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A study on the evaluation of problem posing skills in terms of academic success

Sema Çıldır [a*], Nazan Sezen[b]

[a] *Education Faculty, Hacettepe University, Beytepe, Ankara 06830,Turkey*
[b] *Education Faculty, Hacettepe University, Beytepe, Ankara 06830,Turkey*

Abstract

The aim of this study is to examine problem posing skills of prospective teachers in terms of their academic success. To this end, 9 prospective physics teachers, who are sophomores, from the Department of Physics Teaching were included within the study taking into consideration their GPAs. These prospective teachers were grouped under three titles, namely, low, medium and high. When the total points of these prospective teachers related to problem posing skills were examined, it was seen that those who have high GPAs have higher problem posing skills than those with medium or lower GPAs, however, no significant difference was observed between those with medium or lower GPAs in terms of their problem solving skills.

Keywords: Problem posing; prospective physics teacher; academic accomplishment;

1. Introduction

Problem solving is one of the frequently used methods in exams in order to clarify a topic or to determine student's success. Problem posing, on the other hand, is a comprehensive process that includes problem solving. It has been concluded in many of the studies that just like problem solving, problem posing is among the factors that affect success (Korkmaz & Gür, 2006; Demir, 2005; Soylu & Soylu, 2006). These two concepts are closely related. Because in problem solving the student is confronted with a complex situation or event, or the student feels the responsibility of the situation or the event, those with insufficient problem solving skills cannot succeed in problem posing (Gür and Korkmaz, 2003) because problem posing enables them to understand mathematical situations, to interpret the concepts given in the problems, and to verbalize symbols (Soylu and Soylu, 2006). While Kilpatrick (1987) contends that problem posing is an important component of problem solving, Silver (as cited in Silver & Cai, 1996) defines problem posing as reformulating a given problem and generalizing it into new problems.

As is known, instructors use different teaching techniques. While applying these techniques, the instructor frequently refers to problem solving method to get students attention onto a specific point. He can either bring already posed questions from different sources or he can pose new problems appropriate for the class. Each class or student may have different needs or deficiencies related to the topic. Thus, it would be helpful to pose new problems that are appropriate to the class and the topic during the problem solving process. As such, it would be possible to analyze students' misconceptions, their prejudices, and their deficiencies related to the content in a shorter time and better way. There are certain qualities one should possess in order to be successful during the problem solving process. Problem solving primarily requires experience and proficiency so that the teacher can recognize the negative conditions such as the prejudices, misconceptions, and operational skills deficiencies. It is highly crucial

*Sema Çıldır. Tel.: +90-312-2978601; fax: +90-312-2978600
E-mail address:sselman@hacettepe.edu.tr

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that prospective teachers are provided with problem posing skills before they start their professional lives. Moreover, while acquiring problem posing skills, prospective teachers should also have an idea on what qualities a good problem has. Marton (1955, as cited in Albayrak et al, 2006) lists these qualities as follows:

i) Reality: the question should be appropriate for student's level and daily life
ii) Interest: it should motivate student's curiosity
iii) Language: it should be appropriate for students verbally and in writing
iv) Use of basic skills: the ability to use obtained knowledge.

In literature, problem posing has often been associated with mathematical success and thinking. Nicolaou and Philippou (2004) emphasize that there is a strong relationship between problem posing and mathematical success, and they point out that there is a dramatic difference between 5th grade and 6th grade students in terms of their problem posing skills. Akay et al (2006) have researched the effect of using short and open-ended questions as well as the problem posing approach in comprehending mathematical concepts and learning, and they conclude that problem posing skills give the students the ability to properly express mathematical situations verbally and in writing, and that problem posing skills teach them mathematical reasoning. Silver and Cai (1996) suggest that problem posing is interesting for several reasons. These are:

- its relation to creativity and extraordinary mathematical skills
- it develops students' problem solving skills
- it is a window that opens to students' comprehension of mathematics
- it develops students' aptitude in mathematics and
- it is helpful in making students autonomous individuals.

