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The Role of Mentor-Student Teacher Relationships in Building Standards-based Elementary Mathematics Teaching Pedagogy

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The National Council of Teachers of Mathematics (NCTM) has been the leader of the mathematics reform movement and the Common Core State Standards for Mathematics (CCSSM) are an evolutionary step in mathematics education built on the philosophy of NCTM (Hudson, Miller, & Butler, 2009; Dickey, 2013). Both sets of standards have played a significant role in defining a vision for school mathematics. For instance, the process standards of NCTM (i.e., problem solving, reasoning and proof, communication, connections, and representation) suggest the types of mathematical thinking students should be doing during instruction (Hudson et al., 2009). CCSSM highlights a balance between conceptual understanding and procedural skills, and application of mathematical ideas into real world situations (Gaddy, Harmon, Barlow, Miligan, & Huang, 2014). Gaddy et al. (2014) posit that current reforms in mathematics education challenge many teachers and teacher educators because these shifts require instructional changes to implement the Common Core. In order to implement Common Core and NCTM standards effectively, it is critical to educate in-service teachers and teacher candidates about what it means to know, learn, and teach mathematics in the new model of teaching mathematics. This article focuses on the role of mentor-student teacher relationships in the implementation of standards-based mathematics education in the classroom because mentoring is the most common form of support for new teachers (Polikoff, Desimone, Porter, & Hochberg, 2015).

The major research question for this study was, "What are the critical components of an effective mentor-student teacher relationship in implementing standards-based mathematics classrooms?" The author hoped to find ways to support teacher candidates' capacity to build standards-based mathematics classrooms early in their professional development by focusing on mentor-student teacher relationships. This researcher investigated three cases of mentor-student teacher relationships in elementary mathematics classrooms to understand the characteristics of this important type of relationship.

Literature Review

In response to the recent reform movement in mathematics education, teacher education programs have exerted great effort to build standards-based mathematics, based on the NCTM and

Common Core standards, into their courses. Some researchers argue that teacher education programs need to focus on preservice teachers' initial beliefs of teaching mathematics because preservice teachers typically enter teacher education programs with traditional views of teaching and learning mathematics (Cady, Meier, & Lubinski, 2006; Ebby, 2000). These views are often described as rule bound mathematics instruction that utilizes drill-and-practice, is answer driven, and is highly test based. These studies emphasize one role of teacher education programs is to challenge K-12 preservice teachers' traditional beliefs in order for them to be able to build a standards-based mathematics classroom.

Studies suggest that student teaching experiences challenge the views of teacher candidates because of the tremendous influence cooperating teachers have on new teachers' beliefs and practices (Hamman, Fives, & Olivarez, 2007; Fernandez & Erbilgin, 2009) as student teachers learn from what is modeled in their assigned classrooms (Mewborn, 1999; Hamman et al., 2007). Ideally, as teacher education programs offer new visions of teaching mathematics, the pedagogy of mentors would align with the standards forwarded by such programs and the mentors would effectively model standards-based mathematics teaching pedagogy. Unfortunately, despite the importance and long-lasting influence of the mentor-novice relationship in student teaching, current literature has not addressed the pedagogical influence of interactions between a cooperating teacher and a student teacher (Hamman et al., 2007).

Student teaching is a critical time of transition because this bridging experience connects a student from a teacher education program at a university to a K-12 classroom-teaching situation (Zeichner, 2002). One critique of many teacher preparation programs is a lack of enough opportunities for student teachers to experience classroom teaching which is consistent with the standards-based pedagogy that is central to their university programs (Eisenhart & Borko, 1993; Feiman-Nemser, 2001; Zeichner, 2005; Fernandez & Erbilgin, 2009). Eisenhart and Borko (1993), for example, argued that the contrast between many teacher candidates' student teaching experiences and their methods courses caused students to question the usefulness of university programs. This study demonstrated that student teachers have limited opportunities during their placements to observe or participate in mathematics classrooms that are consistent with a standards-based approach. More recently, Fernandez & Erbilgin (2009) also reported a disconnection between student teaching experiences and the goals of university's teacher education programs. In this study, there were two mathematics student teachers and their cooperating teachers, and a university supervisor working with both dyads. The university supervisor was a doctoral student of the same university program of the student teachers and she provided feedback based on the philosophy of education embraced at the university.

Fernandez and Erbilgin (2009) found that it is difficult to provide meaningful feedback to student teachers when the feedback from cooperating teachers is inconsistent with that of supervisors. Thus, they argued that it is important to support cooperating teachers as they develop an educated supervision approach in alignment with recent reform based teaching pedagogy. The study reported that the student teachers' mathematics teaching experiences and reflections differed depending on whether or not the cooperating teachers' feedback was consistent with the university supervisor's feedback. Thus, these studies bring attention to the need for universities and placement schools to collaborate to reduce pedagogical discrepancies and support student teachers in their transitions to teaching careers.

