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# Pre-service mathematical teachers' knowledge of different teaching methods of the limit and continuity concept

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**Abstract**

This study aims at examining pre-service teachers' knowledge of different teaching methods for the concept of limit and continuity in functions. To gather data, a questionnaire was administered to 37 pre-service teachers studying in the last year of Secondary School Mathematics Education and semi-structured interviews were conducted with 4 pre-service teachers. From the results of the study, it can be concluded that the present teacher training program has some deficiencies in providing preservice teachers to integrate different teaching methods into their teaching. In other words, the practical aspect of the program is not as powerful as its theoretical aspect.


*Keywords:* Pedagogical content knowledge; concept of limit and continuity; teacher training; mathematics education.

## 1. Introduction

A number of factors are effective in performing mathematics teaching effectively. One of these factors is pedagogical content knowledge which teachers have. Shulman (1986a) explains pedagogical content knowledge (PCK) as the knowledge which separates the master of the subject (for example, a mathematician) from an educator (for example, a math educator). Shulman (1986b) describes the most advantageous representations of the content (subject), the strongest metaphors, pictures, examples; that is the kinds of teaching and representations that make the content understandable for the others, as the pedagogical content knowledge. Two features appear in Shulman's (1986a, 1986b, 1987) definition of pedagogical content knowledge: Student difficulties and teaching strategies and representations.

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For the last two decades, mathematics education literature has focused on teachers' and pre-service teachers' pedagogical content knowledge (such as Carpenter, Fennema, Peterson & Carey, 1988; An, Kulm & Wu, 2004; Cha, 1999; Winsor, 2003). These studies investigated various aspects/components of PCK as described in different ways by Shulman (1987) and Grossman (1990). Shulman (1987) puts forward two components in his definition of PCK: knowledge of students understanding, and use of representations and strategies for teaching particular topics. Grossman (1990) proposes four components of PCK: knowledge of strategies and representations for teaching particular topics; knowledge of students' understanding, conceptions, and misconceptions of these topics; knowledge and beliefs about the purposes for teaching particular topics; and knowledge of curriculum materials available for teaching.

## 2. The Research

In this study, the teaching strategies and representations of PCK are focused on. This feature of PCK is how to represent mathematics in education which is not completely separate from the content. This includes dealing with complex subjects and turning these into the representations that could be understood by the students. Turning mathematics into understandable representations is the point which separates mathematics teacher from a mathematician (Fennema and Franke, 1992). When searching this component of PCK, limit and continuity subject which is important because of its use in other subjects, is chosen. Bezuidenhout (2001) states that students' failure to express meaningful ideas in calculus, to a large extent, is due to inappropriate and weak mental links between knowledge of "limit" and knowledge of other calculus concepts such as "continuity", "derivative", and "integral".

## 3. Methodology

The research design used for the study was a descriptive survey method (Karasar, 2000). Descriptive research design is a scientific method which involves observing and describing the behavior of a subject without influencing it in any way. Many scientific disciplines, especially social science and psychology, use this method to obtain a general overview of the subject.

### *3.1. Research Group*

A questionnaire was administered to 37 pre-service teachers studying in the last year of Secondary School Mathematics Education in a government university in Istanbul to investigate their content knowledge related to the concept of limit and continuity. After the analysis of the responses to the questionnaire, 4 pre-service teachers were selected for interviews. These students were selected among those who gave exceptional responses or answers different to the usual ones in the questionnaire. The chosen pre-service teachers have been given nicknames as Moon, Cloud, Flower, and Sea. Among the courses of the pre-service teachers that join the research there are Analyze I-II-III-IV and Special Teaching Methods I-II. For this reason, it is accepted as the pre-service teachers who joined the study know the teaching methods and techniques that could be used in limit and continuity presentation and the subject itself.

### *3.2. Gathering Data*

In this study, multiple research methods (e.g., observation, interview and document analysis) have been used. Firstly, semi-structured interviews were conducted with the selected pre-service teachers. During the interview the pre-service teachers were asked which teaching methods they knew and which of these methods they would use when they became teachers. After the interview, the pre-service teachers were asked to prepare a lesson plan for the concept of limit and continuity and lecture this lesson, in the form of microteaching, in three weeks.

### *3.3. Analysis of Data*

The responses given to the open-ended questions in the area knowledge survey, were examined by descriptive and content analysis. Determining the categories, frequencies and percentages were found according to these categories. The recorded interviews were transferred to written texts later and analyzed. The responses of the questions were examined by descriptive and content analysis. In the process of analyzing research data, pre-service teachers' responses for each question were coded according to the aims of the research. The lesson presentations of the pre-service teachers that were recorded before were watched and written and analyzed by thematic coding. Finally, after examining pre-service teachers' lesson plans, they were analyzed qualitatively extent of the research aims.

