

8

A Triad Approach to Elementary Mathematics Teacher Preparation

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Abstract

Content exploration, examination of pedagogy, and real elementary school experiences are all parts of revised elementary mathematics methods and content courses for pre-service teachers. This paper describes how one institution weaves together the content, methods, and school experiences to create meaningful integrated learning for elementary education pre-service teachers. Using connections to the classroom such as pen-pal journals in the content courses and math buddies in the methods course allow pre-service teachers to value the content and connect it to future teaching aspirations.

The University of South Carolina (USC) Instruction and Teacher Education and Mathematics Departments have collaborated with local schools to create a meaningful triad that enhances the pre-service teacher education program. It connects content exploration, examination of pedagogy, and real elementary school experiences. These connections support pre-service teachers understanding of each of these three essential elements of teaching. Pre-service elementary teachers need to be equipped with conceptual knowledge of both the discipline of mathematics and the school curriculum of mathematics as well as an understanding of how these two areas relate (NCTM, 1991). In addition to knowing the mathematics, teachers need the ability to hear and guide individual students through mathematical situations flexibly and with understanding of diverse needs (Ball & Bass, 2000). Field experiences allow one to explore student thinking and develop understanding with assistance from experienced educators (Mewborn & Stinson, 2007).

Feiman-Nemser (2001) suggests that by analyzing student work, interviewing students, and studying other teachers, teachers can develop the tools to study teaching. When these activities are carried out in the company of other teachers, they advance norms for professional discourse as teachers gain confidence in critically examining teaching. This belief guided the collaborative efforts by faculty in the mathematics department and college of education to create

meaningful mathematical content and methods courses for pre-service teachers at the University of South Carolina.

Mathematics Content Course

Teachers of mathematics at the elementary school level are facing increasing demands in the classroom. Elementary school mathematics has become much more challenging. Today's mathematics curricula require children to demonstrate understanding and competence far beyond basic computational skills. Elementary school teachers of mathematics must have greater content knowledge (NSF advisory committee, 1996; & Ball, 1990). "Aspiring elementary teachers must begin to acquire a deep conceptual knowledge of the mathematics that they will one day need to teach, moving well beyond mere procedural understanding" (National Council on Teacher Quality, 2008). In addition, they must be prepared to address the different learning styles and the different developmental levels of a diverse student population. The *No Child Left Behind Act of 2001* requires that teachers meet the needs of all students. Teacher education programs must provide experiences that will prepare their graduates for these increased demands. Teacher education programs must make pedagogical content knowledge a priority (Brown & Borko, 1992).

Pre-service elementary teachers at the University of South Carolina are required to take four courses taught by mathematics faculty. The effectiveness of such content courses has often been limited for many reasons. The fact that typical mathematics department faculty members have not taken education or child development courses and have little experience in elementary classrooms is a factor that affects the instruction in these courses. They may be unfamiliar with national and state curriculum standards and with the current methods and materials of mathematics education. In teaching the pre-service courses, they may rely on the traditional lecture method and provide little opportunity for student interaction and communication (NSF advisory committee, 1996). "It is doubtful that university mathematicians have the pedagogical knowledge to effectively help teachers" (Ralston, 2004, p. 404).

This lack of pedagogical knowledge can often be seen in the content courses in the Mathematics Department. The content courses tend to provide little or no opportunity for interaction and communication between the students in the class and elementary school students who are studying the same topics. Discussions of national standards are limited and are rarely connected to the topics under consideration in terms of how those standards are implemented at various grade levels within the school districts. There may be no connection between the content course and actual classrooms and area elementary teachers (Sowder & Schappelle, 1995).

The pre-service elementary teachers often approach their mathematics courses with apprehension and less-than-positive attitudes toward mathematics. This apprehension and anxiety towards the course and the content before the first word is spoken are indicators of how open and receptive students may be throughout the course. "As K-12 students they lost their curiosity about mathematics. When the rules and procedures one is taught are not conceptually anchored, memorization must pass for understanding, and mathematics becomes an endless,

senseless parade of disparate facts, definitions, and procedures” (Conference Board of the Mathematical Sciences, 2001).

Another negative factor at many institutions of higher learning for pre-service teacher education is the lack of communication and coordination that often occurs between the Mathematics Department faculty who teach the content courses and College of Education faculty who teach the related pedagogy courses (Ball, 2000; Grouws & Schultz, 1996). The mathematics faculty member may be unaware of how the content courses fit into the overall teacher preparation program and the education faculty may not have a complete understanding about the mathematical content their teachers have before entering their program.