With respect to the mentor-student teacher relationship, Hawkey (1998) investigated the extent to which student teachers tended to emulate their mentors' teaching practices. She found that regardless of mentoring style, a mentor's perspectives about learning to teach influenced a student teachers' practice. Wang and Odell (2006) investigated various types of mentor-student teacher relationships and identified challenges to novices' learning to teach in reform-minded ways. They suggested that developing a shared vision for teaching is central to mentors supporting student teachers well. For instance, in the study of Peterson and Williams (2008), Tara, a middle school math teacher, was more successful in conceptualizing and teaching standards-based mathematics when her mentor, Ms. T., had goals such as conceptual understanding and mathematical discussion, which were in alignment with NCTM standards. Similarly, Eisenhart and Borko (1993) also found that Ms. Daniels' (student teacher) practice was more procedure-oriented when she was with a mentor teacher who stressed procedures in her teaching. When Ms. Daniels had conceptual questions with a different mentor teacher, the teacher consulted with her, and because of this support, Ms. Daniels placed a greater emphasis on conceptual teaching. Overall, Ms. Daniels' teaching practices varied greatly and depended on the characteristics of the mentor teacher. These studies indicated that mentor support holds great potential to shape the development of preservice teachers' teaching practices, which are consistent with standards-based teaching pedagogy. They also showed the importance of clear roles for mentor and preservice teacher pairs, in addition to well-defined goals for both parties in the student teaching experience. Learning develops in settings where the goals of the student teacher and mentor are consistent (Lave & Wenger, 1991; Vygotsky, 1978). Thus, it is wise for the mentors and student teachers to share their mathematics teaching goals as they practice and pursue a standards-based mathematical teaching pedagogy.

The above listed research articulated the critical role of preservice teaching experiences as a way for teacher candidates to learn how to teach mathematics in alignment with standards-based mathematics. However, little research has examined the role of mentor teachers and how their support of student teachers eases the transition between a teacher education program and an elementary mathematics classroom. Feiman-Namser (2001) argued that the literature offered little about what

mentor teachers do to make their knowledge accessible, how they think about their work, and what specifically novices learn from them. Thus, this study addresses a gap in the scholarship with the hope of shedding light on the important relationship between a mentor and a novice and its powerful influence on student teachers' initial teaching practices of standards-based mathematics.

This study utilizes the legitimate peripheral participation construct from Lave and Wenger (1991) in order to explore the relationship between the student teacher and the cooperating teacher. This construct frames the mentor teacher as a master who is a full member of a community and who knows the dynamics of the community well. Meanwhile, the student teacher is a novice who is a peripheral member of the community, but is developing an "identity of master[ing]" (Lave and Wenger, 1991, p. 41) through participation in a teacher education program. Negotiation within the mentor-student teacher relationship requires the teacher to reconcile how much authority the student teacher has during the student teaching period, how the student teacher moves from peripheral to full participation, how negotiation within the given context influences their learning, what the master's modeled teaching looks like, and how they communicate with each other. Student teachers have to negotiate what to adopt or what not to adopt from their mentors and how to balance these choices when teaching moment to moment in an environment assigned by their program. Through these processes, student teachers learn from their mentors and build their mathematics teaching practices.

Methods

This study adopted case study methodology (Yin, 1995) to understand the complex relationship between the mentor and student teacher. The data were collected during two consecutive semesters: one 16-week semester of a mathematics methods class and another 16-week semester of a student teaching experience. The major data sources for this study were weekly classroom observation notes and multiple in-depth interviews with participants.

Participants

The participants were three student teachers enrolled in a teacher education program at a large university located in the southwest United States and their three cooperating teachers. During their teacher preparation program, the participants were required to take nine credits of college mathematics courses. The participants were selected based on their enrollment in a required mathematics methods course during the final year of their program. During the 16-week mathematics methods course, the author observed the participants every week (three hours per session) for the entire class period. The author took field notes on how the teacher candidates interacted with their peers, how they shared their mathematical thinking, and how they participated in course-related activities. The author looked for evidence of students' knowledge of mathematics, instructional practices, and confidence during the classroom observations. Confidence is related to a student's ability to learn and to teach mathematics and was therefore of interest (Graven, 2004).

Based on these observational field notes, the author first selected five student teachers who were committed to their work and who exhibited high levels of engagement. Further selection criteria were the ability to gain access to the local school where these student teachers were placed and to obtain the consent of cooperating teachers. Based on these criteria, three pairs of teacher candidates and cooperating teachers were selected: Jackie and Mr. Brown, Meg and Mrs. Green, and Kerry and Mrs. Olive[1]. All of these mentors and novices worked together for the full 16-week semester. Among the three cooperating teachers, only Mrs. Olive engaged in professional development provided by the school district during the time of this study. Table 1 below provides the background of the participants. Interviews about participants' mathematics experiences prior to the teacher education program revealed both positive and negative experiences and the author hoped to investigate how these contrasting experiences would play out as students built standards-based mathematics teaching practices.

Table 1: Summary of Participants

	Jackie	Meg	Kerry
Teacher Candidates (Novices)	• White female • Senior, Elementary program • Not confident with mathematics	• White female • Senior, Elementary Program • Very confident with mathematics	• White female • Senior, Elementary Program • Very confident with mathematics
Cooperating Teachers (Mentors)	• Mr. Brown • 5th grade • White male • 11 years of experience • Confident in math teaching	• Mrs. Green • 2nd-3rd combination class • White female • 20 years of experience • More confident with literacy teaching	• Mrs. Olive • 5th grade • White female • 8 years of experience • Cognitively Guided Instruction (CGI)[2] district training

[1] All names are pseudonyms.

[2] Author comment: Cognitively Guided Instruction is a research-based project developed by Thomas Carpenter and Elizabeth Fennema (1999) at the University of Wisconsin, Madison. In their book, *Children's Mathematics: Cognitively Guided Instruction* (1999), CGI emphasizes instruction in which teachers use students' mathematical thinking to diagnose their development and then to provide appropriate problems, questions, or tools to help students gain a higher (or deeper) understanding. In terms of norms of practice, it emphasizes problem solving, exploring multiple strategies, and gaining deep conceptual knowledge, which align with NCTM Standards (2000).

