INSTRUCTOR AND STUDENT PERCEPTIONS OF MATHEMATICS FOR TEACHERS COURSES

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This cross case analysis synthesizes results from two qualitative studies on mathematics content courses for prospective elementary teachers: one from the U.S. interviewed instructors, one from Canada interviewed students. Results were examined for common themes. Salient commonalities were found. Two will be discussed here: the role of affect in student learning and the role of connections to the elementary classroom.

Pervasive concerns about the adequacy of the mathematical preparation of elementary teachers (Ball, Hill, & Bass, 2005; Rowland, Huckstep, & Thwaites, 2005) have prompted many institutions of higher education to require specialized mathematics content courses for prospective teachers. These courses, referred to here as *Math for Teachers* (MFT) courses, aim to provide deep understandings of elementary mathematics concepts in order to develop prospective teachers' confidence and flexibility in teaching mathematics (Kilpatrick, Swafford, & Findell, 2001;Williams, 2008). MFT courses are most often taught in mathematics departments by mathematics faculty.

The research described in this paper presents results from a cross-case analysis of two existing studies on MFT courses. The two studies are briefly described here.

The *instructor-focused* study examined ten instructors' perspectives on a MFT course at several institutions in southwestern Canada (Oesterle & Liljedahl, 2009). The purpose of the study was to provide insights into the instructors' approaches in the course and how their beliefs impacted pedagogical decisions. Data from the semi-structured, individual interviews (1 hour in duration) were analyzed for emergent themes using constant comparative analysis. These themes include: instructor identity, tensions, resources, student knowledge, student affect, orientation to mathematics, orientation to teaching, and classroom environment.

The *student-focused* study explored the perspectives of 12 elementary education majors (i.e., prospective elementary teachers) who had completed MFT courses at a university in the southeastern United States (Hart & Swars, 2009).The study was inspired by concerns over the poor success rates of elementary education majors enrolled in these courses. Data collection included semi-structured, individual interviews (approximately 1 hour in duration), and constant comparative analysis was applied to the data, revealing three major themes: (1) domains of mismatch (2) affective reactions, and (3) classroom practices. The domains of mismatch theme had three sub-themes: mismatch with elementary classroom, mismatch in programmatic emphasis, and mismatch in mathematics content.

Overview of Relevant Research

These two extant studies were framed by prior research on mathematics knowledge-for-teaching (e.g. Ball & Bass, 2003) and instructor beliefs about mathematics (Ernest, 1989). Of relevance to both studies, and of particular interest in this paper, is the literature pertaining to: the role of affect, beliefs and efficacy in prospective elementary teacher learning (e.g., Di Martino

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& Sabena, 2007; Thompson, 1992; Swars, Hart, Smith & Smith, 2007); post-secondary mathematics content courses for elementary teacher (e.g., Lubinski & Otto, 2004; Philips, 2007); and perspectives on and characteristics of effective university mathematics instruction (e.g., Schulze & Tomal, 2006; Weinstein, 2004). While there is an abundance of literature on the significant role of beliefs and affect in the pedagogical practices of teachers, far fewer studies are available on mathematics content courses for elementary teachers and those found were primarily limited to outcomes of reform-based approaches in these courses. Scant studies have looked at characteristics of effective post-secondary mathematics instruction in traditional (i.e., non-MFT) mathematics courses.

Theoretical Perspective and Research Question

This cross-case analysis, as well as the two original studies, is grounded in phenomenological interpretation (Burch, 1990). Students and instructors individually reported their perspectives on the MFT courses. Through the interviews, participants reflected on and retrospectively identified the significant or memorable events from their MFT experiences. Through this process, they recovered and verbally reenacted the meaningful components of their lived experiences.

For this cross-case study, we were interested in determining what intersections might exist between the perspectives of instructors of a MFT course and the perspectives of students in the MFT courses. More specifically, we asked this research question: *What common themes exist in instructor perspectives and student perspectives on mathematics content courses for prospective elementary teachers?*

Methods

Participants and Setting

The student-focused study involved twelve students (11 females and 1 male) from one urban university in the southeastern U.S. The students had completed three or four MFT courses. They were randomly selected from 4 cohorts of students in the elementary teacher preparation program with a combined size of 99 students, thus representing approximately 12% of the total population. Collectively they had taken 42 sections of MFT courses. At the time of the original study, all of the students were in the last semester of the program and completing student teaching.

