

## The Effect of Peer Instruction on Conceptual and Operational Approaches Preferred in Problem Solutions

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### Abstract

*The level of using conceptual and operational knowledge is of great importance in the problem-solving process. The previous studies on the measurement of conceptual and operational knowledge, have been, especially examining the problem solutions or in discussing the views. On the other hand, rich learning environments should be established to overcome such difficulties in teaching mathematics in general and analytical geometry in particular. In this study, the researchers provide useful information to the literature since this study aimed to examine quantitatively, whether the peer instruction in analytic geometry has any effect on the conceptual and operational approaches of secondary school mathematics teacher candidates in problem solving. The sample of the research is composed of (including 22 females, and 1 males) secondary school mathematics teacher candidates. Considering the advantages of technological resources on learning, the learning management system (LMS) designed by the second author, was used during the question-answer process. Before the application, the course content was integrated into the online learning management system (LMS). The teacher candidates were divided into groups before the application. In this research, the first group will be presented in the context of the research problem. In the first group, the scores of the prospective teachers who wanted to use the second right to answer were not reduced. Conceptual & Operational Approach towards Problem-Solving scale, developed by Özyıldırım Gümüş and Umay (2018) was used as the data collection tool. One of the two options is conceptual and the other one is the operational. Thus, it is possible to decide on approaches from the responses. Since the value of this approach could be*

*related with the data set, the cut-off point was determined by the ROC curve method in SPSS program and the data were analyzed descriptively by the reference to this cut-off point. It has been determined that the secondary school mathematics teacher candidates display a conceptual knowledge-based approach through peer instruction.*

**Keywords:** Peer instruction, conceptual and operational approaches, problem solutions, mathematics teacher candidates

## 1. Introduction

It is very difficult for teachers to draw students' attention during lessons, especially in large classes (Mazur, 1997). Therefore, peer instruction (PI) was emerged as a student-centered instructional approach and developed by Eric Mazur (1997). PI mainly consists of the lecture and question-answer processes (Chou & Lin 2015).

The multiple choice questions are used in the question-answer process. In this model, questions are asked, students have enough time to think and then, students give their first answers individually. Then they discuss with the group friends on the question, and give the second answers after the discussion. After all the students give their second answers, the instructor solves the question and answers the questions of the students. At this point, if the accuracy of the answers given by the students is low, the instructor explains the subject in detail. Therefore, the potential of PI may be used for the development of secondary school mathematics teacher candidates. Because, it can be said that the development of conceptual understanding skills of mathematics teacher candidates is one of the important goals.

The level of using conceptual and operational knowledge is of great importance in the problem-solving process. The previous studies on the measurement of conceptual and operational knowledge, have been, especially examining the problem solutions or in discussing the views (Byrnes & Wasik, 1991; Che Ghazali & Zakaria, 2011; Soylu & Aydın, 2006). This situation has emerged as a result of the difficulties of separating these two types of knowledge and measuring them independently.

For this reason, a scale which has been developed to solve these difficulties until recently, was used in the research. This scale was applied before and after the analytical geometry course, which is one of the most difficult lesson for mathematics teacher candidates (Baltacı, Yıldız, & Kösa 2015; Gorghiu, Puana & Gorghiu, 2009). Analytical geometry, which is expressed as the application of geometry and algebra together, aims to solve the geometry problems by providing an algebraic explanation (Altun, 2004). Rich learning environments should be established to overcome such difficulties in teaching mathematics in general and analytical geometry in particular. Therefore, the potential of peer instruction has been used in the research as mentioned before.

In this study, the researchers provide useful information to the literature since this

study aimed to examine quantitatively, whether the peer instruction in analytic geometry has any effect on the conceptual and operational approaches of secondary school mathematics teacher candidates in problem solving. It is also thought that research will provide useful information to curriculum developers.

## 2. Method

In this section, the information related to research design, sample, instruments, application process and data analysis will be introduced.

### 2.1 Research Design

Study was designed to be a quantitative research to examine whether the peer instruction has any effect on the conceptual and operational approaches. Therefore, experimental method was used in the research.

