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THE EFFECT OF PROBLEM POSING ON PROBLEM SOLVING IN INTRODUCTORY PHYSICS COURSE

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Abstract

In this study, it was aimed to determine the effects of the problem posing instruction on the students' physics problem solving performances. The research was conducted in 2009-2010 academic year in introductory physics course. University freshman students were enrolled the study. The pretest and posttest research model with control group was used in the study. The research was performed on two groups, which are the control and the experimental groups. During the research, problem posing instruction was applied to the experimental group, whereas in the control group, traditional instruction was applied. The research data was collected by using Classical Physics Test, which was prepared to determine the problem solving performance of the students. The test results were evaluated by using a Problem Solving Rubric. The data was analyzed by SPPP.10.0 and it was found that the effect of problem posing instruction on the problem solving performance of the students was in a positive way and at a significant level.

TEMELFİZİK DERSİNDE PROBLEM TASARIMININ PROBLEM ÇÖZMEYE ETKİSİ

Özetçe

Bu çalışmada, problem tasarlayarak yapılan öğretimin, öğrencilerin fizik problemlerini çözme performanslarına etkisinin belirlenmesi amaçlanmıştır. Araştırma 2009-2010 eğitim ve öğretim yılında temel fizik dersinde üniversite birinci sınıf öğrencileriyle gerçekleştirilmiştir. Çalışmada öntest,-sontest kontrol gruplu deneme modeli kullanılmıştır. Araştırma kapsamında deney ve kontrol grupları oluşturulmuş, deney grubunda problem tasarlayarak yapılan öğretim yöntemi kullanılırken, kontrol grubunda geleneksel öğretim yöntemi kullanılmıştır. Araştırma verileri, öğrencilerin problem çözme performanslarını belirlemek amacıyla kullanılan Klasik Fizik Sınavı'ndan elde edilmiştir. Klasik Fizik Sınavı sonuçları Problem Çözme Rubriği kullanılarak değerlendirilmiş ve SPSS 10 paket programıyla analiz edilmiştir. Araştırma sonucunda, problem tasarlayarak yapılan öğretimin öğrencilerin problem çözme performanslarını istatiksel olarak anlamlı bir şekilde etkilediği belirlenmiştir.

Keywords: Physics Education, Problem Posing, Problem Solving
Anahtar Kelimeler: Fizik Eğitim, Problem Tasarlama, Problem Çözme

1. INTRODUCTION

The goal of physics instructors is to develop the students' conceptual learning and their problem solving performances in physics. Students should be able to apply physics concept in to the problem solving. Instructors are responsible to develop students' problem solving performances. Experienced instructors recognize that in spite of their best efforts, many students emerge from their study of physics with serious gaps in their understanding of important topics. In the last two decades, physicists have begun to approach this problem from a scientific perspective by conducting detailed systematic studies on the learning and teaching of physics. These investigations have included a wide variety of populations, ranging from high school physics to university introductory physics courses [1].

In recent years, researchers and educators have begun to incorporate problem posing into teaching and learning activities. In the literature review, it is seen that especially mathematics educators pay more attention to the problem posing [2,3,4,5,6]. Problem posing involves the creation of a new problem from a given situation or experience and can take place before, during and after solving a problem [7]. There is a close relation between problem solving and problem posing. On the other hand, problem posing takes students beyond the parameters of the solution processes [8]. Recognizing the importance of problem posing as an integral part of the mathematics curriculum, the National Council of Teachers of Mathematics (NCTM, 1991) urges teachers to provide opportunities for students to formulate their own problems [9].

Problem posing may be considered as an instructional strategy or a goal itself, and allows students to formulate problems, using their own language, vocabulary, grammar, sentence structure, context, and syntax for the problem situation [10,11]. Researchers examined problem-posing abilities ranging from elementary school students to prospective teachers [12,13,14]. Although the course of physics is quite appropriate for problem posing activities, there is little research on problem posing in physics. Problem posing is a powerful assessment tool for probing students' understanding of the physics concept, as well as their ability to transfer their knowledge to novel contexts [15]. So, physics teachers can improve their students' physics knowledge, problem solving performance and conceptual learning by incorporating problem posing activities into their classrooms.

