STUDENT TEACHERS' GENERAL AND CONTENT-SPECIFIC PEDAGOGICAL DEVELOPMENT WITHIN A MATHEMATICS MILIEU

Diana L. Piccolo
Missouri State University

Mary Margaret Capraro and Robert M. Capraro
Texas A&M University

Fourteen elementary and 6 middle level student teachers were observed and interviewed throughout their initial field placement teaching experience. The Classroom Observation and Performance Assessment for Teachers-Revised (COPAT-R) observation instrument and semistructured interviews were used to compare general and content-specific pedagogical development. Results from interviews found that both groups of student teachers perceived themselves as most competent in having lesson plans ready, routines evident, utilizing student-centered instruction, and having effective monitoring and motivational techniques. Conversely, both groups felt least competent in having a system for materials distribution, getting students on task quickly, using a variety of teaching strategies, using critical thinking skills, handling inappropriate behavior effectively and providing guided practice.

INTRODUCTION

Pedagogical proficiency and the capability to implement pedagogical skills in the classroom greatly influences teachers' abilities to execute and instruct students in subject-matter learning (Darling-Hammond, 2000). The Interstate New Teacher Assessment and Support Consortium Standards (INTASC, 1992) stated that, "teachers need a deep understanding of how mathematical knowledge is developed and how it can be nurtured through well chosen pedagogical strategies" (p. 1). In addition, the National Council of Teachers of Mathematics (NCTM, 2000) has outlined through their standards and principles the importance of contin-

Diana L. Piccolo, Missouri State University,College of Education, Department of Childhood Education & Family Studies, Missouri State University, 901 South National Ave., Springfield, MO 65897. E-mail: dpiccolo@missouristate.edu

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ued learning of mathematical and pedagogical content knowledge. In order to provide and meet these pedagogical and mathematical requirements for preservice teachers, continued research and understanding of how these factors are interrelated and develop throughout novice teachers' initial teaching experiences is needed.

The purpose of this study is to better understand the general and content-specific pedagogical development complexities student teachers encounter throughout their initial teaching experience. New teachers leave the profession at an alarming rate negatively effecting student learning (Helfeldt, Capraro, Capraro, Foster, & Carter, 2009; National Center for Education Statistics, 2007). Ingersoll (1997) found this was even more apparent for mathematics teachers. This problem needs to be addressed, however, Strawhecker (2005) found there were "few studies that currently exist to document attempts to integrate mathematics content, pedagogy, and field experiences" (p. 4).

General and Content-Specific Pedagogy

An important foundation in mathematics teaching is that teachers have, "common and specialized knowledge" that demonstrates a vast, deep, and thorough understanding of mathematics content (Ball, Lubienski, & Mewborn, 2001; Ma, 1999). However, being able to teach mathematical content knowledge is intertwined within general and content-specific pedagogy or pedagogical content knowledge (Shulman, 1987).

General pedagogy skills include planning and structuring mathematics lessons, organizing activities, having a system for materials distribution, lesson planning, and motivating students (Fennema & Franke, 1992; Interstate New Teacher Assessment and Support Consortium, 1992). Leinhardt and Smith (1985) described this knowledge as "lesson structure knowledge" that is separate from content knowledge. This knowledge includes skills needed to plan a lesson and lesson transitions from one subject to another. However, general pedagogy skills are not used in isolation but within the context of teaching content-specific instruction, such as mathematics.

Pedagogical content knowledge (PCK) is the combination of both general and content-specific pedagogy into a form of knowledge that is understandable to students. Teachers need to understand representations and organization of the content that is best suited to meet students' needs. The development of teachers' pedagogical content knowledge is influenced by several factors, beginning with content knowledge learned during teacher preparation program and initial teaching experiences (Capraro, Capraro, Parker, Kulm, & Raulerson, 2005; Ellis, Contreras, & Martinez-Cruz, 2009). Using both general and content-specific pedagogy in mathematics is especially challenging for student teachers. National, assessment-based standards and principles were created to help guide novice teachers in the formation of mathematics teaching using both general and content-specific pedagogical practices (Capraro, Capraro, & Helfeldt, 2010).

Linking General and Content-Specific Pedagogy to INTASC Standards

Based on the collaboration of more than 30 states and educational agencies, the Interstate New Teacher Assessment and Support Consortium (INTASC) standards provided the framework for new teachers in assessing the content-specific and pedagogical knowledge needed to teach essential ideas, processes, and perspectives to students (INTASC, 1992). The 10 INTASC standards are: (1) subject matter, (2) student learning, (3) diverse learners, (4) instructional strategies, (5) learning environment, (6) communication, (7) planning instruction, (8) assessment, (9) reflection and professional development, and (10) collaboration, ethics, and relationships. The first standard describes the content knowledge for teaching mathematics based on mathematical ideas, processes, and perspectives and the remaining standards describe pedagogical

skills and dispositions needed to implement that knowledge. The INTASC standards are used as a basis for the National Council for Accreditation of Teacher Education (NCATE) teacher licensing and professional development (Darling-Hammond, 1998).