Data Collection

The data sources for this study were multiple interviews with the participants and weekly classroom observations, both in the methods course and the cooperating teachers' classrooms. Table 2 shows a detailed schedule of data collection. The author details each of the data sources in the narrative which follows the table.

Table 2: Schedule of Data Collection

Time of the year	Data Source	Duration
Methods class	Observation	• Once/week • 3 hours/week • 15 weeks
	First student teacher interview	• End of semester • Approximately 30 minutes
Student teaching (Following semester)	Observation	• Once/week • Total 11 weeks
	Second student teacher interview	• Approximately 40 minutes • Middle of semester
	Cooperating teacher interview	• Approximately 30 minutes • End of semester

Methods Class Observations. The author observed the methods course to understand and collect examples of the teaching methods introduced to the student participants in their program. The major content delivered during observations of the methods class was typical in terms of routine with a focus on solving problems, discussion, and suggested teaching methods of the concept. This methods course incorporated standards-based mathematics pedagogy such as Cognitively Guided Instruction (CGI) and *Principles and Standards for School Mathematics* (NCTM, 2000). During the methods class, the student teachers also engaged with mathematics knowledge and skills that were consistent with standards-based pedagogy, such as the use of manipulatives, group work, the development of conceptual understanding, and problem solving.

Student Teaching Observations. The author conducted weekly classroom observations during each teacher candidate's field experience. Observations were focused on 1) the relationship between mentor teachers and student teachers (e.g. specific feedback or comments from mentor and the degree of participation of student teacher), and 2) the mathematics teaching practice of both the mentor and the student teacher (e.g. content, teaching materials, questions and problems, instructional strategies, and focus of the lesson). The observations of mentor and student teachers' mathematics teaching practices helped the author to identify whether the observed teaching pedagogy aligned with standards-based pedagogy.

Interviews of Student Teachers and Mentors. A considerable amount of research indicates that it is important to focus on prospective teachers' personal experiences when they are in the process of framing their own teaching practices (Kagan, 1992; Feiman-Nemser, 1983). Therefore, the interviews with the student teachers included open-ended questions about their beliefs about teaching mathematics, their relationships with their mentors, and their mentor's teaching practices. Specifically, the interview questions for student teachers addressed the following: prior experiences learning math; experiences with their math methods instructor (similar or different); their relationship with their mentor; their mentor's teaching practices; how the mentor provides feedback about the student's teaching; the relationship between how the mentor teacher teaches math and how the student would like to teach it (Brown & Borko, 1999); and to what degree it is evident the student is autonomous and participates (Wenger, 1998). Questions for the mentors were about the mentor's mathematic teaching philosophy; the mentor's goals for the mentoring experience; and ways the mentor provided feedback to student teachers.

Analysis

Drawing on Miles and Huberman (1994), the author coded emergent patterns, which were discernable through analysis of the interview transcripts and field notes of the classroom observations. When reading the data, the author first categorized events in the lives of the student teachers in chronological order as follows: 1) their comments about their experiences in K-12 schools; 2) their experience in the mathematics methods class; and 3) their student teaching experiences. Then the author summarized each segment of data and categorized the common themes. As a part of the process, the author looked for the frequency and consistency of emerging themes in the data to describe the experiences of standards-based teaching pedagogy, structure of mentoring, and teaching practices. The data and the initial themes were examined carefully to determine counter examples that were not consistent throughout the whole body of data. For instance, in terms of the mentor relationships, the author looked for evidence from classroom observations about when and what kind of feedback was offered, and how instructional decisions were made. The author looked for dominant behaviors, teaching materials, and instructional decisions from both the novice and the mentor to describe their teaching practices. This process helped identify which mentor-student teacher relationships were successful in supporting the student teacher implement what they learned from the method course and was consistent with reform-based pedagogy. Table 3 provides an example of how the author analyzed the data for one case.

Validity

The analysis of observational field notes, student teacher interview, and mentor interviews at multiple times provided overlapping evidence of teaching practices of both student teachers and mentors. These multiple data sources were used to triangulate assertions, which formed the analysis. Additionally, data collection was sequential, allowing prior analysis to inform and confirm/disconfirm subsequent data collection. For example, observations of the methods course helped the author develop specific interview

questions for students about their behaviors in order to understand their participation, confidence, knowledge and teaching pedagogy. Likewise, the mentor teacher interview was analyzed in comparison to both the student teacher observations and the second student teacher interview. Therefore, the sequential nature of data collection strengthened the analysis by substantiating evidence for prior assertions.

Table 3: Analysis Codes and Description of Data for One Mentor-Student Teacher Case

Chronological Order	Categories/Coding	Description/Keywords	Data Source
Student teacher's K-12 school experience	Positive experience of learning mathematics	Confidence, enjoyed math, good at math	Student teacher interview
	Traditional experience of learning mathematics	No conceptual understanding, not use of manipulatives, no problem solving, lots of worksheet	Student teacher interview
Math methods class	Positive experience of learning to teach mathematics	Really enjoyed, best instructor, loves everything that she does	Student teacher interview
	Standards-based teaching pedagogy	Heavily focused on conceptual understanding, always explains why it works, lots of problem solving, use of hands-on activity most of time	Student teacher interview/observation field note of methods class
Mentor-student teacher relationship	Focus of teaching math (Traditional)	(Mentor teaching) Lots of worksheets Timed test Lack of focus on conceptual understanding Test pressure	Interview from both mentor and student teacher/classroom observation field notes
	Focus of teaching math (Standards-based)	(Student teacher teaching) Use of word problems Hands-on activities	