In addition to these, in their study, Lavy and Bershadsky (2002) state that problem posing activities include an approach that teaches students how to think critically and how to examine their world analytically, thus, according to them, the importance of critical thinking in learning is revealed in problem posing activities.

Problem posing and solving can appear in all areas of life. Analyzing the event correctly and to be able to reach the solution is a process that we face in the solution of any type of problem. In arraying prospective teachers with this skill, the content of field courses is of crucial importance. The content should include activities related to problem posing, and prospective teachers should be given the opportunity to pose questions on their own.

In this study, the aim is to examine the problem posing skills of prospective physics teachers according to their GPA. To this end, prospective physics teachers were given study sheets in which there were several problem posing scenarios, and the obtained results were interpreted keeping in mind their GPAs.

2. Methodology

This is a descriptive study which aims to determine the problem posing skills of prospective teachers and to expose whether this skill shows differences according to their academic performance.

2.1. Study Group

The study was conducted with the participation of 9 sophomores from the department of Physics Teaching. These students were divided into three groups according to their academic success, namely, high, middle, and low. Students with GPAs lower than 2.00 were put in the low group, those with GPAs between 2.00-3.00 were put in the medium group, and those with GPA are higher than 3.00 were put in the high group. According to this, each group consists of an equal number of students, thus in each group, there are 3 students with similar academic success.

2.2. Data Gathering Tool

Within the scope of the study, prospective teachers were given study sheets which consisted of several problem posing activities and which was comprised of scenario-type questions, all of which were developed by the researchers. The topics of the problems in the problem posing activities were determined according to the class levels of prospective teachers.

In the study sheets, there are 2 questions related to free problem posing situation, 4 questions related to semi-constructed problem posing situation (here, there is one question for each sub-title, namely, Mathematical Situations, Open-Ended Problem Posing Situation, Problem Posing via Enactment, and Problem Posing Situation

with Missing Data), and 2 questions related to constructed problem posing situation, thus prospective teachers were given a total of 8 questions.

In order to determine whether the questions in the measuring tool were appropriate for the purpose, an instructor of mathematics and two physics instructors were consulted to, thus, it was warranted that the questions are valid in terms of language, level, and content.

2.3. Data Analysis

The problems posed by the students in relation to the items in the study sheets were evaluated in accordance with the criteria determined by the researchers. Each question was 10 points. In this grading, the sub-criteria that were taken into consideration were determined as appropriateness to the problem situation, appropriateness to the field, solvability of the problem, scientific accuracy, and language appropriateness. As such, the total points for Free Problem Solving Situation were 20 (10x2), for Semi-Constructed Problem Solving Situation were 40 (10x4), and for Constructed Problem Solving Situation were 20 (10x2) points.

3. Findings

The problems posed by the prospective teachers for each of the situations were evaluated according to the criteria mentioned above. Below are some examples for the situations given to the prospective teachers and the problems they posed for these situations?

Free Problem Posing Situation: You want to put the book which lies on your table to your library but by using minimum energy. Pose a problem related to this situation.

Semi-Constructed Problem Posing Situation: You have recently graduated from university and started working as a physics teacher at a high school. You realized that your students have difficulty in comprehending relative velocity because they cannot relate it to daily life. Pose a problem related to the daily applications of this topic.

Constructed Problem Posing Situation: Pose a problem related to finding the acceleration of an object which moves with F force on a frictional plane providing the necessary numerical values. Pose new problems for the increase of mass or for non-frictional planes.

One of the problems prospective teachers posed for the same situation was given below as an example.

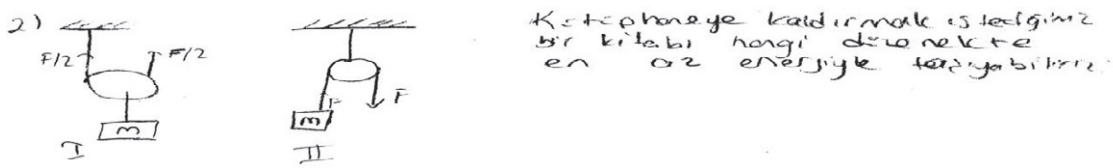

Figure1: The answer of the prospective teacher in the High Level group for the free problem posing situation.