Although the instructor-focused study gathered data from ten instructors, for the purpose of this paper examples will be drawn from the transcripts of only two: Harriet and Bob (pseudonyms). The divergent perspectives they offer on teaching the MFT course provide a sufficient basis for illustrating the common themes identified in this analysis. Harriet and Bob are both experienced instructors, having taught in mathematics departments for 22 and 13 years respectively. Harriet is relatively new to teaching the MFT course but had taught the course six times over three years, while Bob taught it nine times over nine years. Both have Master's degrees in mathematics but neither took mathematics education courses nor had formal teacher training. Harriet was initiated into teaching the MFT course by a colleague with a Master's degree in mathematics education who taught MFT courses for many years. Bob's first forays into teaching the course were guided by his institution's curriculum, the textbook, and informal discussions with colleagues.

Data Collection and Analysis

Data collection for the two extant studies was described in the background section of this paper. To conduct the cross-case analysis for this present study, we created a matrix with the results from the two studies, specifically examining the data for convergence. This analysis revealed two

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commonalities across the themes, including *connections to the elementary classroom* and *student affect*, as shown in Figure 1.

Student-focused Study	Instructor-focused Study
• *affective reactions*	• *student affect*
• classroom practices	• instructor identity
• domains of mismatch	• resources
a. *elementary classroom*	• *orientation to teaching*
b. programmatic emphasis	• tensions
c. mathematics content	• orientation to mathematics
	• student knowledge
	• classroom environment

Figure 1. Themes and commonalities of the two extant studies.

Cross-case Results

The Students' Perspectives on Connections to the Elementary Classroom

After experiencing other courses in their teacher preparation program, the students were acutely aware of disconnections between their experiences in the mathematics content courses and other experiences in the program. The students frequently described an inability to position the mathematics content coursework within their growth as educators, which led to perceptions of lack of usefulness or relevance of the courses as evidenced by this statement: '*I mean a lot of us were always questioning, you know, why we have to take these math courses…It's not even necessary*.' Similarly, another student stated, '*The reason why we were taking those courses was never brought to our attention. We had no clue why we were taking those classes, no clue…It seemed very unnecessary*.' Another student said:

> *It [mathematics courses] had no connection to elementary schools. Anybody could take those courses. I don't think we ever talked about kids. I seriously don't think we ever talked about teaching or students or anything like that. I just don't remember ever that connection.*

Another student explained the lack of connection with elementary classrooms as:

> *In our [elementary] classrooms right now, you know, they're not graphing how many bagels and coffee people are going to eat and drink tomorrow. It was just not very logical for, you know, a kindergartner.'*

The following statements further support this sentiment:

> *They're [mathematics instructors] blind to what we are actually doing with our lives'; '[Elementary] Students were never even brought up… I mean, students or when you get your own classroom were never brought up'*; and '*We're thinking we're learning something about how to be teachers. But, in reality we're learning how to get through their math courses.*

The participants did indicate positive experiences in some of the courses. In particular these related to modeling pedagogical methods that might be used in an elementary classroom or using materials that elementary students use. For example, one student commented:

> [The Number & Operation course instructor] *was big on you know . . . we would do that in class, it wasn't like, take this home and do this but we actually* [did activities in class] *and we did a lot of group work and that was really good too.*

One student provided a specific example of making strong connections:

> *We had to do a project in geometry where we had to go to like a specific county and get a book and find a geometry lesson, but that was just a project and we presented it to the class . . . so just different things like that, just to make it real to us.*

One student noted that the positive experiences and factors that made it positive occurred in her methods course, not in the content course.

> *No* [not in the content]*, this happened in my methods course, mainly because she* [the methods instructor] *took out the manipulatives, showed us what they were going to be doing, she basically took curriculum from those grade levels and put it in front of our faces.*

Ideas for changing the courses were proffered, including*: 'Get some teachers who were actually qualified in elementary [teaching]… They actually know what children are going through and that would help;' 'They [mathematics instructors] could talk to elementary teachers;'* and '*Maybe have us students say, hey, this is what is going on in my [elementary] classroom.'*

The Instructors' Perspectives on Connections to the Elementary Classroom

Harriet's descriptions of her goals and strategies for teaching the MFT course are permeated with comments related to mathematics-for-teaching knowledge (Ball & Bass, 2003) and how her students' learning relates to their future as teachers. When asked if there is anything that she teaches MFT students about fractions that she would not teach other students, she states:

> *The fact that there are different models, there are different ways of picturing what's going on, and that they are appropriate for [...] what may work well for some situation, or for some [elementary school] student, may not work for some other one.*

She also emphasizes connections between mathematical ideas both within and across grade levels. She explains:

> *At all times I connect it [the course content], as far as I can, to what goes on at different levels. What you might do with a grade 1 class, how that connects to what they're going to see in, you know grade 4 or 5 or something like that, how that connects to what they might do in high school and how that connects to what I'm doing in Calculus. Because they've got to see how it's connected, and how we build bigger and bigger [...] understandings of sets of numbers, or calculations.*

Harriet does not just pay lip-service to these ideas. She describes assignments that allow her students to build their mathematics-for-teaching knowledge, such as analysis of pupil errors and discussion of alternative solutions.