Results: Three Critical Components of Mentor-Student Teacher Relationships

Analysis of the first student teacher interview data confirmed that all three of the students found the mathematics methods course challenged their traditional beliefs about teaching mathematics. All three aspired to teach mathematics in alignment with standards-based pedagogy and NCTM standards. For instance, Jackie emphasized the use of manipulatives to teach mathematics, Meg highly valued teaching mathematics with conceptual understanding, and Kerry viewed mathematics literacy – to know how to use mathematics in the real word – as the most important aspect of teaching mathematics. As discussed earlier, these are the central tenets of Common Core standards, especially conceptual understanding and real world application. However, despite their desire to teach standards-based mathematics, the student teachers' mathematics instruction varied greatly depending on the relationships with their mentor teachers. The data indicated that among the three mentor-student teacher relationships, Mrs. Olive and Kerry demonstrated the most effective mentoring relationship in implementing standards-based teaching mathematics. In comparison with the other two mentor-student teacher relationships, there were three notable components in the relationship between Mrs. Olive and Kerry. They were as follows: 1) they shared a vision of teaching mathematics, 2) the structure of the mentor's feedback to the student, and 3) the school district's support for the mentor to teach in alignment with NCTM and Common Core standards. The next section describes each critical component of the mentor-student teacher relationship in detail, beginning with shared visions of teaching mathematics, followed by the structure of mentoring, and closing with shared district support.

A Shared Vision

The analysis of the three mentor teachers' interviews and classroom observations indicated that only two mentor teachers – Mr. Brown and Mrs. Olive demonstrated their vision of mathematics in alignment with standards-based pedagogy. Therefore, two cases of mentor-student teacher relationships – Mr. Brown-Jackie and Mrs. Olive-Kerry - seemed to share their vision of teaching mathematics and Mrs. Green and Meg shared the vision of teaching mathematics the least.

However, even though Jackie and Kerry shared their vision of mathematics teaching with their mentors, after taking an in-depth look at the mentor-student teacher relationships, there were noticeable, yet subtle differences. To explore these differences the author first investigated the degree to which the mentor and student teacher shared their vision of teaching mathematics and then focused on how this shared vision influenced a teacher candidate's initial teaching practice of standards-based teaching mathematics.

Mr. Brown and Jackie. In Mr. Brown's classroom, the majority of mathematics instruction focused on standards, in particular, problem solving and multiple strategies (NCTM, 2000) and real world application through problem solving (Common Core, 2010). Mr. Brown said his personal, most important goals of teaching mathematics were problem solving and the use of multiple methods. He believed problem solving was important because of its real world connection and thought that such application convinced students of the

value of mathematics. He stated during an interview:

> When I teach, what I really stress with my kids is to solve the problem, how to solve, what are the steps, what is the key information because life is so much about problem solving. I want to give them those kinds of skills. If I am able to get all the students to logically solve problems, and to think logically, and to understand problem solving, I think that is probably my biggest goal. (Mentor interview)

His teaching beliefs were easily discernible during classroom observations of his mathematics instruction. Mr. Brown typically began his mathematics instruction with problem solving, and he often challenged students to think about, "When would we ever need to use problem solving in our real world?" Students were expected to explain how they solved a problem. Mr. Brown also asked the class for alternative strategies for problem solving, and if a student demonstrated a different approach to a problem, he shared it with the class. These patterns of teaching were observed consistently in Mr. Brown's classroom.

Since Jackie was placed in Mr. Brown's standards-based mathematics classroom, she engaged with specific mathematics knowledge and skills pertaining to problem solving, multiple methods, and asked questions to promote students' mathematical understanding. However, Jackie's vision of teaching mathematics only partially paralleled Mr. Brown's. Jackie clearly conveyed the importance of teaching mathematics with hands-on materials. When asked in her interview, "How do you believe children learn mathematics best?" she explained:

> I believe children learn the best with hands on, anytime they can do hands on, that is one of the best ways. Whole-group participation on the white board or telling me the answers to the problem, or working this out, those are also great assessment but when students can participate as a class and also get their hands involved, kids will do better on by themselves, and work on their space. I think it is really beneficial when they can do hands-on but I think most of them, hands-on are the best, I think (Jackie's first interview).

This statement is evidence of how strongly Jackie wanted to teach mathematics through hands-on methods. Reflecting on her mathematics methods class and teaching experience with a previous practicum teacher, Jackie wanted most to learn from her mentors how to teach mathematics using hands-on materials. In Jackie's view, hands-on mathematics was more important than problem solving or multiple strategies. Although the goal of using manipulatives was important to Jackie, the mentor teacher did not emphasize their use. Thus, it seems that Jackie and Mr. Brown shared a vision of teaching mathematics in a limited way. Even though Mr. Brown taught mathematics by focusing on core ideas of standards, Jackie valued hands-on activity more than problem solving and multiple strategies. Due to this inconsistency, Jackie had limited opportunities to develop a standards-based mathematics teaching practice.

