



SKILL LEVELS OF PROSPECTIVE PHYSICS TEACHERS ON PROBLEM POSING

FİZİK ÖĞRETMEN ADAYLARININ PROBLEM KURMA BECERİ DÜZEYLERİ

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ABSTRACT: Problem posing is one of the topics which the educators thoroughly accentuate. Problem posing skill is defined as an introvert activity of a student's learning. In this study, skill levels of prospective physics teachers on problem posing were determined and their views on problem posing were evaluated. To this end, prospective teachers were given 10 different activities on free problem posing, semi-constructed problem posing, and constructed problem posing; and they were asked to pose problems relating to these activities. At the end of the problem posing activities, it was seen that prospective teachers were more efficient in constructed problem posing, and that they were comparatively less competent in free problem posing. In addition to this, it was determined that the prospective teachers usually posed same kind of problems. According to the interviews, it was determined that prospective teachers consider problem posing as a more difficult task than problem solving. Moreover, it was reached some conclusions such as students think problem posing can be improved and this ability has an important role in their professional life.

Keywords: problem solving skill, problem posing skill, prospective teacher

ÖZET: Problem kurma, eğitimcilerin üzerinde dikkatle durduğu konular arasındadır. Bu çalışmada fizik öğretmen adaylarının problem kurma beceri düzeylerinin belirlenmesi ve problem kurma hakkındaki görüşlerinin değerlendirilmesi yapılmıştır. Bu amaçla öğretmen adaylarına serbest problem kurma, yarı-yapılandırılmış problem kurma ve yapılandırılmış problem kurma durumlarına yönelik 10 farklı etkinlik verilmiş ve bu etkinliklere yönelik problem kurmaları istenilmiştir. Problem kurma etkinliklerinin sonrasında öğretmen adaylarıyla odak grup görüşmeleri yapılarak problem kurmaya yönelik görüşleri alınmıştır. Çalışmanın sonunda öğretmen adaylarının yapılandırılmış problem kurma durumlarında daha etkin oldukları, serbest problem kurma durumlarında ise diğer durumlara nazaran daha yetersiz oldukları tespit edilmiştir. Buna ek olarak, öğretmen adaylarının, genellikle aynı tür problemler kurdukları belirlenmiştir. Yapılan görüşmelerde ise öğretmen adaylarının problem kurmayı, problem çözmeye göre daha zor bir etkinlik olarak algıladıkları belirlenmiştir. Ayrıca öğretmen adaylarının problem kurmayı geliştirilebilir bir beceri olarak gördükleri ve bu becerinin mesleki yaşamlarında önemli bir role sahip olacağını düşündükleri sonucu ortaya çıkmıştır.

Anahtar Sözcükler: problem çözme becerisi, problem kurma becerisi, öğretmen aday

1. INTRODUCTION

Just like in many sub-branches of science education, in mathematics education, too, different teaching methods and techniques have started to be used in order to increase the quality of education. While some of these methods have been improved by studies on their effectiveness, some of them have not been used due to the fact that they are not appropriate for the field. In the curriculum, among the main objectives of mathematics education, problem solving and problem posing skills are undoubtedly one of the most effective methods.

Problem posing or constructing consists of creating new problems or questions to be explored or examined about a given situation. At the same time, it consists of the reformulation of the problem during the process of problem solving (Akay, 2006). Silver (1994) stated that problem posing as a mathematical activity is applied in three different ways. These are: (a) Before solving the problem, (b) During solving the problem, and (c) After solving the problem. These stages comprise different activities. In (a), problems that are different and original than the existing problem are created. In (b), there is reformulating or

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recreating the problem. In (c), there is a construction of new situations by changing the aims and circumstances of the existing problem in order to create new problems (Silver and Cai, 1996).

Starting off with these definitions, we conclude that problem posing is an extensive process which also includes problem solving. During the problem posing process, both the student as the applier and the teacher as the guide have very important responsibilities. That the teacher should accommodate the environment for such activities and give students the necessary foreknowledge is among the main responsibilities. Silver (1994) states that problem posing is interesting due to the following facts:

- It is related to creativity and extraordinary mathematical skill
- It improves students' problem solving skills.
- It is a window for students to understand mathematics
- It is a way for students to improve their mathematical understanding
- It is a helpful way for students to become autonomous learners.