Pedagogical Competencies of Novice Teachers

Novice teachers, such as student teachers, approach and execute pedagogical skills within the classroom very differently than expert teachers. What pedagogical competencies or abilities do student teachers typically bring to their initial teaching experience? Borko and Livingston (1989) reported distinct differences between expert and novice mathematics teachers. First, novice teachers regarded the classroom as a whole unit rather than being comprised of individual students. When planning instruction they considered mathematical needs for the whole class rather than for individual students. Second, novice teachers focused on short-term planning with scripted lessons. They planned the types of questions to ask students before the lesson began and had a difficult time answering questions during the lesson that did not relate to pre-scripted questions and maintaining the direction of the lesson after questions were answered. Third, when novice teachers were asked to reflect upon their mathematics instruction, they focused on the, "clarity of explanations and examples, use of the chalkboard, and ability to respond to student questions" (p. 488). Only one of the novice teachers discussed classroom management effectiveness. Overall, the most common concerns discussed by these mathematics teachers were the amount of time planning lessons and their inability to anticipate student problems. These differences highlighted their limited, "propositional structures for pedagogical content knowledge structures" (p. 490). Borko and Livingston suggested that teacher preparation programs focus more on pedagogical content knowledge and pedagogical reasoning development throughout preservice teachers' initial teaching experiences. They also recommended the need for increased studies that focused on the development of pedagogical expertise within specific content areas, such as mathematics.

Classroom management is one of the most difficult areas of pedagogical development for novice teachers. Jones and Vesilind (1995) studied the cognitive frameworks of classroom management on novice teachers. As they gained experience in managing their classroom, they began to shift their focus from concerns about being the authority figure and students liking them to establishing relationships between classroom management, instruction, and learning. They began to worry less about their own teaching strategies and more about students' learning. Mapolelo (1999) found that even if novice teachers were confident in their mathematical content knowledge, they still had difficulties engaging their students in quality discourse, creating meaningful mathematics activities that enhanced student understanding, and lacking the ability to anticipate student misconceptions learning mathematical concepts. Follow-up responses to students' answers were typically, "That is good," or "who could help him?" These types of responses were generally encouraging but elicited only low-level responses from students (Piccolo, Carter, Harbaugh, Capraro, & Capraro, 2008). Mathematical explanations were generally clear and accurate, but were procedural, teacher centered, and did not promote linking mathematical concepts together (Piccolo et al.). Novice teachers throughout their initial teaching episodes typically experience this level of pedagogical competency development. Preservice teachers must transition from the role of student to that of teacher—learning to develop pedagogical and content knowledge strategies within the classroom. As stated by the National Commission on Teaching and America's Future (1996), in order to teach mathematics effectively, one must combine a profound understanding of mathematics with knowledge of students as

learners with skillfully chosen pedagogical strategies.

METHODOLOGY

Participants

In this study 14 elementary and 6 middle grades preservice teachers (N = 20) participated throughout their semester-long student teaching experience. All student teacher participants (pseudonyms are listed in this report), were White and female with the exception of one Hispanic male. The elementary level student teachers (ELSTs) taught mathematics daily for approximately 50-90 minutes to extant groups of students. Four student teachers taught kindergarten (Barbara, Brittany, Jamie, and Mary), one taught first grade (Samantha), three taught second grade (Amanda, Heidi, and Patricia), two taught third grade (Abby and Janet), and four taught fourth grade (Brianna, Fran, Whitney, and Wanda), three taught fifth grade (Faith, Rebecca, and Taylor), two taught seventh grade (Anna and Yazmin) and one taught eighth grade (Richard). The middle level student teachers (MLSTs) taught mathematics approximately 225 minutes daily (i.e., 45 minutes per class) to five different groups of students, with the exception of the fifth-grade teacher, who taught all subjects. Fifth grade is contained in the middle grades certification, however this teacher taught in an elementary school. Student teachers were invited to participate in this study through an invitation by the researcher extended to them during their senior methods courses. Student teacher placements were in districts located in south central Texas, all of which were 2-3 hours from the university in which they were enrolled.

The following were the requirements for participating in the student teaching program: (a) completed their education coursework and field-based clinical experiences; (b) obtained at least a 3.0 grade point average; (c) completed all degree requirements, except for student teaching; and (d) successfully completed all written state teacher certification exams.

