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The effects of problem-based learning on the students' success in physics course

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Abstract

The aim of this study was to investigate the effects of the problem-based learning (PBL) on the students' success in physics course. 44 second year undergraduate students were randomly assigned to experimental group (20 students) in which problem-based learning was used, and control (24 students) in which conventional teaching method was used. The data were obtained through physics exam which is developed by researchers. At the end of the study ıt was determined that there was a statistically significant difference between two groups in terms of students total mean scores in favour of PBL group and PBL is affective on students' physics achievement.

Keywords: problem-based learning; physics achievement; teacher candidates

1. Introduction

Physics is a science researching the reasons for the events in nature, and investigating what kinds of laws and principles they depend on [1]. It provides humanbeings with opportunity of understanding the world they live in, and estimating the unknowns. Thus, inventions are found out, and by this way, new technologies are allowed to arise. Together with the improved technology in recent years, necessity to use physics in daily life and business life has been gradually increasing day by day. Therefore physics education has become an extremely important subject. In the knowledge era we live in, the most fundamental purpose of modern science/physics education is to educate individuals who can research, investigate and establish correlation between their daily lives and science subjects, use scientific methods to solve the problems encountered, andhave an attitude towards life from the point of view of a scientist [2]. It is revealed in many researches done [3, 4, 5, 6, 7, 8, 9, 10,11] that *"Problem Based Learning (PBL)"* which is fundamentally based on the theory of constructivism, is a quite effective method in helping students gain all of these skills. According to constructivism, learning occurs by construction of knowledge in the mind of the learner [12]. The most important thing in this process is the previous knowledge and experiences of the individuals. If the new information is consistent with their prior knowledge, it can be assimilated easily. But, such prior knowledge may be incorrect, and can adversely affect subsequent learning [13]. And the problem based learning is one of the most important applications to apply the theory of constructivism in classroom environment since it is based on learning new information by using the prior knowledge and skills, and eliminating the existing mislearnings by means of individual and group work. It is a method improving active learning, problem solving skill, field information, and based on understanding and problem solving. [14, 15]. This method presents the

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students with the complex event(s), and wants them to define the problem, hypothesize, and reach valid solution by testing these hypotheses by survey [16]. In PBL, instruction is executed based on independent learning, practical studies and problem solving sessions performed under the supervision of an education director especially in small groups [17]. In this process, problems are given to students by means of scenarios. It is extremely important that the scenario should be prepared realistically, contain hints to help to achieve the intended learning targets, not contain unnecessary information, cover factors which increase curiosity and motivation, and be written in plain language [18]. It should include as many drawings, pictures, and comics as possible. In PBL, teachers are named as education directors, and do the cognitive guidance and counselling duty during the process by selecting problems from daily life, asking various directory questions, and canalizing the students to struggle with themselves [5].

Nowadays, PBL became a method which has miscellaneous benefits such as determining the problems, investigating the causes of them, hypothesizing about these causes, testing these hypotheses, gaining information, determining the learning targets, developing problem solving skill, and using these gained informations in each stage of life [219]. Moreover, PBL has a wide range of benefits such as being student-centered; helping to students to develop miscellaneous points of view; performing deep, active and meaningful learning; and developing problem solving, researching, creative and critical thinking skills [15].

The aim of the present research performed in the light of this information is to investigate the effects of the problem-based learning on the teacher candidates' physics achievements. It is thought that it is necessary to do more research on PBL subject, especially in physics education. By means of this study it is intended to eliminate the deficiencies in the field literature.

2. Method

2.1. Purpose of the Research

The purpose of the research was to investigate the effects of the problem-based learning on the teacher candidates' success in physics course.

2.2. Sub-Problem

Does problem-based learning make any significant difference in the teacher candidates' physics achievements?

2.3. Limitations

This study is restricted to 44 second grade students enrolled at Dokuz Eylül University, Mathematics Education Department. The Unit of "Current and Resistance" is chosen for the research, and the duration is limited up to four weeks.

2.4. Participants

Participants of the research consist of 44 teacher candidates from Mathematics Education Department at Dokuz Eylül University, Buca Education Faculty. These teacher candidates were randomly assigned to experimental group (20 students) in which problem-based learning was used, and control (24 students) in which conventional teaching method was used.