(Student posed above problem: Which mechanism enables you to carry the book you want to put on the library shelf with minimum energy?)

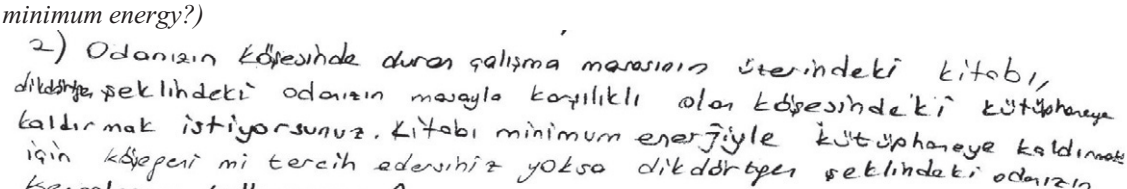

Figure 2: The answer of the prospective teacher in the Medium Level group for the free problem posing situation.

(Student posed above problem: You would like to carry the book lying on the study desk which is at the corner of your room to the library shelf which is at the opposing corner of your room which is rectangular. In order to carry the book with minimum energy, would you use the lines or the corners of your rectangular room?)

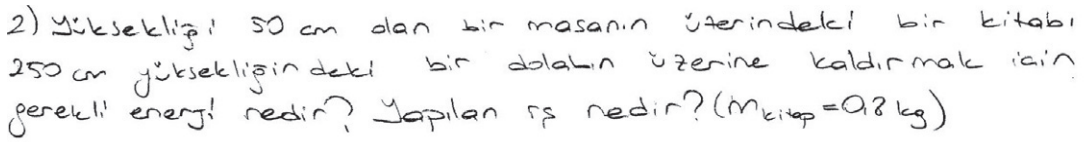

Figure 3: The answer of the prospective teacher in the Low Level group for the free problem posing situation.

(Student posed above problem: What is the required energy to carry a book lying on a table which has a height of 50 cm to the wardrobe with a height of 250 cm? What is the act done? (mass of the book 's 0.8 kg))

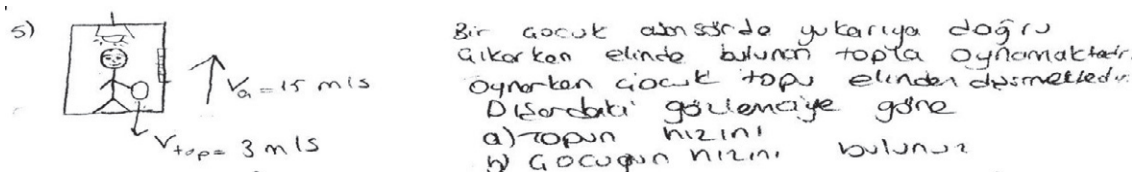

Figure 4: The answer of the prospective teacher in the High Level group for the semi-constructed problem posing situation.

(Student posed above problem: A child is playing with a ball while ascending in an elevator. The ball falls. According to an outside observer a) what is the velocity of the ball?, b) what is the velocity of the child?)

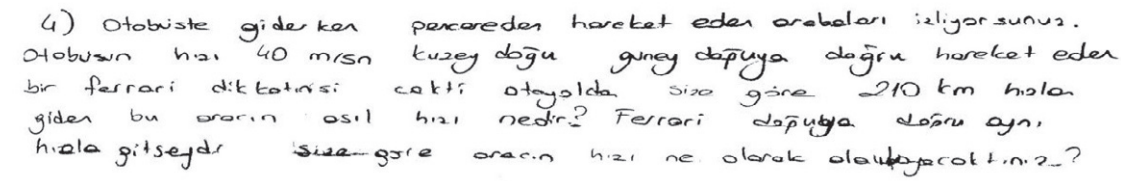

Figure 5: The answer of the prospective teacher in the Medium Level group for the semi-constructed problem posing situation.