The Researcher

The primary researcher for this study developed expertise in assessing student teachers in classrooms on general and content-specific pedagogy by: (a) having 15 years elementary, middle, and university-level mathematics teaching experience; (b) being trained to use the Classroom Observation and Performance Assessment for Teachers-Revised (COPAT-R) by the instrument developer; (c) interviewing university-level student teaching program leaders to gain a better understanding of program design, expectations, and implementation; and (d) having conducted a pilot study using the COPAT-R on a similar groups of student teachers.

Assuming the role of *observer-as-participant* (Johnson & Christensen, 2004), the researcher developed relationships with the student teachers and gathered assessments, self-reports, interviews, and observational data on each participant for 9 months, beginning in the final year of their teacher preparation program and continuing through the conclusion of his/her student teaching experience. She also met with each of the student teachers three times in their respective classroom teaching assignments, therefore, this report focused on the student teaching period. During the first visit the format of the study was reviewed with each participant; the mentor and/or other supervisors were met; the student teacher described classroom compositions and routines; and other preliminary items were discussed. The format for the next two visits involved formal observations using the COPAT-R. The researcher only observed mathematics lessons student teachers taught. Informed by the pilot study, detailed notes and audio recordings were collected during observations to facilitate completion of the COPAT-R after the lesson was over. Worksheets used by students during the lessons, lesson plans, classroom seating diagrams, and

lesson audiotapes were used to triangulate findings. The student teachers and researcher also engaged in member check and informal interactions through phone conversations (Denzin & Lincoln, 2000).

Research Questions

To examine and compare general and content-specific pedagogical skills of ELSTs and MLSTs, the following research questions framed this study. (1) What trends in general and content-specific pedagogical behaviors, resulted in ELSTs' and MLSTs' pedagogical development such as: (a) instructional preparedness, (b) instructional environment/classroom management, (c) format and structure of instructional content delivery, (d) instructional monitoring, and (e) motivation and feedback, in teaching mathematics? (2) What self-perceptions of general and content-specific pedagogical skills did student teachers possess? (3) What were the most important differences between general and content-specific teaching behaviors evident between the researchers' external observations and student teachers' self-perceptions?

Instrumentation

The COPAT-R contains six general pedagogical domains measured by 60 descriptors: instructional preparedness (IP), instructional environment/management (IEM), instructional lesson (IL), instructional monitoring (IM), instructional motivation and feedback (IMF) and one instructional content domain (IC), a content-specific pedagogical domain. This instrument was designed using the INTASC standards (1992), and the Danielson (1996) instructional framework.

Administration of the COPAT-R. The COPAT-R was used on a pre- and posttest basis. Pretest data were collected during the fifth and sixth weeks of student teaching, coinciding with the inception of the student teachers' full time teaching responsibilities. Posttest data were collected during the 11th and 12th weeks, comprising the final 2 weeks of the student teachers' full time teaching responsibilities.

The pretest Cronbach's alpha reliability estimates for ELSTs and MLSTs on each domain (IP, IEM, IL, IC, IM, IMF) was .66, .91, .84, .70, .82, and .90, respectively, with a combined reliability for all six domains of .96. Similarly, the posttest Cronbach's alpha reliability estimates for both groups on each domain were .55, .88, .66, .43, .79, and .86, respectively, with a combined reliability for all six domains of .93. Cohen's kappa reliability between the researcher and another rater trained in using the COPAT-R was found to be .40, indicating moderate agreement (Viera & Garrett, 2005).

Qualitative data collected on the COPAT-R included written notes and descriptions for each domain gathered during lesson observations. These notes helped to clarify and explain results of the COPAT-R domain factors on certification level.

Student teacher interviews. Data were collected using audio-taped, summative semi-structured interview questions. The interviews were completed during the 12th-13th week of student teaching lasting an average of 45 minutes. The 10 questions focused on general and content-specific pedagogy and structured as conversation starters and not intended to be all encompassing. This semistructured interviewing technique (Seidman, 2006) was designed to provide insights while allowing for flexibility to probe participants for details about their perceptions. Even though each question was asked to all participants, the researcher allowed them to expand upon answers, as desired.

Interview questions. The analysis used for interview data grouped interview responses by certification level (elementary and middle) and general and content-specific domain type. Student teachers were asked to select and explain which COPAT-R descriptors where they perceived themselves as being either competent or developmental. The researcher did not require each descriptor be ranked, but allowed partici-

pants to select descriptors within each domain in which they felt they were most and least competent. An emergent design was employed to examine common themes or ideas as they developed throughout the organizing and examination of data. Patterns in responses were used to group chunks of data into interpretable categories. Trustworthiness was established by: (a) collecting thick descriptions in the interviews, (b) engaging both the student teacher and researcher as conversational partners, (c) conducting a pilot study that examined pedagogical factors of former student teachers using classroom observations, and (d) consulting with mentoring and mathematics education experts.