2.5. Measurement Tool

In this research, "The Physics Exam" (PE) which was developed by the researchers to determine the teacher candidates' physics course achievements related to the Unit of "Current and Resistance" was used. The exam consists of 5 structured problems and 1 open-ended question totally. 5 structured problems existing within PE were evaluated by the developed "Problem Solving Grading Scale (PSGS)". PSGS was arranged in 3 dimensions (understanding the problem, planning for the solution, and solving) each of which contains their own sub-

dimensions. The dimension of "understanding the problem" was encoded as 0 point if the given and asked information of the problem was not written, and 1 point if they were written by wrong unit conversions, and 2 points if they were written by correct unit conversions. For the dimension of "planning for the solution", it was determined as 0 point if the fundamental equations necessary for the problem were not written, and 1 point if they were written incompletely or wrongly, and 2 points if they were written correctly. Finally, the dimension of "solving" was encoded as 0 point if no mathematical operations were performed, and 1 point if the numeric data was placed wrongly in the equations, and 2 points if they were placed correctly, but final result could not be achieved, or made an error in the mathematical operations, and 3 points if the correct result was found completely. Accordingly, the minimum score which can be taken by a student from a structured problem is determined as 0, and the maximum one is determined as 7. Responses to the open-ended question were classified as no response (0 points), incorrect (1 points), partially correct (2 points) and correct (3 points). Each of the answers was evaluated by researchers. Scores were compared and discussed until an agreement was reached.

In order to calculate the reliability; PEs of 63 students were encoded by the researchers two times every one month. And the Pearson Correlation Coefficient, "r" which displays the consistency among the obtained scores was found as 0.86.

2.6. Developed Materials

In order to apply PBL method during the research, in the direction of learning targets determined related to the Unit of "Current and Resistance", a scenario consisting of three sessions, and a work sheet consisting of four structured problems from application and analysis levels were developed. At this stage, some experts were consulted with.

3. Experimental Design

In this research, pre-test post-test design with nonequivalent control group was used. The study was done on two groups, one of which is the experimental (PBL group), and the other is the control group. Moreover, 20 teacher candidates from PBL group were randomly assigned to two groups consisting of 7 students and one group consisting of 6 students according to their physics course achievements. While in the control group, lectures were given by traditional instructional method, in the experimental group, problem-based learning method was used. One week before starting to the research, PE was applied on both groups, and a sample scenario application was performed by giving detailed information to the teacher candidates about the description of PBL method, what can be expected from the sessions during the application, and how the sessions will go on.

In 1st PBL session, the scenario was presented as written, and PBL group was made to understand the problem and organize their thinkings. Then, the teacher candidates were asked to discuss the problem and make suggestions (develop hypotheses) about the solution by means of brain storming technique. Meanwhile, the education director prevented them from straying from the point by wandering among the groups, and asking guiding questions when necessary. At the end of the session, the parts which teacher candidates could not understand or wanted to take more information about were determined, and noted as bulleted on the "*What should I learn*?" section of the scenario, and they were asked to come to the second session to be performed after one week.

The second session started with the presentation of new information learned as a result of individual work, previous hypotheses were reviewed, and the solution of the problem existing in the scenario and the learning targets were tried to be achieved by means of discussion. After the education director ensured that all of the questions noted on "*What should I learn*?" section were answered, a 20- minute break was taken in the session.

In the first 20 minutes of the third session, work sheets were delivered to PBL groups, and they were asked to solve the structured physics problems related to the unit. In last 30 minutes, these problems were solved by the teacher candidates on the board by the help of the education director.

4. Findings

One week before starting the research, PE was applied on both groups, and no significant difference was found between the two groups ($p>.05$).

In order to investigate the effects of the problem based learning on the teacher candidates' physics course achievements, Independent-Samples t Test was performed among the arithmetical averages of the scores of PE applied on both group again at the end of the experimental study (Table 1).

Table1. Mean PE Scores of PBL and Control Groups

	PBL Group (N=20)		Control Group (N=24)		t	p
	M	SD	M	SD		
Exam (PE)	78.85	11.25	61. 45	17.61	3.81	0.00*

*p<.05

It is determined at the end of t test that PE scores of the teacher candidates from the experimental group were statistically significantly higher than the PE scores of the teacher candidates from the control group: $t(42)=3.81$, $p<.05$.

5. Conclusion

This research has been performed to determine the effects of PBL on teacher candidates' physics course achievements.

As a result of the research, it was determined that there was a statistically significant difference between two groups in terms of teacher candidates' total mean scores in favour of PBL group and PBL was effective on students' physics achievements. When the studies existing in the literature are examined, it is seen that similar results are reached by different researchers also [20, 21]. According to this, it can be said that PBL is more effective than the traditional instruction method in increasing teacher candidates' physics course achievements. And it is thought that this is due to PBL's being student centered, helping to construct the information, and performing the meaningful learning.

However, this research is limited with data collected from 44 teacher candidates who are from Mathematics Education. The studies including data collected from higher number of teacher candidates will be important in terms of generalizability of findings.

Generally PBL is accepted as the most effective instructional method in increasing researching and group working skills in the literature [22]. And it is thought that the use of PBL method more frequently during teacher training process will also enable these teacher candidates to educate students who have high team-working and researching skills.

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