(Student posed above problem: You are looking at the passing cars while riding the bus. The speed of the bus is 40 m/sn. You noticed a Ferrari which moves in the north-east to south-east. What is the real speed of this car which moves in 210 km according to you? How would you perceive the speed if the car moved in the east?)

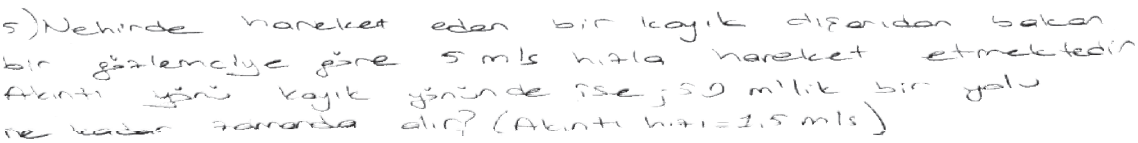

Figure 6: The answer of the prospective teacher in the Low Level group for the semi-constructed problem posing situation.

(Student posed above problem A boat moves in the river with the speed of 5 m/s according to an outside observer. If the current is in the direction of the boat, how long does it take the boat to travel a 50 m distance? (velocity of the current = 1,5 m/s))

Averages of the points for the problems posed by the students were given in the table below:

Table 1. Averages of the points for the problems posed by the students

Groups	Free Problem Solving Situation	Semi-constructed Problem Solving Situation	Constructed Problem Solving Situation
Low LevelGroup	7,66 / 20	7 / 40	9,00 / 20
Medium LevelGroup	8,33/20	8 / 40	10,00 / 20
High LevelGroup	11/ 20	16,6 / 40	15,00 / 20

4. Conclusion And Suggestions

In this study, problem posing skills of prospective physics teachers were examined according to the variant of academic success. The problems posed by the prospective physics teachers were evaluated under the headings determined by the researchers, and whether these skills show any difference according to their academic success was examined. Under the light of the obtained data, in the majority of prospective teachers, an increase was observed from their free problem posing points to constructed problem posing points.

When each case was taken into consideration within itself, it was seen that the points prospective teachers in the low and medium level groups took do not show much difference, however, we can say that this changes when we look at the high level group. The conspicuous result here is that although the total point of the high level group in free problem solving situation was higher, this difference is lower than the difference in other situations. In other words, it was concluded that there is very little relationship between free problem solving situation and academic success.

When the problems prospective teachers posed related to different situations were examined, it was seen that prospective teacher in the high level group frequently use graphics and several figures. Visualizing problems as such both makes them more comprehensible and it brings a new dimension to the classic conception of problems. Polya (1945) states that visualizing a problem by drawing figures and diagrams increases the success in solving problems. When the close relationship between problem posing and solving are taken into consideration, use of such visual expressions should be taken into consideration in the education of students, and it should be emphasized.

The fact that prospective students in the low and medium level group predominantly made use of verbal four arithmetical operations and the fact that they depended on the problem types given in books proved that they failed to come up with the required mathematical thinking and reasoning skills. Thus, it is possible to say that the lack of providing such skills can affect academic success in a negative way. It is also noticeable that prospective teachers in these groups did not use creativity when posing problems. To solve this, an in-class activity in which each of the strategies can be used during a course where problem posing approach is applied can be arranged. Students can be given the opportunity to use their own perspectives to pose problems related to the semi-constructed situations created through the scenarios related to daily life or scenarios that include mathematical components. Thus, they would be able to pose new problems by determining the situations they face and by coming up with questions.

Giving prospective teachers problem posing activities during classes would both make them active participants in class and enable them to think more analytically. Moreover, problem posing is an activity that requires mastery in the subject as well as an ability to draw relationships between situations. Thus, it is inevitable that prospective teachers with this skill will be more in command in their fields.

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