Problem posing activities in the classroom improve students' problem-solving abilities, reinforce and enrich basic concepts, foster more diverse and flexible thinking and alert both teacher and children to misunderstandings and preconceptions [2,11]. Although various aspects of problem posing have been examined, far less attention has been paid for the assessment of problem posing which was studied by a few researchers [3,12,16]. Educators have recently paid more attention to problem posing; therefore they have incorporated it into classroom instruction. Various aspects of problem posing were researched, such as the relation between problem posing and problem solving, effectiveness of problem posing task, strategies used to pose problems etc. When the literatures were scanned, No study was found on physics problem posing in Turkey. There are only a limited number of studies devoted to problem posing in mathematics. So this study is significant for physics education.

2. METHODOLOGY

2.1. Research Design and Participants

In this research, a quasi-experimental design with a pre-test and post-test was implemented. The participants of the study were 110 university freshman students who enrolled the study in introductory physics course during the 2009-2010 academic year.

The research was carried out on two groups, which were experimental and control groups. In experimental group, problem-posing instruction was applied, whereas in the control group traditional instruction was applied.

2.2. Collection and Analysis of the Data

Research data was collected by Classical Physics Test that consists of five classical physics problems, prepared by the researcher. The test results were evaluated by a problem-solving rubric, which was developed by a researcher [17]. The data were analyzed by using SPPP statistical program. Independent samples of t-test were used for comparing the problem solving performances of both groups.

2.3. Procedure

The study was performed during the fall semester in the introductory physics course covering kinematics and dynamics in the experimental and the control groups. There were 56 students in the experimental group and there were 54 students in the control group. During the research, problem-posing instruction was used with the experimental group and traditional instruction was used with the control group over a period of 10 weeks.

The details of the procedure were given as follows.

1. The Classical Physics test was given to the both groups as a pre-test in order to determine the initial problem solving performances of the students in the first lecture.

2. Before teaching of planned chapters, the students included in experimental group were informed about problem posing instruction, benefits of problem posing activities and results of the research related to problem posing instruction in the world. Besides, the students included in the control group were informed about traditional instruction and problems of the students related with physics lecture. Also they were informed about how they would study to be successful in physics.

3. The following lecture, the main concepts were given to the students about the motion in one dimension. The researcher mentioned about, velocity, acceleration, displacement, speed etc. in a traditional way in both groups. During the research period, the theoretical parts of the lecture were given to the both groups at the same way.

4. After theoretical teaching, two different procedures were applied to the experimental group and the control group. In the experimental group, a problem was written and solved on the blackboard. Solution of the problem was discussed in the class with students. All students participated to the discussion. Then researcher asked students to add extra questions to the problem. This is the beginning of problem posing instruction. The students were requested a few questions to add to the problem. Questions were related to the problem that was solved on the board. Meanwhile, in the control group, problems from the textbook were solved on the board by the researcher and the students. It was focused on the similar problems in both groups.

5. For the following lectures, in experimental group, participants were given the opportunity to pose their own problems in a given task through the instructional treatment. Participants were asked to generate problems from the given tasks. The quality of problems in which students generated depends on the given task [12]. Three different tasks were given to students during problem posing activities. They posed problems in the classroom during instructional treatment and also they posed problems as a homework assignment. Participants had no prior problem posing experience but they were aware of the well feature of well posed problems, because they had solved many problems during their academic life. Researchers read and explained the directions of the problem posing tasks to the participants. It was explained that they could scan all the problems on their textbook to get experience about the kind of problems related with their topic, but they were not allowed to take any problem without change. They were forced to pose their own problems.