Mrs. Olive and Kerry. There were stronger interpersonal similarities in terms of a vision of teaching mathematics, dispositions, and values in the relationship between Mrs. Olive and Kerry. Mrs. Olive believed it was important to highlight differentiated instruction, problem solving,

and real world scenarios during her mathematics instruction, central ideas of Common Core. Based on her vision of teaching mathematics by using a variety of teaching methods, Mrs. Olive routinely provided context-based story problems and many kinds of mathematics games. She employed multiple strategies including discussions and differentiated group work, often related to real life situations, to engage students actively. As Kerry discussed Mrs. Olive's mathematics teaching she stated:

> I think she teaches math the way I would like to teach math, just with the nice balance. Because I think that is critical in helping students learn to love mathematics and apply them in the real world like what we did for the department store mathematics. (Kerry's second interview)

For Kerry, mathematical literacy was the core purpose of teaching mathematics, and she perceived mathematics literacy as equivalent to a real-world application of math. Since Mrs. Olive's teaching practice contained real world application problems, Kerry found a common teaching goal with her mentor, which she wanted to adopt. Kerry also wanted to implement her mentor's differentiated group work strategy in her future classes. In this standards-based classroom, Mrs. Olive and Kerry commonly valued real world applications of math and differentiated group work in mathematics teaching practice. Since they shared vision of teaching mathematics, and Kerry respected Mrs. Olive's teaching pedagogy, this student teacher was able to comprehend what it meant to teach mathematics in alignment with standards. Of the three mentor-novice pairs, this relationship was the strongest example of a mentor who modeled teaching practices to a student who, in turn, engaged with particular knowledge and practice around standards-based mathematics teaching pedagogy.

Mrs. Green and Meg. By contrast, significant inconsistencies in their visions of teaching mathematics characterized the relationship between Mrs. Green and Meg. Mrs. Green's teaching practice was more traditional than that of the other two mentors. She often mentioned that students needed to have repetition and practice to master skills and a majority of her instructional materials focused on simple math facts and timed tests rather than story-based problems or real world applications. For Mrs. Green, procedural knowledge appeared more important than conceptual understanding. This perspective was expressed clearly, when she talked about her teaching goals and concerns regarding testing pressure and the expectation of the *No Child Left Behind Act of 2001*[3]. She believed traditional methods for teaching mathematics yielded better test scores on standardized testing and wanted to continue to teach this way because of programs like NCLB and their associated assessments. Mrs. Green stated:

> You know, with the testing pressure and the expectation of No Child Left Behind, I don't feel that you can move

[3]Author Comment: The No Child Left Behind Act of 2001 (NCLB) was a U.S. Act of Congress which reauthorized the elementary and secondary education Act. Under this Act, states are required to test students in reading and math in grades 3-8.

> more to the reform way of teaching, my personal feeling is that, because kids have to know the fact like this (snapping fingers to show fast) and test and sometimes some of them by rote, some of them by traditional way, you do have to do that. The number one thing for them to learn is understanding concepts for real life but there is quite a bit a pressure on test scores, so I feel like you got to hold on to a little of traditional teaching. (Mentor interview)

This example demonstrated that Mrs. Green's mathematics teaching was more associated with traditional teaching mathematics, and the data suggested that Meg was not a big fan of traditional methods. As a student in the reform-based mathematics methods course, Meg had realized that teaching mathematics with conceptual understanding was very important. She stated:

> The central idea of reform is to go back and check if students really have, really, really have deep understanding rather than giving them surface information and make sure that you cover all year contents. (Meg's first interview)

Meg wanted to learn how to teach mathematics conceptually from her mentor teacher, but she was placed in a classroom where the traditional method of teaching mathematics was modeled as best teaching practice. In Mrs. Green's classroom, Meg engaged with specific mathematics skills focused on procedural knowledge, repetition, and test preparation. These practices differed not only from her understanding of mathematics instruction as learned in her methods course, but also from her vision of teaching mathematics. Meg spoke to Mrs. Green's mathematics teaching pedagogy:

> She would probably not teach mathematics in relation to how I would like to teach because she is a big fan of worksheets, packets, and reinforcement, which is good in a small amount but I am not a fan of that every day. I feel like I am honestly going off of what I am learning from method class more than I am learning from her. I would definitely adopt her management skills but not in math. In math, I think I can stick to my ways, I like what I am doing, and all I need to do is management (Meg's second interview).

In this statement, Meg clearly expressed that she only wanted to adopt the part of Mrs. Green's practice that involved classroom management skills, and she opted to stick with her own reform style for mathematics teaching.

In summary, a shared vision for teaching mathematics was most parallel in the relationship between Mrs. Olive and Kerry, and the least consistent between Mrs. Green and Meg. Mrs. Olive and Kerry shared a vision that enabled the mentor to help the novice understand standards based teaching pedagogy, and the novice to develop a teaching practice under a mentor's guidance in a classroom context. By contrast, the inconsistency in the visions of mathematics teaching between Mrs. Green and Meg deprived the student of the opportunity to observe a standards-based mathematics teaching practice, and thus hindered the development of the standards-based teaching practice the novice hoped to build.

Structure of Mentoring

The apprenticeship framework offered by Lave & Wenger (1991) described the typical apprenticeship pattern in which student teachers initially observe their

mentors and then gradually increase their roles until they can assume full responsibility of some key aspect of practice. The relationship of Jackie and Mr. Brown developed in this typical apprenticeship pattern in the beginning, but Jackie's role did not reach full responsibility for teaching mathematics, mainly due to the student's lack of confidence. Meg and Mrs. Green did not follow the typical pattern either, because Meg took full responsibility of teaching mathematics from the beginning of their time together. Of the three cases, the relationship between Mrs. Olive and Kerry was most similar to the typical apprenticeship pattern.