## 4. Results

When the findings of the research were assessed, it is seen that all the pre-service teachers except Moon, generally use the presentation and question-answer method, although they were aware of most parts of teaching methods and techniques. The Pre-service teachers mentioned in the interviews that mathematics was an abstract concept and it was needed to explain mathematics in a more concrete way in order to make the students understand the subjects completely by using different methods. For example;

> *Researcher: Which techniques and methods do you use while presenting the lesson? Or which teaching techniques and methods do you know?*
> *Moon: The biggest lack of mathematics is the difficulty in transferring it to the students; is that mathematics is an abstract subject. The student cannot imagine mathematics from beginning to end. What is the teacher talking about? If he/she draws a picture, a shape on the board, the student will understand what it is.*

However, it was seen that the pre-service teachers do not use any techniques to make the subject more concrete for the students during the teaching of limit and continuity. In the interviews, one of the points that the pre-service teachers insisted on mentioning is to make students learn where the lesson subject can be used in everyday life. The pre-service teachers said that students are interested in the lesson would increase by this way. Likewise, when the lesson presentations were watched only one pre-service teachers (Cloud) stated where to use limit in everyday life before starting to explain limit and continuity subject, none of the other trainees stated this point.

Even though the pre-service teachers are engaged with technology and saw practically how to present the derivative concept by using some softwares (Cabri, derive, graphic analysis etc.) in some of the courses they had (optional courses) none of the pre-service teachers used this kind of software while presenting limit and continuity subject. This situation can be interpreted as they cannot integrate the technology into their lessons or they cannot use their initiative.

When all these data is combined, it is seen that although the pre-service teachers who participated in this study know the teaching methods and techniques they can use while presenting the limit and continuity subject, when it comes to presenting the lesson, they do not use the things they know, but explain the lesson in the same way as they were told the lesson, that is explanation, and question-answer method. This shows that it is not enough for pre-service teachers to know teaching methods and techniques to explain the lesson more effectively.

## 5. Discussion and Implications

The findings of this study revealed that although generally the preservice teachers were aware of most parts of teaching methods, they only used lecturing or question-answer techniques. Although in the interviews the pre-service teachers emphasised the importance of using different methods and teaching mathematics in a concrete way to ensure students to understand the subject completely, they did not use any methods to do realise their ideas. As a result, it can be concluded that the present teacher training program has some deficiencies in providing preservice teachers to integrate different teaching methods into their teaching. In other words, the practical aspect of the program is not as powerful as its theoretical aspect.

In Turkey, with the new structure of educational faculties, pre-service teachers began to complete first 3.5 years of their license education (7 semesters) in science and art faculties by taking content knowledge courses and other 1.5 years (3 semesters) in educational faculties by taking pedagogical content knowledge and pedagogical courses (YOK, 1998). Undoubtedly, as every program has positive or negative sides, this new structure process is also criticized or appreciated. For example, the program has effects of the American and English educational systems (Baki, 1998) and that is why it is criticized by several educators. According to Aslan (2003), as the courses aim to provide general culture and the program is flexible, it is normal that content knowledge courses are taken in sciences and art faculties in the USA. However in Turkey, their courses aim at making specialists, so the program of science and art faculties is unnecessary and exorbitant for student teachers (Aslan, 2003). Some studies such as Yigit & Akdeniz (2004) and Sarac (2006) give support to this consideration by putting forward that student teachers' process in science and art faculties negatively influences their attitudes toward profession of teaching and prevent them from feeling as a teacher.

In this point, we think that However, as stated by Stylianides and Stylianides (2006), mathematics courses for pre-service elementary (or secondary) teachers should use mathematics tasks that provide preservice teachers with rich opportunities to learn mathematics in connection with the domain to which this learning will be used, namely, the work of mathematics teaching. On the other hand, student teachers are asked to teach mathematics by using different teaching methods and to assess students with alternative assessment methods in their teaching practice in some courses such as Teaching Practice and in their future professions. Unfortunately in Science and Arts Faculties they never see any teaching methods other than lecturing and are only evaluated by written exams. By supporting on the assumption that student teachers teach mathematics in the way they learnt, it can be concluded that these student teachers will rather tend to use lecturing and evaluate students with written exams.

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