Quantitative analyses. The researcher calculated the total number of most and least competent occurrences from the interview perceptions selected by ELSTs and MLSTs for each descriptor. Differences between groups for each level (most and least competent) were ranked according to largest descriptor differences for each domain. During the coding process each descriptor was given a frequency occurrence of one, each time it was selected by a student teacher. Because the number of participants in the two groups of student teachers was not equal and they could select more than one descriptor within a domain the number of occurrences was reported as a percentage of the total in that domain. For example, if 7 out of the 14 ELS teachers selected a descriptor it would be reported in the table as 50% ($7 \div 14 = \frac{1}{2} = .50$). Transcribed dialogue and explanations for descriptors with the greatest differences between percentages were included to provide a rationale that supported student teachers' self-report perceptions of their general and content-specific pedagogical development.

The COPAT-R descriptors were scored using the following scale: (a) a score of 4 was given when an occurrence was observed accurately and consistently throughout the lesson; (b) a score of 3 was given when an occurrence was satisfactorily observed but not consistently used throughout the lesson; (c) a score of 2 was given when the descriptor was evident but not consistent in application; and (d) a score of 1 was given when the descriptor was not appropriately evident during the lesson.

INTERVIEW RESULTS

Using a constructivist theory (Denzin & Lincoln, 2003), the researcher examined how student teachers constructed and developed their general and content-specific pedagogies throughout their student teaching experience. Through interviews based on the COPAT-R, the researcher gained an understanding of self-perceptions ELSTs and MLSTs had concerning their general and content specific pedagogical development. Table 1 contains a summary of this information.

Instructional Preparedness (IP)

Perception of most competent descriptors. The MLSTs felt more competent than ELSTs for having a *system for materials distribution* while, ELSTs felt more competent in *having lesson plans ready*. Janet explained how the lesson plan helped organize her day:

> I realized that if you don't have it [lesson plan] together it is like flying by the seat of your pants … and that is crazy! … when you come into the classroom … you don't know what's going to happen next.

In comparison, Anna taught the same lesson to five different groups of students each day. Even though she had her lesson plan, she noticed fluctuations following her lesson plan with each subsequent class.

> I tried to be prepared, whereas I can see now that the first class would get the [most] mistakes … just me learning through my mistakes with the lesson plan helped me to realize that I need to go over it a few more times [before teaching it to students].

TABLE 1
General and Content-Specific Pedagogy Descriptor Competencies

		*% **Most** Competent*			*% **Least** Competent*		
Domains	*Descriptors*	*ELS*	*MLS*	*% Δ*	*ELS*	*MMLS*	*% Δ*
IP	**System for materials distribution**	14	50	**36**	21	0	**21**
	Lesson plan ready	50	17		7	17	
	Selects instructional goals	36	17		7	17	
	Percentage total	100	84		35	34	
IEM	Routines are identified/evident	50	17		7	0	
	Inappropriate behavior handled effectively	14	17		29	67	**38**
	Consistent application of rules	14	67	**53**	36	17	
	Minimal disruptions to class	0	0		50	17	
	Students on task quickly	14	17		71	33	
	High levels of time on task	0	17		43	67	
	Students engaged productively	14	0		29	0	
	Prevention techniques used	0	0		29	33	
	Materials ready	57	83		0	0	
	Necessary items available	50	50		7	0	
	Sets reasonable work standards	50	17		7	7	
	Assigns independent practice	43	33		7	7	
	Percentage total	306	318		315	268	
	Objective, purpose and intent clearly presented	29	17		0	17	
IL	Lesson initiation; interesting, compelling	7	0		0	17	
	Speech, fluent, clear	14	50	**36**	7	0	
	Directions clear and precise	36	50		7	0	
	Transitions, smooth	7	0		21	17	
	Interactive	21	17		7	0	
	All parts of lesson tie together	7	0		7	0	
	Lively/appropriate pace	29	0		14	17	
	Student reflection included	0	0		21	0	
	Engagement, equitable	7	0		0	17	
	Closure included	29	0		14	50	**36**
	All critical lesson components evident	7	0		0	0	
	Lesson modifications made, if needed	14	17		21	17	
	Lesson culturally responsive	0	0		7	0	
	Objective met	29	17		0	17	
	Student seating supports lesson	29	17		14	17	
	Strategies, varied	14	0		29	0	
	Examples relevant	14	17		0	0	
	Percentage total	293	202		169	186	
	Prior knowledge point of reflection	0	0		7	0	
IC	Strategies, developmental (age appropriate)	7	0		7	0	
	Strategies, adjusted as needed	0	0		0	0	