The analysis of the mentor interviews revealed that not only apprenticeship patterns differed across the three mentors, but their underlying philosophies about mentoring student teachers and their mentoring goals were inconsistent as well. These differences influenced the structure of their mentoring relationships and the nature of their feedback interactions. The next section describes how each mentor teacher provided support and feedback to their student teacher.

Mr. Brown. Jackie reported that Mr. Brown typically designed the lessons, but that she and Mr. Brown occasionally co-planned lessons in the morning. Mr. Brown gave her specific feedback about what part of a lesson went well the previous day, how to change a lesson next time, and how to make lessons beneficial for the students. As mentioned previously, Jackie rarely taught a whole lesson, therefore the comments usually focused on homework review or the parts of the lesson she had enacted. Jackie's comments indicated that Mr. Brown provided some feedback, usually in the morning, but not during the lesson. Mr. Brown stated:

> At the beginning, she was observing and asking questions, and I was giving her feedback. When she started doing her lessons, I provided her a lot of feedback mostly after the lesson. And then as she started teaching full time, she was comfortable enough and I was comfortable enough that if I need to interject something for the benefit of kids or for the benefit of her I was able to interject, and she welcomed that. (Mentor interview)

One notable aspect of this statement is the fact that Mr. Brown primarily provided his feedback after the class or the lesson, not during the lesson. He said he offered feedback during lessons once they both were comfortable with one another and when Jackie started full time teaching, which happened at the end of the semester. In fact, immediate feedback was observed only twice during the 15 week semester. Mr. Brown interjected once to correct a mistake and another time to offer explanation, but it was more common that Mr. Brown let Jackie finish her instruction without interruption, which he accurately self-reported as typical of his feedback support. The author observed this pattern when Jackie taught fractions and probability and she knew an answer, but she struggled with why the answer was correct conceptually. In this case, Mr. Brown did not step in and clarify the concept for the students, but instead let her finish the lesson.

The content of the feedback that Mr. Brown provided to Jackie was an important aspect of their mentor-student teacher relationship. Mr. Brown explained that his mentoring goals were rooted in his own experiences as a university student and student teacher in a teacher education program. He recalled learning more about

what teaching was really about in a week of student teaching than he learned in four years of college. Based on his experience, he considered how he could help Jackie build her general, rather than content-specific, teaching skills. He said, "My job is to help her to prepare for…all those little things they don't teach you in school about." Mr. Brown explained that his major focus of feedback was not necessarily content, but instead on relationship building with children and with other teachers.

Mr. Brown placed more emphasis on practical teaching strategies than specific mathematics content, a goal that originated in his background of learning mathematics. Mr. Brown was a confident learner of mathematics, very confident in teaching mathematics, and he stated that mathematics was his strongest subject area to teach. It is possible that he did not think about providing feedback about mathematics content because of these characteristics. Content-specific feedback is certainly helpful for student teachers, and probably Jackie could have benefited from this kind of support in that she expressed that she was dependent on her mentor and needed extra help especially with mathematics because it was the hardest subject for her to teach. Even though Jackie received general feedback from her mentor, she lacked specific feedback with respect to the mathematics content and the style of instruction that she wanted to practice. It is likely this hindered her ability to develop standards-based pedagogical skills as a novice teacher.

Mrs. Green. Mrs. Green highlighted the novice's autonomy as the most important goal of mentoring in her philosophy. She stated:

> I try to give Meg more autonomy because if I see something really isn't working I would tell her, but I think it is important for her to have the experience to try whatever she wants to try, and that way she can really justify if that works or if it doesn't work, what she would do differently.
>
> I think if she gets just the way that I want to do it she is not getting the true experience for herself and then that first year will be even harder because eventually people always go back to their way I think, and I think if she doesn't get to do it her way now, I would rather have her stumble a little bit with me here to help, and kind of see 'oh, maybe I don't like to do it that way or maybe I am more traditional than I thought'. So I think it lets her be her own, and I think it is good for me and good for children to see different ways. (Mentor interview)

Mrs. Green's mentoring goal of autonomy was evident in her mentor-novice relationship with Meg, who assumed the role of teacher from the beginning of the semester, with mathematics in particular. Meg's role was that of an actual teacher, and her mentor's role was supplementary. Meg agreed that Mrs. Green allowed her to try new things as long as they covered the standards. Mrs. Green gave Meg such flexibility because the student had interned in her classroom during the previous semester, they had already begun a mentor-student relationship, and Meg was comfortable in the classroom. Assuming a primary teaching role is helpful for the novice in that the student can engage in a number of confidence building opportunities to teach mathematics. However, as in this case, it precluded the opportunity for Meg to

observe a master teacher model the teaching of mathematics in ways that aligned with her understanding of reform-based pedagogy. In addition, Meg stated during interviews that she received little verbal feedback from her mentor. While gaining confidence and building knowledge from experience was certainly helpful for Meg, she also wanted content-specific support and feedback from her mentor in order to reach her goal of conceptual teaching of mathematics. It was evident from the classroom observations that little verbal feedback in relation to teaching mathematics was given to this student in general, and therefore Meg did not learn from her mentor how to teach mathematics in alignment with standards-based teaching pedagogy.