In contrast, Bob makes very little reference to mathematics-for-teaching knowledge. His emphasis is instead on developing a strong understanding of fundamental mathematics and communication skills. Varieties of algorithms and models form part of his course content, but he does not specifically address how they can be applied differently at various grade levels.

Bob needed to be pressed by the interviewer to consider what aspects of the course content might be particularly relevant to prospective teachers as opposed to general learners of mathematics. Initially his comments revolve around his teaching methods, such as the use of group work and manipulatives, but he makes no reference to any special mathematics knowledge for teaching. Eventually he describes challenging his students to think about the kinds of questions that they will encounter as teachers:

> *. . . what kinds of questions will you encounter? And why is it important that you to be able to communicate your ideas effectively, […], why should you understand this material to the most, [...], fundamental and basic level, and understand all of the structure?*

He adds:

> *when you get some of these obtuse questions, that are seemingly [...] obtuse, you have to be able to appreciate it and be able to differentiate whether that's something that can lead you into a teachable moment*

His response appears to be a justification for his goals of developing strong mathematics content knowledge and communication skills. For Bob, mastery of the subject content along with general pedagogical skills, seem to be sufficient for the teaching of mathematics—a traditional and prevalent point of view (Hill et al., 2007).

The Students' Perspectives on Student Affect

A second theme across the interviews was students' affective reactions to the coursework experiences. Many statements described negative emotions, for example, they used words such as '*emotional wreck', 'so stressed', 'very belittling', 'discouraged', 'terrified', 'struggling',* and *'frustrating'.* A student asserted, '*I felt like I was just hanging on. Just trying to dig myself out of a hole, and I kept falling down.'*

The students also portrayed the courses as having deleterious influences on their mathematics teaching efficacy beliefs and self-efficacy beliefs, which were often linked with the classroom practices of the instructors. Most often, descriptions of ineffective pedagogy were related to traditional approaches to instruction. The students mentioned a preponderance of 'lecture,' 'note-taking', and 'power point presentations,' and asserted the 'classes were not hands-on.' In describing how the courses impacted teaching efficacy beliefs, a student stated, '*I felt less confident [about teaching mathematics] when I walked out of those classes because it's just so much and it just seemed so unnecessary… It was just very discouraging.'* In response to a question on how the courses prepared her to teach elementary mathematics, a student stated the courses made her, '*Feel less prepared. Feeling more scared, definitely.'* One student attributed this negative impact on her teaching efficacy to the attitude of the instructor of the course, '*The attitude was if you don't get this [math content], you won't be able to teach it, basically.'*

Students also commented on how the experiences in the courses influenced their self-efficacy beliefs in mathematics, as represented by this student's statement:

> *[I felt] terrified, struggling, especially in geometry. It was just, it was very frustrating because I didn't get it. I didn't understand why we're doing what we were doing, how we were coming out with the answer, and especially if I didn't get the answer right.*

Further, another student stated:

> *Like geometry… I came out of there in tears. I felt very disappointed. I felt stupid. I felt alone. And, I know that I am an intelligent person, or I have the potential to learn something. If I don't know it, I'm willing to give up my time and my efforts. But, I felt like my efforts didn't matter.*

Similarly, another student said:

> *It (mathematics courses) made me feel so low in math. Even though I knew those math courses, I would never be teaching that stuff… It totally lowered my self-esteem in mathematics*.

The Instructors' Perspectives on Student Affect

Both Bob and Harriet describe their students as suffering from mathematics anxiety and lacking confidence in their ability to do mathematics. However, there are considerable differences in their perspectives and pedagogical approaches to these negative affective states.

Harriet observes that her students: '*are very anxious around problem solving. They are just*

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terrified, most of them, of a problem they haven't seen before.' Her efforts to address this seem to be centered on changing their ideas of what the enterprise of mathematics is all about. She tries to convince them that '*we're supposed to have fun with this*' and tells her students that '*you may never have seen it; you might not get all the way through it. But what I'm looking for is how far did you get, and how well can you explain what it is that you got*', shifting the focus away from getting the right answer toward less threatening goals.