(Table continues on next page)

TABLE 1
(Continued)

		% ***Most*** *Competent*			% ***Least*** *Competent*		
Domains	*Descriptors*	*ELS*	*MLS*	*%Δ*	*ELS*	*MMLS*	*%Δ*
	Questions (open, varied levels)	14	0		14	33	
	Lesson has core integration	0	0		0	0	
	Critical thinking encouraged	0	0		29	17	
	Content information accurate	0	17		0	0	
	Student centered	36	0	**36**	21	0	**21**
	Total:	57	34		78	50	
	Monitoring occurs	50	17		14	17	
IM	**Circulates to check performance**	29	83	**54**	14	0	**14**
	Checks progress frequently	50	50		14	17	
	Checks both whole class and individual	21	0		29	17	
	Stands/sits to see all students	21	0		14	0	**14**
	Frequent visual scanning	50	17		0	0	
	Immediate feedback on work or answers	21	33		21	33	
	Confirms correct answers	14	17		14	17	
	Uses informal or formal assessments	14	0		14	0	**14**
	Percentage total:	270	217		134	101	
IMF	**Effective motivation techniques used**	36	0	**36**	7	10	
	Sustains feedback with incorrect answers	36	17		14	17	
	Appears enthusiastic	43	67		7	0	
	Respectful and valued responses	50	67		0	0	
	Positive climate in classroom	36	50		7	0	
	Students appear motivated	14	0		29	0	**29**
	Responsive to student questions	21	0		7	0	
	Receives oral/written data	7	0		7	17	
	Provides guided practice	29	0		14	33	
	Percentage total:	272	201		92	84	
	Percentage total for all 6 domains	1,298	1,056		823	723	

Note: Descriptors in bold indicate items with the largest difference between the ELS and MLS self-evaluation rating. Percentages within domains do not sum to 100% because participants could have selected more than one descriptor for each more or less competent category.

Perceptions of least competent descriptors. The ELSTs felt least competent than MLSTs for having a *system for materials distribution* while, MLSTs felt least competent in *having lesson plans ready* and *selecting instructional goals*. Amanda explained a frustration she experienced when asking students to assist with distribution of materials. Amanda stated

> lately I have been asking whoever is ready or whoever is quiet to pass out papers … but I don't like so many students [walking] around the room because it gets them off task and

> they'll start talking to whoever they're passing the papers to."

Instructional Environment/Management (IEM)

Perceptions of most competent descriptors. The MLSTs felt more competent than ELSTs for having a *consistent application of rules* while, ELSTs felt more competent in having *materials ready*. Taylor's approach in being consistent with rules was similar to the statements of two other MLSTs. She stated, "The students know what to expect from me and they know that if they choose to break a rule it be consistent with the consequence … I won't vary my rules according to what mood I am in."

ELSTs felt having materials ready was especially important when using manipulatives and to help keep students on-task. Anna stated that, "if you don't have your materials ready, you're going to have a hard time with classroom management and just getting through the lesson."

Perceptions of least competent descriptors. The MLSTs felt least competent than ELSTs for *handling inappropriate behavior effectively,* while, ELSTs felt least competent in *having students on task quickly*. Anna felt that she gave students too many chances for students to misbehave and was ineffective at stopping the misbehavior before it got out of control.

> I think that I give too many chances because I am young. I don't want to come across as mean … I just kinda blow it [the misbehavior] off for a while until it really becomes a problem.

Student teachers also described how difficult it was keeping students on task and focused when learning mathematics and completing assignments. Samantha stated, "If you give them [students] manipulatives, you have to make sure they are really listening and using them as tools rather than as play toys." Sometimes the scheduling of mathematics classes during the day can make it hard to keep students on task. Abby stated that,

> keeping the students on task quickly has been a struggle, especially in math because our math time is right after lunch … they go the restroom and they come into the room all excited … then keeping them on task for the whole hour of math … and they know that at the end of math is recess.

Instructional Lesson (IL)

Perceptions of most competent descriptors. The MLSTs felt more competent than ELSTs for having *fluent, clear speech* while, ELSTs felt more competent in *having a lively appropriate pace* and *providing lesson closure.* Anna felt that she was loud and clear and had good speech fluency. Faith also felt that she spoke well and students could understand her directions. Several MLSTs stated that it was important to speak clearly and accurately because students only had 45-50 minutes in class and so they did not have a lot of time for restating directions again.

