

# **The Development of Pre-service Elementary Mathematics Teachers' Pedagogical Content Knowledge: The Role of Integrated Program**

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## **Introduction**

Increasing the quality of mathematics education is directly associated with the quality of the teacher in many researches, and the quality of teacher is described with his/her knowledge, belief and applications (Fennema& Franke, 1992; Thompson, 1992). It is certain that mathematics teacher's deeply understanding of mathematics he/she will teach and use these understandings to teaching activities efficiently is the basic teacher competence playing role on developing the students' understandings of mathematics. For teaching mathematics efficiently, teachers have to adapt their subject matter knowledge in accordance with pedagogical objectives. Shulman (1987) describes this adapting process as transformation of content knowledge. At this point, transformation concept refers to a movement towards the understanding about how the understanding of the teacher can help the student understand the content. Shulman (1986) uses *pedagogical content knowledge* term to describe the content knowledge formed by these kinds of transformations. According to Shulman(1987), pedagogical content knowledge is a knowledge type where content knowledge intersects with pedagogical knowledge, theoretical and practical knowledge integrates, and playing a central role in teaching. Concerning the taught content or concept; being able to create different representation forms, analogies, examples, problems, providing the understandings of the student, giving effective answers to student questions are elements of pedagogical content knowledge of the teacher. More specific to mathematics, Ball et al. (2001) describe pedagogical content knowledge as a special form of knowledge that " bundles mathematical knowledge with knowledge of learners, learning, and pedagogy" and serves as a resource for teaching mathematics. On the other hand, research indicates that teachers' beliefs about mathematics and the teaching and learning of mathematics have powerful impact on their teaching, and related their all knowledge structures (Ernest, 1989). In this study, pedagogical content knowledge (PCK) refers to both teachers' mathematical knowledge and beliefs for teaching.

Research on teacher knowledge contains numerous examples of a mismatch between the aims of teacher education programs and pre-service teachers' knowledge and beliefs. Increasingly teacher educators/researchers report that the subject-matter understanding pre-service teachers bring to teacher education coursework is not the sort o conceptual

understanding that they will need to develop in their future students (Ball, 1987; Thompson, 1992; Ebert, 1993; Magnusson, 1994; Fuller, 1996). In addition to, Baki(1997) state that prospective mathematics teachers do not come to the faculty of education as empty vessels; they have beliefs about mathematics and its teaching which have been constructed throughout their school years in which they have learnt that mathematics is a fixed body of rules and procedures, an uninteresting subject best taught through memorization and repetition. It is well documented in the literature that the procedural understanding of mathematics that pre-service teachers typically exhibit in university mathematics courses, mathematics methods courses, and other teacher education coursework is not adequate to teach the reform-mathematics curricula (Ball, 1990; NCTM, 2000).

The necessity to involve teachers in the type of learning experiences and environments that they are expected to implement in their teaching, has been advocated by various researcher. They propose that pre-service teachers should have practical experiences with approaches, materials and activities that they are expected to employ when they will eventually be teaching (Baki, 1997). Ball (1990) contended that mathematics methods courses can change pre-service teachers' knowledge, assumptions, and feelings about mathematics, as well as their beliefs concerning their role as teachers in the classroom. With this in mind, new courses or integrated models should be designed and implemented as an alternative to traditional types of teacher education courses in some significant ways. Distinctive aspects of the courses should include student task-based lessons, exploration and investigation together with groupwork and discussion, engaging non-routine problem solving activities, designing and preparing lesson plans with a constructivist manner that pre-service teachers reinterpret their past experiences with mathematics and construct new understandings and conceptions about mathematics and its teaching. In this way, they can enrich and develop PCK with powerful constructs to effectively implement the new innovative curriculum program in elementary schools in the future.

### **The Problem**

Thus, the primary research question is: How do pre-service elementary mathematics teachers develop pedagogical content knowledge over four semesters in the teacher education faculty via an integrated program?