### 2.2 Sample

The sample of the research is composed of (including 22 females, and 1 males) secondary school mathematics teacher candidates in the academic year of 2018-2019. They were selected amongst those who take analytic geometry course that was taught by one of the researcher of this study at a state university.

### 2.3 Instruments

Conceptual & Operational Approach towards Problem-Solving scale, developed by Özyıldırım Gümüş and Umay (2018), was used as the data collection tool. Thanks to this scale, in order to measure conceptual and operational knowledge, some misunderstandings in the literature are thought to be corrected such as; a valid, reliable and standardized approach has not yet, and fully been established. The scale consisting of 14 items. The subjects were asked to complete the sentences for each item in the scale with one of two options. One of the two options is conceptual and the other one is the operational. Thus, it is possible to decide on approaches from the responses.

### 2.4 Procedure

This research took place at a state university during Analytical Geometry course conducted. Considering the advantages of technological resources on learning, the learning management system (LMS) designed by the second author, was used during the

question-answer process.

Before the application, the course content was integrated into the online learning management system (LMS). A preparatory training was also provided for teacher candidates to adapt to this process. The teacher candidates were divided into groups before the application. Prospective teachers were randomly divided into three groups and a research was designed as follows. After the teacher candidates gave their first answers in each group, a discussion environment was initiated in the classroom. Afterwards, prospective teachers were able to change their answers by using the right of second answer. In the first group, the scores of the prospective teachers who wanted to use the second right to answer were not reduced. In the second responses, the scores of the prospective teachers in the second group were calculated over 80 points. In the third group of teacher candidates; the score of the prospective teachers who wanted to give the second answer was calculated over 60 points. In this research, the first group will be presented in the context of the research problem.

## 2.5 Data Analysis

A total score was calculated for each participant by scoring "1" representing the use of conceptual knowledge in the scale form and "0" representing the use of operational knowledge.

Thus, when the total score of the participants is close to the full score (14), it can be said to be conceptual, on the other hand, when it is close to "0", it can be said to be the operational approach. However, since the value of this approach could be related with the data set, the cut-off point was determined by the ROC curve method in SPSS program and the data were analyzed descriptively by the reference to this cut-off point. The cut-off point was found as "10" according to the ROC curve result. If the data result is below "10", it is handled as operational-weighted approach; however, if the data result is above "10", it is handled as conceptual-weighted approach.

## 3. Results

In this part, it has been examined whether the analytical geometry course described by the peer instruction model has any effect on the conceptual and operational approaches of secondary school mathematics teacher candidates in problem solving with some factors such as; the average academic grade point and the order of preference of the department.

The change in conceptual and operational approaches according to the academic grade point is given in Table 1.

**Table 1.** The effect of peer instruction model on conceptual and operational approach of prospective teachers according to academic grade point.

Academic Grade Point	Pre-test		Final Test	
	Conceptual Weighted Approach (f)	Operational Weighted Approach (f)	Conceptual Weighted Approach (f)	Operational Weighted Approach (f)
2.00-3.00	3	7	5	5
3.01-4.00	7	6	9	4

When the data in Table 1 are analyzed, it is seen that 2 out of 10 students whose grades are between 2.00 - 3.00 pass into conceptual weighted approach after the study. On the other hand, it was determined that 2 of the 13 teacher candidates whose grades were higher, ie between 3.01 and 4.00, moved to a more conceptual-weighted approach. Considering the number of pre-service teachers according to their grade point average, it can be said that the peer instruction model is effective in passing the secondary school mathematics teacher candidates to the conceptual-weighted approach.

The change in conceptual and operational approaches according to the order of preference of the department is given in Table 2.

**Table 2.** The effect of peer instruction model on conceptual and operational approach of pre-service teachers in terms of department preference order.

Department's preferred	Pre-test		Final Test	
	Conceptual Weighted Approach (f)	Operational Weighted Approach (f)	Conceptual Weighted Approach (f)	Operational Weighted Approach (f)
1-5	5	8	8	5
6-10	1	4	3	2
11 and above	1	4	3	2

When the data in the above table are analyzed, it is seen that secondary school mathematics teacher candidates exhibit operational weighted approach to all sub-varieties of this variable. However, after the study, three of the pre-service teachers who preferred the department in the first five were changed into conceptual-weighted approach. Again, it is seen from the data in the table that two of the teacher candidates in the department preferences in the order of 6 - 10 and 11 and more have switched to a more conceptual approach.

