs, the primary purpose of student teaching is to interact with experienced teachers in real classrooms, and in so doing to learn how to successfully manage such classrooms. They concluded that in order for the student teaching experience to meet the needs of PSMTs to learn how to teach mathematics in meaningful ways so that student learning may occur, it would be helpful (i) to articulate the most important purposes of student teaching and then (ii) to define the roles that teacher educators, cooperating teachers, and PSMTs need to play to accomplish those purposes.

Rhoads et al. (2010) explored prospective secondary mathematics teachers' "professed philosophies of teaching" and how they felt they compared to those of their cooperating teachers. They further explored the prospective teachers' views of important factors impacting relationships with mentors, including cooperating

teachers and university mentors. The subjects of the study were graduates of a post-baccalaureate teacher certification program at a large state university in the U.S.; while graduates are certified to teach mathematics grades K-12, most elect to teach high school. Semi-structured interviews, lasting 1–2 h, were held with 9 subjects. A constant-comparative method was used to analyze the transcripts. While most of the student teachers spoke against an overemphasis on procedures, all of them worked with at least one cooperating teacher who they felt emphasized procedures; four of the nine felt this mismatch negatively impacted their experience. Four of the student teachers had positive relationships with their cooperating teachers; factors impacting their relationship included honest and constructive feedback, a sense of "kinship," and freedom in their teaching. Negative factors impacting the relationship included inadequate feedback and difficult personal relationships. "Candid and relevant" feedback and emotional support were important factors for positive relationships with the university supervisor (Rhoads et al. 2010, p. 1016); inadequate feedback was an important factor in negative relationships. A lack of content knowledge by the supervisor was also cited as a negative factor. The authors note that these results are limited in that they rely only on reports of the student teachers; gaining other perspectives would provide valuable insights.

Rhoads et al. (2013) investigated interpersonal difficulties that student teachers and cooperating teachers may experience during the teaching internship by exploring the tension between one high school mathematics student teacher and his cooperating teacher. The data came from multiple sources, including individual interviews with Luis, the student teacher, and Sheri, his cooperating teacher, about their internship experiences; the evaluations of Luis's teaching that were provided separately by Sheri, the university supervisor, and a second cooperating teacher; 20 pages of hand-written notes that Sheri provided for Luis during the beginning part of his student teaching experience; and an interview with the university supervisor. The authors identified seven causes of the tension that existed between Luis and Sheri, which included different ideas about what mathematics should be taught, how it should be taught, and a strained personal relationship. The researchers compared these findings with results from interviews with six other student teachers and eight of their mentors to explore the uniqueness of this case. As a result of the study, Rhoads et al. (2013) posited that it is important for PSMTs and cooperative teachers to discuss common issues that can arise during the internship and ways to communicate openly about philosophies of teaching and philosophies of mentoring. They also suggested that cooperating teachers and PSMTs be encouraged to approach the internship with mutual respect, open minds, and a willingness to learn from their colleagues.

3.5 Professors Reflecting on How to Improve Clinical Experiences for Their Prospective Teachers

Goodell (2006) reported the results of a 4-year naturalistic study, which focused on how her students learned to become mathematics teachers during the combined 15-week methods and field placement course that she teaches. She determined the critical incidents that PSMTs encountered during their field experience and what they learned about teaching for understanding through reflecting on those critical incidents. The researcher noted that PSMTs raised issues in their incident reports that focused on four main areas: teaching and classroom management; student factors such as pre-requisite knowledge, understanding, resistance and motivation; issues concerning relationships with colleagues, students and parents; and school organizational issues such as policies and access to resources. She also found that the PSMTs' learning about teaching for understanding focused on three broad areas: the conditions necessary to teach for understanding; facilitation of teaching for understanding; and barriers to teaching for understanding. One of the major recommendations provided by Goodell (2006) as a result of her analysis is "teacher education programs that are serious about developing teachers' abilities to become reflective practitioners must make a commitment to assigning full-time faculty to field experiences, and to linking those experiences to methods classes" (p. 242).

Nolan (2012) described how she transformed and reformed her own practice as a teacher educator and faculty advisor by listening to the stories of prospective teachers. Data for the study included interviews and focus groups with eight interns with whom she worked during two internship semesters. The intent of her interviews was to understand how interns reflected on their own processes of learning to teach and of negotiating spaces for agency during their field experience. Nolan (2012) used Bourdieu's social field theory, which highlights the network of relations and discursive practices that support (and (re)produce) traditional practices in the teaching of mathematics the theoretical underpinning for her study.