The recommendations made by NCTM (2000) for elementary mathematics instruction led the mathematics department at the USC to make significant changes in the mathematics content courses for elementary teachers. Collaboration with area elementary teachers and the college of education at USC resulted in the reform of coursework for elementary pre-service teachers. Rather than offering the traditional mathematics for elementary teachers’ course, two courses were developed and instituted, that explore elementary content using the National Council Teachers of Mathematics Standards (2000) as a guide.

After the reform, the University of South Carolina’s two mathematics content courses for elementary teachers consist of numbers and operations, and geometry and measurement. According to the National Science Foundation Advisory Committee (1996) math content courses for elementary school teachers must be rigorous and guarantee mastery of the subject matter. At the same time they must take into account the intended use of the content; that is, the content must be presented in context. In order to accomplish this, the courses must provide students with a thorough grounding in the NCTM standards which help provide “guidance and vision” for mathematics teaching and learning (Principles and Standards, 2000), how the standards are implemented at the state and school district levels, and how the various content areas of the course are addressed by standards. It is also important that there is a focus on mastery of the concepts and skills of elementary mathematics and the ability to explain the reasoning behind the rules and algorithms (Principles and Standards, 2000), an understanding of how the content fits into an elementary school curriculum based on developmental principles (Holmes, 1995), and an understanding of the available technology for mathematics teaching and its implementation at the various grade levels (Ralston, 2004). Valid models of mathematics content teaching should be demonstrated in these courses which emphasize guided exploration, student interaction, appropriate use of manipulatives, oral and written communication of mathematical ideas, observing connections between mathematical ideas, mathematical modeling and problem solving (Principles and Standards, 2000).

The USC mathematics department has worked to apply these principles to the content courses for elementary teachers. Mathematics faculty worked with area teachers to select topics, and add meaningful activities such as Pen Pal Journals. Collaborative learning, manipulatives, math games and math lessons through children’s literature have put the mathematics in context and made the content course more meaningful for the prospective teachers. In collaborating on

the creation of the mathematics content, the College of Education faculty provided deeper insight into developmental issues and the benefit of current research in elementary classroom methodology.

“Good pedagogical practice is facilitated by access to modern instructional equipment...” (NSF advisory committee, 1996, p. 51). The redesigned mathematics courses are taught in a specially configured and furnished room in Department of Mathematics called the Educational Learning Classroom (ELC). The ELC is equipped with mathematical manipulatives, multiple types of technology, and curricula materials used by schools. Books, journals, and articles that discuss research in mathematics education and applications of mathematical content is housed in the ELC. Students are learning how to integrate technology into the elementary mathematics classroom in ways that address students’ multiple learning styles and developmental levels.

A Peer Leader program has been created for the mathematics content courses. The Peer Leaders are pre-service elementary teachers who have completed both of the content courses. They help to coordinate the Pen Pal component, assist in the classroom during collaborative or laboratory activities, and serve as a resource for the students.

One innovation has been a particular success: the Pen Pal journal program. This program pairs the pre-service teachers with elementary students at a local elementary school for a weekly or bi-weekly exchange on the mathematics each group is studying. Through this activity, pre-service teachers gain insight into how students perceive instructions and mathematical content. Actual classroom experience is very important in the preparation of teachers (NSF advisory committee, 1996). Pen pal journals provide opportunities for students to develop mathematical problems, explore student responses, and connect these with the content they have learned and the NCTM standards.

They allow for authentic communication between pre-service teachers and elementary students. Journals are a means for pre-service teachers to develop strategies for communication in and about mathematics. They allow pre-service teachers to explore mathematical concepts and thinking both receptively and initiatively, which addresses all the points in NCTM’s Communication Standard. The culminating activity for this project is a celebration where the elementary students take a field trip to the USC campus to meet their math pen pals.

The University of South Carolina’s students who have taken the redesigned mathematics courses rank the courses as one of the most useful components of their teacher preparation program. The pen pal experience validates and reinforces the material of the course, and provides valuable information about child development and math content at a particular grade level. Students acknowledge the impact of the pen pal journals. Some comments made by students at the end of the semester include:

“I had a hard time explaining how to do a problem because in my head I know how to do it but explaining it to someone else on paper was difficult for me”.

“I was amazed to see what they were learning in the third grade”.

“At first my directions were really unclear to a third grader”.

“I learned that now students are learning math backwards, forwards, and upside down rather than just strict memorization”.

“I believe I became a much better communicator through the pen pal journal”.

“My pen pal was a very good math student, but I did need to change the way I communicated directions because I realized she did not understand what I was saying”.