By the end of the course she hopes her students have grown in confidence and also '*they have more of a sense of play [...] I think they're more flexible. They think they're more flexible. They're not as scared if [...] that someone will ask them a question that they can't answer.*'

Bob describes his students as believing that mathematics is arbitrary and incomprehensible: '*So many things seem magical to them'*. He affirms that '*it's not your standard sort of math group, it's one that has encountered some challenges along the way, and it hasn't always left them with a positive impression of mathematics.'* In his view, their confusion and anxiety is closely linked to their skills:

> *In many cases, some of the very elementary arithmetic operations are in fact, confused in their minds and so when they hit upon things, in particular when you hit rational numbers, as an example, that's one place where students have a great deal of anxiety and they would demonstrate poor understanding of ideas.*

More than once he describes the MFT course as a second start for these students. He attempts to reshape their beliefs and attitudes by providing them with opportunities to see the logical structure of mathematics and deepen their understanding. For Bob, the course '*focuses on a very sound fundamental ability to appreciate it [mathematics], in a theoretical way, why things work, as opposed to technical aspects of how do you do mathematics.*' However, although he believes that improved skills will lead to increased appreciation and confidence, he confesses that the realities of the course conspire against this occurring. Early in the interview he expresses a wish that his MFT students develop a love of math, but when asked about whether this goal is accomplished, he admits: '*in terms of the other goal, for love of math? Unfortunately, the course is so packed, that in some ways, I think they do get a little bit beaten by the end, and they're just tired*.' This statement illustrates Bob's realization that the volume of content covered in a limited time is at odds with his affective goals.

Discussion

Although the two groups of participants in these studies were in different settings, they provide two distinct viewpoints on a similar experience: MFT courses. When juxtaposed the data reveals salient commonalities. The findings provide important insights into issues and concerns around creating experiences in MFT courses that best support elementary prospective teachers' learning of mathematics; they also enrich our understandings of the realities of MFT classrooms, revealing both the affordances and the constraints.

The student voices emphatically call for the need for connecting the mathematics to the elementary classroom. Without this connection, the students were not able to find relevance in their learning. This need is recognised in the literature (Philip, 2007). Ball and Bass (2003) also strongly advocate for this link:

> *Practice in solving the mathematical problems they will face in their work would help teachers learn to use mathematics in the ways they will do so in practice, and is likely also to strengthen and deepen their understanding of the ideas.* (p. 13)

The instructor-focused study reveals how differently instructors may perceive the need for

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incorporating these connections. Harriet is very aware that these links help to motivate her students, helping them to see why a deeper understanding of mathematics is required of them in this course as compared to their previous mathematics courses. For Bob, making these connections is not an explicit part of his course. One reason for this may be that as a mathematician his lack of experience in elementary classrooms limits his ability to do so. However, Harriet also lacks such experience. Another possibility is that Bob takes such connections for granted. His inability to identify content in his course that would be particularly relevant to future teachers of mathematics as opposed to general mathematics students reflects a lack of awareness of specialized mathematics knowledge-for-teaching. For Bob, subject content knowledge and pedagogical knowledge are distinct. He sees his role as supporting the development of the former.

With regard to the theme of affect, the student-focused study reports an alarming number of negative comments, indicating increases in students' anxiety and decreases in self-efficacy. Both instructors were acutely aware of the impact of affect and described their students as coming into the course with high mathematics anxiety and lack of confidence. However, their perceptions about the cause of the anxiety and strategies for addressing it were quite different. For Bob, the source is students' lack of fundamental skills. As a result, his solution is to help them see the logical structures of mathematics and develop these skills, though he acknowledges that the sheer volume of the material he must cover, in fact, adds to his students' stress. For Harriet the source is negative past experiences and a perception of mathematics as rigid. Her efforts focus on moving students away from the 'one right answer' view of mathematics, helping them develop more flexibility in approaching mathematical problems and to just have *fun*.

From the students we hear that traditional instructional methods of lecture, power point presentations, and drill and practice tended to elevate anxiety and decrease efficacy, while reform approaches such as small group work, hands-on learning, and opportunities to share and discuss were less stressful and increased efficacy. They also shared that the instructor having a caring manner, an approachable demeanour, and a perceived willingness to help supported their learning. This echoes Schulte & Tomal (2006) cited above. Regardless of their perceptions of the source of their students' anxieties, knowledge of this research could help inform instructor choices with respect to how to address concerns around student affect.

The voices of the students in the student-focused study lend support to concerns that mathematicians in mathematics departments may be unprepared to take on the task of preparing elementary teachers. The lack of connections of content with the elementary classroom and traditional teaching approaches seem to contribute to frustration and anxiety as well as decreased self-efficacy. However, the instructor-focused study shows that though lack of explicit connections to elementary learning may occur, this need not be so. The differences between Harriet and Bob in this regard may have been the result of the mentorship Harriet received, suggesting a potential means for supporting the mathematicians who teach these courses.

Another side of this issue is that mathematicians, at their best, have much to offer future teachers, even at the elementary school level (Hodgson, 2001; Williams, 2008). Jonker (in review) describes mathematicians in mathematics departments as 'stewards of their discipline,' 'passionate about mathematics', and 'eager to share their excitement with students and concerned about the place of mathematics in the world.' The challenge is to create opportunities for conversations between mathematics educators and mathematicians so that students in MFT courses are better prepared to teach mathematics to elementary children.

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