Perceptions of least competent descriptors. The MLSTs felt least competent than ELSTs for having *lesson closure* while*,* ELSTs felt less competent in having *varied strategies* MLSTs felt least competent when providing closure to a lesson. Taylor explained how she always felt rushed at the end of the lesson.

> I always feel rushed and the students are thinking "why are we doing this? I would rather just move on to the next activity." I would like to not be so repetitive but actually sum up the lesson and have it interactive so students can answer questions.

Faith described closure as a time management issue.

> Closure is a struggle because it's not that I don't know what to say. It's more about time management and has been a huge lesson for me to learn.

Brittany said one reason she used the same strategy of using manipulatives, such as Unifix Cubes, is because her mentor did not have a good variety of resources. Amanda reflected that she would like to use more student-centered strategies in mathematics, such as working in groups or in centers, but is afraid of losing control of students. "Sometimes I wish we could do more where they break up into groups, like more center things. I just feel like I would lose control of the classroom … I've done games before and it got very loud."

Comparison of Instructional Content (IC)

Perceptions of most competent descriptors. The ELSTs felt more competent than MLSTs for having *student centered instruction* while, MLSTs felt more competent in teaching *accurate content*. Patricia used student-centered instruction to keep students on task and motivated. "I try to involve the students as much as I can so they can respond to questions, and not just me blabbing my mouth. I want students to be involved and motivated."

MLSTs felt better prepared to use accurate content information when teaching mathematics. Anna expressed the importance of how lesson planning can help in teaching accurate content. "I've learned to mix that [mathematics content] up and make sure I know what I am doing. I usually try to work the problems out and figure out the answers before I get up there [in the classroom]." She also stated why it was important for students to have an in-depth understanding of mathematics content.

> I ask a lot of "whys" [questions] … you can memorize math, but I want them to understand why, and where the concept is coming from because … we are seeing this on the TEKS [Texas Essential of Knowledge and Skills]. The [students] know the material for school, but when it comes to reading and having to actually comprehend and use those math content skills, that's missing.

Perceptions of least competent descriptors. The MLSTs felt least competent than ELSTs for asking questions at open, varied levels while, ELSTs felt least competent in encouraging critical thinking skills. Faith described the difficulties of using varied levels of questions when teaching mathematics.

> After we learned the area of a rectangle we tried to derive the area of a triangle … by starting off with identifying polygons. [Questions asked were] "Why do we all agree they are all polygons?" What kind of polygons are they?" I was really surprised by some kids' answers. One [special needs] boy said a really great thing … two triangles can fit together with another one to make a rectangle.

Faith was pleasantly surprised that asking higher level questions to varied levels of students provided the potential for all students to learn and understand mathematics concepts.

Comparison of Instructional Monitoring (IM)

Perceptions of most competent descriptors. The MLSTs felt more competent than ELSTs for *circulating to check performance* while, ELSTs felt more competent in *monitoring students* and *frequent visual scanning.* Anna believed she encouraged her students by walking around while they completed seatwork.

> Circulating to check performance is something I really try to do and my legs will tell you the same thing. I get finished at the end of the day and I haven't sat down all day. I think that if I go sit down, they may get off task.

Amanda described how she used her physical presence to circulate and check student performance.

> "I tried to walk around a lot … and sit on someone's desk that is talking. I tried to not do as many verbal reprimands so I would just touch them or whisper in their ear if they are

> off task. I am always walking around and looking at them [students].

Perceptions of least competent descriptors. The ELSTs felt least competent than MLSTs for *circulating to check performance*, *stands/ sits to see all students*, and *using informal or formal assessments*, while, MLSTs felt least competent in *providing immediate feedback on work or answers*. Janet felt that she did not need to circulate because there were several teaching assistants in the classroom. "I definitely need to circulate more. I guess that I am kinda spoiled because we have so many aides in the classroom. I feel safe in front of the room since there are aides and helpers by the students." Mary used mathematics centers for instruction but had a difficult time circulating to all centers.

> It was hard to circulate and sit at the teacher table [teaching her group of students]. That really frustrated me because so many of my students [from other centers] kept coming to my table and saying "how do you do this … I wasn't really listening to them [because I was teaching].

Samantha stated that she needed more experience with informal practice because most of their mathematics assessments used formal assessments. Conversely, Brittany felt that she needed more practice administering formal mathematics assessments because her class did not complete assessments, other than journals.

The lack of ability of MLSTs to provide immediate feedback was sometimes a result of the large amount of papers that needed to be graded and returned to students. Taylor felt that,

> if they turn in a worksheet, then sometimes it can take me a couple of days to return it to them. So … it leaves them still wondering … they are wanting some type of follow up to know they did the questions correctly, especially if one was a difficult problem solving question.