Mrs. Olive. Mrs. Olive considered making a student teacher feel comfortable the most important aspect of mentoring and her effort to meet this goal was evident in the relationship she built with Kerry, her student teacher. Her support afforded Kerry a degree of comfort that enabled the student to share her ideas and ask for feedback from her mentor from the outset of the field experience. Kerry mentioned that she really enjoyed working with Mrs. Olive, who in turn described their feedback time together as follows:

> A lot of it was just verbally after the lesson, during the special, or during the break we would like to talk, some of it would be written. We had weekly reflections we talked about went over together, too. (Mentor interview)

Mrs. Olive provided written feedback and had reflection times on a regular basis, while the other two mentor teachers did not. Mrs. Olive said she provided feedback to Kerry during lessons when she felt it was necessary, such as offering further explanation when Kerry led the instruction of a math problem. This mentor was observed frequently throughout the semester stepping in during lessons to support both the class and Kerry as she taught. The environment was so comfortable that Kerry did not to hesitate to ask questions or for feedback anytime during the class, even mid-instruction. By contrast, Mrs. Green and Mr. Brown tended to let the student teachers teach lesson independently, and it was uncommon to see these mentors jump in while student teachers were teaching.

Kerry took an active role in lesson design, and asked for and received feedback about lessons from Mrs. Olive. The other two mentors-student teacher pairs co-planned, each in different ways. Jackie's role supported her mentor's lesson design, while Meg independently planned lessons with little help from her mentor.

Continuous District Support

The third theme that made Mrs. Olive the most effective mentor teacher was the professional support she received from her school district. Mrs. Olive's instruction focused heavily on problem solving and real life application of mathematics, key components of NCTM standards. She indicated that district training had shaped her vision of teaching mathematics, particularly training in Cognitive Guided Instruction (CGI), which had caused her mathematics teaching practice to evolve over the last several years. During an interview, she stated:

> I actually would say my most recent training in CGI has probably been the most helpful and the most beneficial because I am able to see that you just do not teach kids one way and force into them this way of doing something or that way of learning it because it may

> not make sense to them. Letting kids have their own way of thinking and then explaining that to other kids usually has more buy-in for the other kids in the room (Mentor interview).

She added that she believed this pedagogy has the potential to expose students to higher levels of mathematics and help make sense of how to apply mathematics in real life situations. Mrs. Olive reflected that she had learned mathematics in the traditional way in which a teacher tells you what to do, but she does not teach that way and employs alternative methods instead. It was easy to see in the analysis of Mrs. Olive's classroom observations that her teaching practice focused on CGI. For instance, she often called up individual students to justify their answers and share their strategies. Students were also required to record their mathematical thinking in their math journal when they solved the problems. In addition, Mrs. Olive employed different student grouping strategies often to enhance students' conceptual understanding.

Mrs. Olive stated that CGI was new to her and that she was still integrating it into her own teaching practice, and she continued to hone her CGI skills while she worked with her student teacher, Kerry. Mrs. Olive said she tried to attend all CGI training sessions and collaborated with other fifth grade teachers to develop standards-based mathematics lessons. As a result of ongoing district training, and even though standards-based teaching pedagogy was new to her, Mrs. Olive provided her class with authentic opportunities to deeply engage with real-life mathematical problems. Of the three mentor teachers participating in this study, Mrs. Olive was the only mentor teacher who received continuous professional development designed to meet the NCTM standards.

Discussion

This study investigated the role of mentor-student relationships in building standards-based mathematics classrooms during the traditional student teaching experience. The results of the analysis of the three mentor-student teacher cases indicated the most effective mentor in this study was Mrs. Olive. The factors which led to her effective mentoring were 1) sharing a vision of teaching mathematics in alignment with standards-based teaching mathematics with her student, 2) her active feedback during lessons and written feedback, and 3) the consistent professional support Mrs. Olive received from her school district. These factors enabled Mrs. Olive to model teaching mathematics in ways that Kerry wanted to adopt, and Kerry experienced an extensive amount of teaching practice with active feedback.

There is a prevalent belief that mentor teachers are supposed to serve as role models for student teachers, and that student teachers should emulate mentor teachers' teaching practices (Wang and Odell, 2006). Learning is maximized in the mentor-student relationship if the apprentice has goals similar to those of the teaching community. As Ronfeldt and Grossman (2008) noted, it is difficult to reconcile an existing identity with an emerging identity as a mathematics teacher, when a student teacher and the mentor do not share the same ideas about what it means to become a mathematics teacher. The findings of this study support this argument.

Among the three pairs of mentor-student teacher relationships, findings demonstrated that Mrs. Olive and Kerry

shared the most similar vision of teaching mathematics with standards-based pedagogy. This allowed Kerry to engage in crucial learning experiences in a standards-based classroom. However, in the case of Meg and Mrs. Green, Mrs. Green's mathematics teaching practice was not parallel with the teaching pedagogy that Meg learned in her teacher education program. Meg had to negotiate which practices to adopt from the traditional teaching methods of her mentor and which practices to implement from the standards-based pedagogy she learned in her teacher education program. This disconnect resulted in limited opportunities for Meg to see standards-based teaching modeled.

More importantly, the case of Mrs. Green and Meg stressed that sharing a vision of teaching mathematics is important in terms of providing feedback. Mrs. Green gave Meg a high level of autonomy in teaching mathematics and Meg had extensive teaching experiences of teaching standards-based mathematics when compared to other student teachers. However, despite Meg's opportunities to teach standards-based mathematics pedagogy, she did not receive feedback that solidified her teaching strategies from her mentor teacher. One possible explanation for this may lie in the contrast between Meg's and Mrs. Green's shared visions of teaching mathematics. Mrs. Green was more knowledgeable and skilled with traditional teaching mathematics than standards-based teaching pedagogy. Therefore, it might have been a challenge for Mrs. Green to provide feedback regarding the particular knowledge and skills Meg wanted to practice. Zeichner and Tabachnik (1981) argued that beginning teachers are very likely to fall back on traditional ways of teaching mathematics that may reflect the way they themselves were taught, even though they are not fond of the methodology. Meg had plenty of opportunity to practice mathematics teaching, but she was not able to build a solid standards-based teaching repertoire, mainly due to the fact her teaching vision and goals did not align with her mentor's and she failed to receive useful feedback.