The related research questions are:

1. How do pre-service elementary mathematics teachers change beliefs about mathematics and its teaching/learning over four semesters in the teacher education program?

2. How do pre-service elementary mathematics teachers develop mathematics knowledge for teaching during this period?

3. How does the integrated professional development program affect pre-service teachers' teaching practices during this period?

### **Purpose of the Study**

The purpose of this study is to examine the development of pre-service elementary mathematics teachers' PCK in a two year integrated program.

### **Significance of the Study**

Today in Türkiye, procedural knowledge of mathematics and the transmission model of learning and teaching are dominant at all levels in the education system. This dominant pattern undoubtedly reinforces prospective teachers' conceptions about learning and teaching primarily that teaching is telling and learning is reproducing what the teacher says. The teacher training programs do not provide prospective teachers with an opportunity to experience alternative methods and approaches to the learning and teaching of mathematics. Also, teacher educators should take into account pre-service teachers' attitudes, and beliefs while developing content and pedagogy rich courses (Haser, 2006). This longitudinal study is an attempt to develop more integrated program in the existing pre-service faculty courses for supporting PCK in a meaningful way that take into account these ideas.

In an attempt of examining and tracing development of pre-service teachers' knowledge structures before their graduation from teacher education program is believed to give valuable insights to both policy makers and mathematics educators in terms of understand and develop the nature of this knowledge structures. Haser (2006) who investigated pre-service and in-service teachers' mathematics related beliefs and perceived effect of middle school mathematics education program on these beliefs, mentioned that cross-sectional data of the sophomore, junior, and senior pre-service teachers' beliefs about the nature of, teaching and learning of mathematics did not differ due to the grade level in the program. She added that courses in elementary mathematics education program were not specifically designed to challenge pre-service teachers, beliefs and did not have strong or long-lasting impact on pre-service teachers' belief. She stated that program lacked the continuity and consistency of the courses that challenges the pedagogical content knowledge of pre-service teaches (Haser, 2006). This study investigates pre-service mathematics teachers' development of PCK throughout two years period in response to continuity and consistency.

### Methods

The integrated program will be implemented in elementary mathematics education in the department of mathematics education in Karadeniz Technical University in the context of the existing content and content methods courses during two years time (2008/2009-2009/2010). The participants in this study will be third graders preservice teachers in the mathematics teacher education program. The program will have following components:

- Workshops and model lessons for preservice teachers in both content and content methods courses
- Examination of preservice mathematics teachers' PCK throughout their micro-teaching practices
- Examination of preservice mathematics teachers PCK throughout their teaching practices in the school setting

Workshops and model lessons will be designed to place the preservice teachers in unfamiliar contexts for learning mathematics and provide opportunities for them to reflect on their experiences as both learners of mathematics and future teachers of mathematics. Small and whole-group discussion, activity sheets, and journal writings will provide opportunity for engaging in reflective thought about the experiences and deep their PCK. The mathematical topics in the content and content methods courses will be aligned with the existing curriculum contents. All activities and lesson plans in the first part will be related to both elementary (school mathematics) and advanced mathematical (university mathematics) topics. In the content courses, investigative learning environments will be designed for some advanced mathematical topics/concepts, instead of a traditional lecture course. In the content methods courses, various tasks will be designed to enhance preservice teachers' pedagogical content knowledge, provide forum for reflections, and open up opportunities for collaboration. The preservice teachers will engage in collaborative problem solving and analyze children's thinking in key content areas. After, in the process of micro-teaching, some participants will prepare lesson plans and teach in this context. Lastly, these preservice teachers will teach various school subject in real classrooms and the development of their PCK will be examined more deeply. Several sources will be collected throughout the study, including interviews, journal entries, questionnaires, teaching scenarios, lesson plans and classroom observations. For example, prior to the start the integrated program some pre-service teachers will participate in an interview regarding their views about mathematics and the teaching and learning of mathematics. Some preliminary results regarding these factors will be presented in summer school on August.

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