First task: “Pose a problem which is related with physics topic that you have studied in the classroom”.

Second task: “Pose a problem from a given problem by using re-formulation strategy”.

Third task: “Pose a problem from a given set of information or a problem statement”.

Firstly, participants posed problems related with the first task and then they posed problems by using re-formulation strategy related with the second task, lastly they posed problems from given set of information or problem statement related with the third task. For the first task, they had no experience on problem posing and also they hadn’t got any information about problem posing strategies. They posed problems freely. The researchers wanted to determine, problem posing capacity of the students and properties of the problem posing products by the help of first task.

After the first task, participants were given information about the problem posing strategies related with the second and the third tasks. The researchers posed some problems as guiding examples. They helped and guided the students how to pose physics problems. Then students applied what they had learned by posing a problem. For the second task; "What if not" problem posing strategy was used which was developed by Brown and Walter (1983). In this strategy, students pose new problems from a previously solved problem using a process of extending the original problem, changing the context of the original problem, switching the given and wanted information, changing the given, and changing the wanted and varying the conditions, numbers or goals of the original problem.

Finally, the students posed problems from a given set of information or problem statement.

Researchers gave problem-posing tasks as a homework assignment to the students who attended the experimental group. Also, problem-solving tasks were given to the students who attended the control group.

3. RESULTS

The Classical physics test was applied both experimental and control group as a pre test and post test in order to observe the effect of problem posing instruction on problem solving performance of the students. Arithmetic mean of pre test and standard deviation of the scale were calculated. t-test was performed to check the meaningful difference between the average of the groups and the results are shown on Table-1

Table 1. The Classical Physics Test Pre-Scores of Experimental and Control Groups

Groups	**N**	**x**	**SD**	***df***	**t**	**p**
Experimental	56	23,43	14,01	108	.223	.824
Control	54	22,80	15,73			

As it can be seen from Table 1, according to pre-test scores, there is no meaningful difference between experimental and control groups regarding their problem solving performances. At the beginning of the research, problem-solving performance of both groups was found the same [$t_{(108)} = 0.223$; $p > 0.05$].

Problem solving performance of the students in the experimental and control groups was determined after the research to compare the effects of the problem posing instruction. Therefore, the arithmetic mean of the post-scores and standard deviation of the Classical Physics Test were calculated and t-test was applied to check the difference between the averages of the groups if it was meaningful or not. Results can be seen on Table 2.

Table 2. The Classical Physics Test Post-Scores of Experimental and Control Groups

Groups	N	x	SD	*df*	t	p
Experimental	56	70,80	14,64	108	4,256	.000
Control	54	56,26	20,78			

Table 2 shows that there is a significant difference between the experimental and control groups regarding their problem solving performances in favor of experimental group at the end of instruction.

4. CONCLUSION

Over the past two decades, researchers have been studying problems of physics education in order to make our physics classes work effectively. One of the main problem in physics education is students' having difficulty in problem solving. Many instructors generally believe that problem solving leads to understanding of physics but students don't know how to apply the mathematical skills they have to particular problem situation in physics.

In this study we focused on problem posing instruction in physics course. Problem generation is the process of posing a problem based on a set of information. Generated problems may include additional information to the original set but must be related to the original set of information. Earlier researches show that there is a strong relationship between problem posing instruction and problem solving performance of the students [2,15].

Problem posing allows students to formulate problems, using their own language, vocabulary, grammar, sentence structure, context and the syntax for the problem situation. Students were asked to write and solve their own original physics problems and then share the results in group interactions with their peers. Problem posing allows students to view physics from the perspective of a physician while they are engaged in problem posing activities. According to Silver (1994), problem posing provides a potentially rich area to develop mathematical thinking .

In this research, it was determined that problem posing instruction was effective on the problem solving performances of the students. This result of the research was supported by the other studies carried out in the past [2,15]. Problem posing instruction developed the problem solving performance of the students in the experimental group.

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