Comparison of Instructional Motivation and Feedback (IMF)

Perceptions of most competent descriptors. The ELSTs felt more competent than MLSTs for *using effective motivation techniques* while, MLSTs felt more competent in *appearing enthusiastic* and *being respectful and valuing student responses.* Samantha stated that an effective motivation technique was using manipulatives during mathematics instruction. "They [the students] got really excited about using manipulatives in math class." Amanda used a classroom management money system to motivate students. Most motivational techniques were extrinsic rather than intrinsic.

Brianna hoped that her "children knew their answers were respected and appreciated in the classroom." She wanted them to "enjoy being in the classroom, where it is a safe environment and where their answers and learning were respected." Anna also wanted her students to enjoy mathematics as much as she did. "I love math and I want them to love the class. I know we go through the same process everyday but sometimes I'll try to change it up."

Perceptions of least competent descriptors. The ELSTs felt least competent than MLSTs for *motivating their students,* while MLSTs felt least competent than ELSTs for *providing guided instruction*. Whitney explained that motivating all students can be a challenge. "Some of them are fine [to motivate] and want to do their work but there are a few that have no motivation and trying to find ways to motivate them is hard." Brianna realized that students are not motivated to learn because of the influences of personal issues. "It's amazing how much home life affects their [motivation]." Samantha said that she used manipulatives during mathematics to motivate students. Most student teachers described using extrinsic motivation techniques to motivate engage and retain students' attention.

MLSTs felt least competent to provide guided practice for students. Faith described the perils of providing guided practice. "I lose some kids during guided practice. I really talk

to them a lot about raising their hand and realizing … there are times where you don't know [if they understand]." Taylor stated that sometimes she does not realize students need more guided practice until they begin working on their independent seat work.

> Sometimes I think that they are ready for independent work [after doing guided work together] but then about 10 of them would say, "I can't do the work." I realized that oops, I had them jump into that [independent work] too quickly. We needed more practice together, first.

DISCUSSION

This study found that MLSTs demonstrated higher general and content specific pedagogical competencies than ELSTs, with largest differences within the instructional preparedness (IP) and instructional environment/management (IEM) domains. Both the researcher and student teachers felt that MLSTs demonstrated increased competency in the IEM domain. In contrast, the researcher felt that MLSTs demonstrated higher competency than ELSTs in instructional preparedness, whereas ELSTs perceived themselves as more competent than MLSTs. A few reasons why the researcher felt MLSTs demonstrated higher general and content specific pedagogical competencies was because: (1) MLSTs selected the mathematics class in which the researcher observed them, (2) the cooperating teacher was present during lessons more often than ELSTs cooperating teachers, (3) MLSTs planned and prepared fewer classes, and (4) they only taught mathematics and not several other subjects, as did the ELSTs. Typically, MLSTs would invite the researcher to observe them in well-behaved and/or academically advanced classes. This made it more likely for them to maintain effective classroom management, organize and execute the lesson with minimal student interruptions, and therefore receive higher IEM domain scores. Whereas, in elementary school, the classroom student composition did not change throughout the day so ELSTs typically taught the same group of students for the entire day.

Further examination of the IC domain found there were group similarities demonstrated in content knowledge for teaching mathematics. First, both ELSTs and MLSTs primarily used procedurally based teaching strategies during instruction. These findings align with Mapolelo's (1999) conclusion that mathematics lessons were generally procedural based. In this study, use of conceptually based teaching was evident only in one kindergarten and one seventh-grade student teacher's mathematics classroom. These two student teachers generally asked higher-order questions, engaged students in longer, more in-depth discourse, and were able to guide students through effective questioning strategies to understand mathematical concepts. However, these were not used in the majority of mathematics classrooms among both groups of student teachers. Second, both groups of student teachers used manipulatives to facilitate mathematics instruction but did not incorporate them into the actual teaching of the lesson. Lessons were generally taught using the overhead or chalkboard with student teachers calculating mathematical algorithms and steps to solve mathematical problems. Manipulatives were used by students after the lesson was taught to aid in completing worksheets or activities that reinforced recently learned mathematical skills or concepts. The most effective use of manipulatives in teaching concepts were seen by kindergarten teachers during "calendar time" when both teacher and student would use clocks to tell time; place value sticks to trade ones, tens, and hundreds; hundreds chart to skip count by 2s, 5s, 10s, and a calendar to show linear and nonlinear patterns. Third, a combination of student-centered and teacher-centered instruction was demonstrated by both groups of student teachers. This is contradictory to Mapolelo's (1999) study, in which student teachers used primarily teacher-centered instruction. Finally, both groups demonstrated mathematical content proficiency by

using accurate mathematics strategies and algorithms. Occasionally, incorrect terminology, such as ounces instead of pounds, were stated but overall skills and concepts were taught mathematically correct and accurate mathematical terminology were used in lessons.