3.6 Program Organization of Field Experiences

In response to the Third International Mathematics and Science Study (TIMSS) video study, which showed clear differences in how teachers from the U.S. and Japan teach, Peterson (2005) explored why this is the case by comparing the preparation of Japanese to that of U.S. prospective teachers. Based on field notes collected during observations of student teachers at three Japanese universities for 3 or 4 days each, he described the general student teaching experience in comparison to that in the U.S. Differences were found in the school context and the structure of lessons, which tended to focused on having students engage in problem solving. The duration and organization of the student teaching experience were also different, with students teaching for 2–3 week periods in several contexts; in addition,

they were typically assigned to cooperating teachers in groups. The focus of the student teaching experience is also quite different, with primary attention given to preparing, teaching, and reflecting on selected lessons. The cooperating teacher and group of student teachers assigned to him/her provided intensive feedback on each lesson plan to be taught by a student teacher prior to it being taught, observed their teaching of the lesson, and participated in a reflection meeting after the lesson. Throughout this process, focus was placed on the structure of the lesson and its impact on student thinking, rather than the presentation of the lesson. Peterson (2005) concluded that this emphasis on lesson preparation might be useful for U.S. teacher educators to consider.

Arbaugh et al. (2007) explored viewpoints surrounding field experiences in a post-baccalaureate certification program for secondary mathematics and science teachers. Such programs can be completed in a short period of time following completion of an undergraduate degree, which raises questions about how to incorporate effective field experiences. The program the authors designed and studied was grounded in Shulman's work on pedagogical content knowledge (PCK) and how to create a "transformative pathway" (Arbaugh et al. 2007, p. 193), which led them to create a year-long internship experience. They collected data during a day-long meeting of students, cooperating teachers, and university personnel in which participants evaluated different ways of organizing the field experience—such as participating every day but perhaps for less than a full day versus participating full days but perhaps not every day, and one single year-long placement versus multiple shorter placements. They also conducted exit interviews at the end of the year. Arbaugh et al. (2007) found that while all three groups liked the intensity of the year-long model, they had very different ideas about how the experience should be organized, based on their personal needs and experiences. The interns preferred the every-day model in which they participated half-days, which was similar to what they were experiencing. They felt this provided more depth in seeing how content developed as well as more flexibility in scheduling. In contrast, the coopering teachers had more reservations about the students only teaching half-days, noting that is does not reflect the full teacher role and creates more disruptions. The university personnel saw merits in the half-day format, since its flexibility might help with recruitment, but felt that two semester-long placements might be more effective given difficulties in identifying year-long placements. The authors used these findings to adapt their model for the next cohort so that it would better meet the needs of the different stakeholders in alignment with their emphasis on PCK and creating transformative pathways.

4 Discussion

The studies included in this survey focused on different aspects of the field experiences provided to PSMTs—field experiences connected to methods courses, use of video cases as "virtual" field experiences, and summative student teaching

experiences. Studies focusing on the student teaching experience addressed the roles of those involved in the experience, how the experience is organized, and how it can be improved. These studies provide useful insights into effective incorporation of field experiences into the preparation of PSMTs.

Interestingly, very few of these studies took an explicit theoretical stance, instead framing their research within more specific frameworks specific to the question being addressed, such as realistic mathematics education (Nguyen et al. 2008), teacher reflection (Ricks 2011) or learning to notice (Alawaise and Alghazo 2010). In general, the studies tended to focus on more pragmatic concerns related to providing effective field experiences and were less focused on theory building.

Nearly all of the studies used qualitative methods with relatively small numbers of subjects. This is perhaps not surprising due to the nature of field placements and the small number of PSMTs that are typically engaged in a field experience. Case studies were commonly employed, but with different subjects, including a single or small group of PSMT (Cavey and Berenson 2005; Lloyd 2005; Nguyen et al. 2008), student teachers and their mentors (Fernandez and Erbilgin 2009; Peterson and Williams 2008; Rhoads et al. 2013), or themselves (Goodell 2006; Nolan 2012). Of studies using quantitative methods, all focused on PSMT during field experiences associated with methods classes (Alsawaie and Alghazo 2010; Leatham and Peterson 2010; Santagata et al. 2007; Stockeroo 2008); all but one had a sample size less than 50.

Even though the designs and sample size may limit the generalizability of results, these studies provide the field with detailed descriptions about the context and the participants involved in the studies, which can provide the field with information about promising practices and challenges. It is important that PSMTs have coursework that is integrated with field experiences to promote reflection on what it means to teach mathematics (Cavey and Berenson 2005; Nguyen et al. 2008; Ricks 2011). Video cases can serve as a "virtual" field experience to help PSMTs understand what reform-based teaching looks like (Santagata et al. 2007; Stockeroo 2008). Other studies suggest the importance of understanding the roles of PSMTs, their cooperating teacher, and their university supervisors within the student teaching experience and the difficulties that may arise (Fernadez and Erbilgin 2009; Leatham and Peterson 2010; Rhoads et al. 2010, 2012). Teacher educators might also interrogate how student teaching experiences are organized (Arbaugh et al. 2007; Peterson 2005) and actively reflect on their own practice (Goodell 2006; Nolan 2012).

In conclusion, it is somewhat surprising that this survey uncovered so few studies that carefully research the field experiences of PSMTs, given the importance of those experiences within teacher preparation programs. Preparing PSMTs seems to be an area ripe for new researchers to explore, building on a number of careful studies presented in this section that suggest useful areas for exploration.

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