The importance of feedback also stood out in case of Mr. Brown and Jackie. It seems that Mr. Brown did not clearly realize where Jackie was in her development of learning to teach mathematics. Since Mr. Brown was a strong learner of mathematics and confident in teaching mathematics, it was difficult for him to understand what kind of feedback and support was necessary for a novice like Jackie, who needed extra help with mathematics content. It is important to serve the needs of adult students by honoring their mathematical thinking and backgrounds in the same ways we honor children's development and histories as they learn mathematics. Student teachers come to the field experience of apprenticeship with their own backgrounds and experiences with mathematics, teaching perspectives, and newly learned knowledge and skills from their method courses. To help novice teachers succeed in their first year of teaching mathematics, it is important to educate mentors about how to support their student teachers based on their needs. Schwille (2008) emphasized the value of such tailored mentoring and stressed the importance of mentor education to help mentors understand where novices are in their learning processes and what they need to implement standards-based teaching mathematics.

The results of this study also bring to attention the importance of the timing of feedback. All of the mentor teachers in this study provided feedback to their novice teachers, but Mr. Brown and Mrs. Green provided their feedback primarily before or after class. Mrs. Olive also provided similarly timed feedback, with the addition of instant feedback through instructional interruptions during lessons, which the author observed throughout the semester. Schwille (2008) defined this type of effective mentoring structure as coaching, in which the mentor "steps in" to teach or "steps out" so that the student teacher can resume the lesson. By contrast, Mrs. Green and Mr. Brown tended to let the student teachers teach lessons independently, and the author rarely observed these mentors interrupting lessons with feedback while the student teachers were teaching. Schwille (2008) asserted that this type of mentoring—outside of action—is less effective than inside-of-action mentoring in helping student teachers learn the complex skills of teaching moment to moment.

In addition, Mrs. Green and Mr. Brown did not provide written feedback to their students, but Mrs. Olive provided written feedback and held reflection time on a regular basis. Collins, Brown, and Newman (1998) articulated the importance of reflection in the apprenticeship structure. They considered reflection necessary to maximize learning because reflections "enable students to compare their own problem solving processes with that of an expert, other students, and ultimately an internal cognitive model of expertise" (p.19). This stance suggests Kerry's development as a teacher benefited from reflecting on a regular basis with her mentor.

Another notable element of the relationship between Mrs. Olive and Kerry was the comfort level they shared. Mrs. Olive's primary goal of mentoring was to make Kerry feel comfortable enough to communicate openly with her, which she did by sharing ideas and frequently asking for feedback about her work. This student planned and taught various lessons with a focus on standards-based teaching pedagogy with her mentor's support. When lessons were over, Kerry received feedback from Mrs. Olive. According to Lave and Wenger (1991), learning occurs with increased participation. Schwille (2008) argued that the learner's active participation and interaction with the environment result in growth through the learning process. Thus, Kerry's active participation played a critical role in her development as a mathematics teacher and Mrs. Olive's apprentice structure also helped Kerry master the skills she needed to be a beginning standards-based mathematics teacher.

Lastly, unlike the other two mentor teachers, Mrs. Olive received constant professional development from her school district - CGI training - that aligned with both the standards of the university's teacher education program and with standards-based mathematics concepts. This training developed Mrs. Olive's teaching practices so that they aligned with what mathematics educators teach in their teacher education programs. An implication of this finding is that mentors need ongoing professional development, not one-time events, if their teaching practices are to be reasonably consistent with reform-based teaching mathematics. For example, Mrs. Green might have been able to better support Meg if she had experienced such training. She was a

veteran teacher and more knowledgeable of traditional ways of teaching mathematics than standards-based teaching pedagogy. If she had received continuous professional support from school district, she may have been able help her student fulfill her goal of building a standards-based mathematics classroom.

Mentor training should include pedagogical content knowledge and classroom management content, which parallels the information that protégés receive in teacher education programs. Further study is needed to identify how to educate mentors regarding effective feedback. Suggested topics for feedback training include the following: the methods used for feedback (for example oral, and written), the timing of feedback (for example stepping in and out mid-instruction, and before and after lessons), and the major foci of the feedback (for example pedagogical content knowledge, knowledge including questioning, students' mathematical thinking, and classroom management).

As many research studies have pointed out (Eisenhart & Borko, 1993; Kagan, 1992; Grossman 2000), it is crucial to address the existing gap between student teachers' university experiences and their student teaching social environments in order to help them transition as smoothly as possible from one to the other. This current study suggests that mentor training has the potential to ease the transition between theory and practice. Additional research about the various types and patterns of successful mentor-novice relationships would likely support the growth of novice teachers. A type of mentor-student relationship of interest is one in which a student is matched with a mentor who can meet their needs, such as that of Mrs. Olive and Kerry. An example of a relationship pattern worth investigating is the exchange of content specific feedback, such as happened with Mr. Brown and Jackie. It may also be useful to conduct brief surveys of in-service teachers to identify and understand their foci of teaching practice and visions of teaching mathematics in general. Survey data could inform the effective pairing of student teachers with well-matched mentors in order to maximize learning experiences that align with standards-based teaching mathematics.

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