Through observations of mathematical lessons, student teachers demonstrated a solid understanding of mathematical content. However, it was more difficult to teach this content until these beginning teachers gained better control and proficiency in utilizing pedagogical strategies. As found in Jones and Vesilind's (1995) study of classroom management, this area of pedagogical competency was difficult for both groups of student teachers to maintain. The ELSTs felt least competent to get students on task quickly and to minimize classroom disruptions. Similarly, the MLSTs felt least competent to handle inappropriate behavior effectively and engage students in high levels of time on task. Where student teachers in Jones and Vesilind's study worried less about their teaching strategies and more about students' learning by the end of student teaching, the majority of student teachers in this study were still focused on improving their pedagogical and mathematical competencies and teaching strategies. They were more focused on improving their own teaching skills, such as planning lessons, developing questioning and classroom management techniques, than on their students learning of mathematics. As Borko and Livingston (1989) found in their study, during classroom instruction, they viewed the classroom as a whole unit, rather than focusing on individual student learning. During observations, it was obvious to the researcher that they stuck to scripted lessons and questioning techniques and seldom varied in their preplanned goals and objectives. Only Barbara and Anna showed the ability to focus on individual students' learning of mathematics during group instruction using conceptually based teaching strategies. In member check discussions with the researcher, they discussed how they would modify student questions and redirect instruction to meet the needs of students as they occurred. The researcher also observed these types of teaching skills in the classroom. For example, Barbara began her lesson by passing out interlinking cubes and black work mats to students. She led students through an imaginary journey to a zoo where they began to add and subtract using the interlinking cubes as animals and mats as animal cages. After adding or subtracting animals together, she asked students to explain what they had just calculated and to compare computations in one problem to computations in another. After several of these types of guided practice examples using the interlinking cubes to add and subtract whole numbers, students were then encouraged to lead the class in creating their own word problems using the interlinking cubes (i.e., zoo animals) as manipulatives. However, if students answered a problem incorrectly or had difficulty understanding a question, Barbara spent time guiding and probing the student to determine their level of understanding. While doing this, she was able to keep the rest of the class focused on the discourse between her and the other student and would often bring other students into the conversation. Questions were regarded as avenues for further investigation instead of delays in completing the lesson. They were not constrained by the dictates of planned lessons and questions but felt secure enough with their own knowledge of teaching and their students' mathematical needs to alter from the prescribed lesson, if needed. Again, this was not typical of the other student teachers' instructional delivery and format. Common responses to indirect or unexpected questions from students were polite but brief answers in an attempt to redirect them to the curriculum being taught. The researcher even observed a few instances where student questions and responses were completely ignored by the student teacher due to lack of time to finish the lesson or difficulty in maintaining classroom control.

One limitation of this study was the small sample size employed in data collection and

classroom observations. At the beginning of student teaching, 52 student teachers had agreed to participate in the study. Unfortunately, after the first week, only 20 student teachers still agreed to participate. As found by Strawhecker (2005) "large-scale studies on pedagogical content knowledge have not been conducted" (p. 2). Ball and Wilson (1990) and Ma (1999) have contributed a more complete understanding of how preservice mathematics teachers' content knowledge has developed and Wilson, Floden, and Ferrini-Mundy (2001) suggested ways of reorganizing pedagogy and content within mathematics methods courses using a constructivist approach. According to Strawhecker (2005), there is currently no model that integrates both mathematical content and pedagogy in the context of teaching for student teachers. However, one aim of this study was to contribute to current findings and understandings between content for teaching mathematics combined with general and content specific pedagogical skills among elementary and middle level student teachers.

There is a steep learning curve student teachers experience in both teaching mathematics content and implementing effective pedagogical skills within mathematics classrooms. General and content specific pedagogical behaviors must be developed in conjunction with having deep, vast, and thorough understanding of mathematical content knowledge. In addition, more large-scale studies need to be conducted in classrooms of both elementary and middle level student teachers to develop schema for understanding what is actually occurring as student teachers transition into veteran teachers. Additionally, differences between certification levels should be examined. This will help teacher preparation programs better prepare preservice teachers to understand the interrelatedness of pedagogical and content knowledges for teaching mathematics skills. This study made an initial attempt to contribute to this knowledge base of amalgamating mathematical knowledge for teaching and pedagogy.

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