“I thoroughly enjoyed communicating with my pen pal. It was something to look forward to each week when coming to class”.

Mathematics Methods Course

The elementary mathematics methods course is taught at a local elementary professional development school that is also a culturally diverse, Title 1 school. Moyer and Husman (2006) found that pre-service teachers whose methods courses were held at an elementary school seemed more focused on developing the skills necessary to become a teacher. This 3 hour one day a week course enables pre-service teachers to explore a successful school with children from economically disadvantaged families. Many of their cultural biases are challenged and they are able to see the success that can happen when teachers connect students' lives to the content they are learning. As one past student noted, “These students see the real world meaning in math that I so often missed. Their enthusiasm and confidence in their ability to make sense of math was intimidating at first, but it actually changed my view of mathematics.”

The pre-service teachers in the mathematics methods course spend 30 minutes of the course time each week working with elementary students in the area of mathematics, in addition to their regular day of general field experiences. During this 30 minutes, they are involved in observing how elementary students approach problem solving and how they communicate their mathematical thinking. The first week pre-service teachers conduct interviews with their “small teachers” to examine the students' mathematical affect and gain a basic overview of his/her content knowledge. The information from the interview is shared with the classroom teacher in order to provide a different perspective about the student for the classroom teacher. In addition the classroom teacher has received permission from parents of students to share information about his/ her mathematical progress with the pre-service teacher. This enables the pre-service teachers to make more informed instructional decisions. Findings from this interview and information from the classroom teacher is then used by the pre-service teacher to support the student in his/ her mathematical growth during the thirty-minute intervention time.

In the remaining classes pre-service teachers create mathematics games, develop problems, and plan lessons based on their individual student needs. Class discussions and connections to readings follow each session with the elementary students. One example includes a discussion on the standard algorithm that developed as pre-service teachers connected the readings from the text with the alternative algorithms many of their “small teachers” used in problem solving scenarios they had done together. Some pre-service teachers observed, through the eyes of their fourth grade students, the difficulties so often experienced by students when using the traditional algorithm without conceptual understanding. In addition, others were able to

see how alternative algorithms gave ownership of mathematics to the students and empowered them to believe that math should make sense. As one pre-service teacher said in an interview:

“Just reading about it, I wouldn’t have understood why students don’t just learn as I did. However, when *X* explained why he worked his problem and how it made sense to him, it made sense to me. Suddenly things just clicked. I saw how this [alternative algorithms] could be an important step towards understanding the regular way. Then I was fascinated when we got back together and others shared some of the strategies their small teachers used. Teaching is like working a puzzle.”

All too often discussion of teaching experiences in mathematics methods courses is about lessons that occurred days before or teaching within the constraints of a coaching teacher’s philosophy of teaching mathematics. As pre-service teachers reflect upon their experiences with the fourth graders during the methods course and plan for future lessons, they are able to integrate what they gained from their content courses, which are prerequisites, with the current methods course and the needs of specific, actual elementary students. This gives deeper meaning and connection of these facets of teaching elementary mathematics. In addition, it allows pre-service teachers opportunities to discuss questions, issues, and observations concerning teaching mathematics with their peers and mathematics methods instructor immediately following teaching opportunities. This connection of actual students with the course lessons creates an atmosphere of professional collaboration during the course and creates a model for professional collaboration in the future.

The collaborative model is further supported by the interaction they have with the classroom teachers of their students. Information about students that is gained from the interview and lessons are given to the classroom teacher in the form of a weekly note. This note lets classroom teachers know what was discussed and can provide insight into students, that due to time and class size they may overlook. As classroom teachers find content areas in which students could use additional support they also communicate this with the pre-service teachers. Each of these facets of the time with their students welcomes pre-service teachers into the professional learning community known as teaching.

Conclusion

The collaboration between the departments to create and sustain the courses has provided more intentionally, meaningful experiences for pre-service teachers. The departments have worked to create courses that connect experiences to each other and to the local schools through pen pals in the content courses and working directly with students during the methods course creates a unique situation. Pre-service teachers are now able during their freshman year of college to begin seeing the importance of teachers in children’s mathematical development. They connect to elementary students in the first content course through the pen pal journals, and are meaningfully explain and explore the content they will be teaching in the future. During their mathematics methods course, they are able to have focused instruction with students and

then immediately collaborate about student thinking and future pedagogical approaches with the instructor and peers. The triad of collaboration and experiences between the mathematics department, college of education, and local schools has been seen to enhance pre-service preparation through observations, student reflections, and case study interviews.

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