Problem posing process in mathematics classes begins with tracking students' problem solving and helping them through this process (Brown & Walter, 1983, as cited in Lavy & Shriki, 2007).

Problem posing and solving constitutes a great of all mathematical and scientific research (Ada & Kurtuluş, 2009). Xia et al (2008) contends that problem posing is an important component of the mathematics curriculum while Silver (1994) defines problem posing as reformulating a problem and generalizing it for new problems. Problem posing is not limited to making generalizations for new problems with given problems or only to given mathematical situations. There is a closed correlation between problem posing and problem solving as a cognitive process (Lowrie, 2002). Problem posing is usually associated with the "looking back" step which is one of the four steps Polya proposed for problem solving. This step is known as the most important one of Polya's problem solving steps (Silver et al, 1996).

Problem posing, for teachers, can be regarded as a window that opens to the thinking styles of students. By this way, teachers can pay attention to students' cognitive processes, and can detect students' misconceptions at a more early stage (Akay & Boz, 2010). Nixon-Ponder (2001) defines problem posing as a concept that contains more than just analytical thinking, they define it as a philosophy. According to this, problem posing is a way of thinking analytically and thinking on the ability of students to reflect their lives analytically, and it is an inductive questioning process which shapes and organizes class dialogue. Moreover, problem solving is dynamic, participatory, and it gives freedom and authority. In other words, problem posing activities include an approach of teaching students how to think analytically and how to analytically examine the world they live (Akay & Boz, 2010).

The studies of problem posing were made on the physics courses too. Mestre (2002) has asked to pose mechanics problems to high-performing university students which have finished an introductory physics course. His findings indicate that, when followed by an interview, problem posing is a powerful assessment tool for probing students' understanding of physics concepts, as well as their ability to transfer their knowledge to novel contexts. In the other study, a problem posing orientation teacher education course has been developed at Utrecht University for physics students. For that purpose, an inventory study of the 1995 orientation physics course was carried. At the end of this study, five motives have been found, the most important being the desire to learn whether being a secondary school teacher will suit them, with job prospects and acquiring presentation skills being important motives as well. These results offer a basis for the development of a preliminary 'didactical structure' for the course (Van der Valk, 1996). Nguyen et al. (2010), they developed problem sets for each major topic in introductory mechanics in their study.

Researchers and educators have been including problem posing into mathematics teaching and learning more and more. Leung and Silver (1997) argue that prospective primary education teachers have problem posing skills but that they have deficiencies in certain mathematical constructions. In his study on prospective teachers, Philippou (2001) contends that prospective teachers who have high expectations can pose more complex problems compared to those who have low expectations, and that all participants consider problem posing as a more difficult activity than problem solving. In his study, Leung (1993) comes to the conclusion that students who have advanced mathematical knowledge can manipulate problems whose solution structures are related. Similarly, in their studies, Krutetskii (1976) and Ellerton (1986) conclude that students with advanced mathematical skills are more advanced in problem posing.

It is possible to handle problems in different ways. Stoyanova and Ellerton (1996, as cited in Yuan & Sriraman, 2010) classify problems as free, semi-constructed and constructed. In this study, as it was in Akay's (2006) study, we can determine problem situations that are presented to the students as shown in the Figure 1.

Free Problem Posing Situation: If students are asked to create a problem out of a given artificial or natural situation, this is a free problem posing situation (Yuan & Sriraman, 2010). In free situations, students pose questions without any restrictions. An example of a free problem posing situation can be students' writing problems for their friends or students' being encouraged to pose problems for mathematics Olympics (Pittalis et al., 2004). Students are encouraged to "pose an easy or a difficult question," "prepare a question that is appropriate for mathematics contests or tests," or "to pose a problem of their choice." If the teacher relates the topics that are taught with daily situations and asks students to pose new problems out of these, it is more effective (Akay, 2006).