## 4. Discussion

Teachers should help their students to organize the thinking processes while solving problems. Thanks to the peer instruction model used in the research, teacher candidates were able to enrich their thoughts due to the discussions with their peers and the instructors. Furthermore, secondary school mathematics teacher candidates expressed that they enjoyed this atypical method even though they were unfamiliar to this way of teaching.

In the absence of conceptual and operational knowledge, the problem-solving process does not reach its aim (Silver, 1986). In the research, it was observed that the teacher candidates solved the analytical geometry problems with difficulty at the beginning, but later on, despite the topics becoming more complex and abstract, the success on solving the problems without difficulty was increased. As a matter of fact, the research results show the following picture in general. It has been determined that the secondary school mathematics teacher candidates display a conceptual knowledge-based approach through peer instruction. From this point, for an effective problem solving process, it can be concluded that waiting for everyone to produce their own solutions, how effective these solutions are and how to ensure the correctness of these solutions and thus to see different perspectives will be, an effective approach that develops the conceptual knowledge. In fact, this result is in line with the studies of Kulm (1994) and Vistro (1991).

## References

- Baltacı, S., Yıldız, A., & Kösa, T. (2015). The potential of GeoGebra dynamic mathematics software in teaching analytic geometry: The opinion of pre-service mathematics teachers. *Turkish Journal of Computer and Mathematics Education*, 6 (3), 483-505.
- Byrnes, J. P., & Wasik, B. A. (1991). Role of conceptual knowledge in mathematical procedural learning. *Developmental Psychology*, 27 (5), 777-786.
- Che Ghazali, N. H., & Zakaria, E. (2011). Students' procedural and conceptual understanding of mathematics. *Australian Journal of Basic and Applied Sciences*, 5 (7), 684-691.
- Chou, C. Y., & Lin, P. H. (2015). Promoting discussion in peer instruction: Discussion partner assignment and accountability scoring mechanisms. *British Journal of Educational Technology*, 46(4), 839-847.
- Cortright, R. N., Collins, H. L., & DiCarlo, S. E. (2005). Peer instruction enhanced meaningful learning: Ability to solve novel problems. *Advances in Physiology Education*, 29 (2), 107-111.
- Gorghiu, G., Puana, N., & Gorghiu L. M. (2009). Solving geometrical locus problems using dynamic interactive geometry applications. *Research, Reflections and Innovations in Integrating ICT in Education*, 2, 681-1231.
- Kulm, G. (1994). *Mathematics assessment: What works in the classroom*. San Francisco: Jossey-Bass.

- Lester, F. K. (1994). Musing about mathematical problem solving researchs: 1970-1994. *Journal for Research in Mathematics Education*, 25 (6), 660-675.
- Low, R., & Over, R. (1989). Detection of missing and irrelevant information within algebraic story problems. *British Journal of Educational Psychology*, 59 (3), 296-305.
- Mazur, E. (1997). *Peer instruction: A user's manual*. Upper Saddle River: Prentice Hall.
- Özyıldırım Gümüş F., & Umay, A. (2018). Problem çözümüne kavramsal / işlemsel yaklaşım ölçeğinin geliştirilmesi [Developing a scale about conceptual / procedural approach towards problem-solving]. *Abant İzzet Baysal University Journal of Faculty of Education*, 18 (1), 375-391.
- Silver, E. A. (1986). *Using conceptual and procedural knowledge: A focus on relationships*. In J. Hiebert (Ed.), *Conceptual and procedural knowledge: The case of mathematics* (pp. 181-198). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Soylu, Y., & Aydın, S. (2006). Matematik derslerinde kavramsal ve işlemsel öğrenmenin dengelenmesinin önemi üzerine bir çalışma [A study on importance of the conceptual and operational knowledge are balanced in mathematics lessons]. *Erzincan University Journal of Education Faculty*, 8 (2), 83-95.
- Vistro, C. P. (1991). *Preservice elementary teachers' conceptual and procedural knowledge of perimeter, area, volume, and surface area*. Unpublished Doctoral Thesis, University of Georgia, ABD.