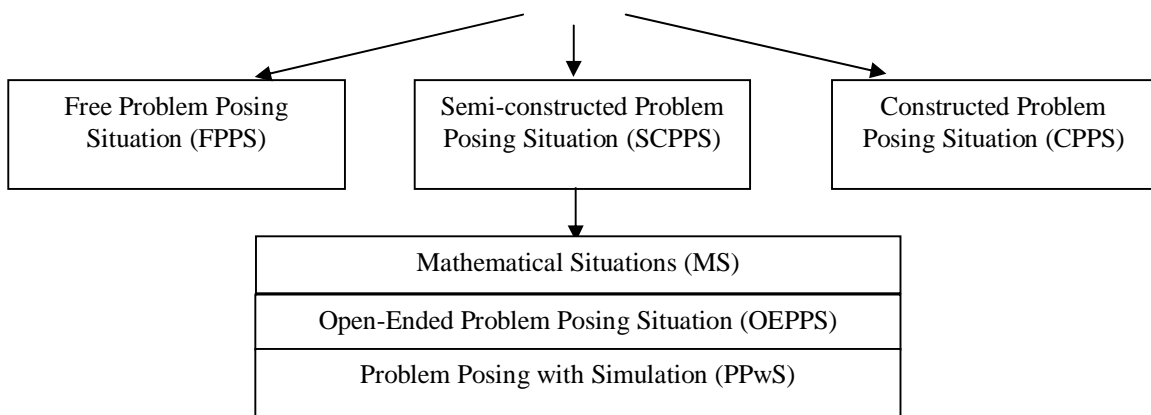


Figure 1: Scheme of Problem Posing Situations

Semi-constructed problem posing situation: In this case, students use their prior mathematical experience to explain and complete a situation and the structure of this situation (Yuan & Sriraman, 2010). In semi-constructed problem posing situation, students are asked to pose problems that include certain pictures or graphics, or problems similar to given ones (Pittalis et al, 2004). Students are given an open-ended situation and they are asked to examine a situation by using concepts and their knowledge, skills, prior experience. Problem situations consist of these following: open-ended problems (mathematical researches), problems similar to given ones, similar problems, problems related to very special theories, problems deduced out of given pictures, and verbal problems (Akay, 2006). Dickerson (1999, as cited in Akay, 2006) deal with semi-constructed problems under three titles:

- a) *Mathematical situations:* Mathematical situations are rich environments in which concepts and components are given but the main component is missing. Mathematical situations are an important strategy in preparing problem posing activities. In mathematical situations, expectations may be explained along with aims and objectives but usually there is no explanation on the real root of the problem in the information provided.
- b) *Open-ended problem posing situation:* In order to solve a problem with this approach, we start with a scenario that has a story which includes an incomplete problem. Students are expected to complete the scenario through brainstorming. Examining the scenario, students add certain details and curiosity raising questions to the scenario.
- c) *Problem posing with simulation:* In this approach, students are directed towards problem solving through simulating real-life themes or through concretization.

Constructed problem posing situation: In constructed problem posing, the activities deal with a certain problem (Yuan & Sriraman, 2010). In cases of constructed problem posing, students pose questions either by reformulating already solved problems or by changing the circumstances of the given questions (Pittalis et al, 2004). Any problem consists of known data (there is a need for givens and an

unknown). The teacher can pose a new question by changing the given, or he can change the needed by keeping the given data constant.

When the studies made in the field of mathematics education are taken into consideration, it is seen that there are new movements in relation to teaching as well as certain changes in the teaching curriculum (Akay, 2006). The approach of problem posing dates back to the studies of Dewey and Piaget who strongly support research and an active education in which student-centered programs are effective (Shor, 1992, as cited in Nixon-Ponder, 2001). In this approach, the aim is to give students the role of an active participant. In this case, training prospective teachers so that they have this ability gains importance. Prospective teachers are expected to undertake this role and moreover, they are expected to enable their students to have it as well. This study aims to determine the problem posing skills of prospective physics teachers and to evaluate the results so that there will be a contribution to literature.

1.1. Problem Situation

In this study, the aim was to determine the problem posing skill levels of prospective teachers and to evaluate their views on problem posing. To this end, problem solving situations which were prepared under different sub-headings were presented to the students, and the students were asked to realize these activities. At the end of this application, the answers to the following questions were sought for:

1. What is the level of free problem posing skills of prospective physics teachers?
2. What is the level of semi-constructed problem posing skills of prospective physics teachers?
 - 2.a. What is the level of problem posing skills of prospective physics teachers related to mathematical situations?
 - 2.b. What is the level of skills of prospective physics teachers related to open-ended problem posing?
 - 2.c. What is the level of problem posing skills of prospective physics teachers related to problem posing with simulation?
3. What is the level of constructed problem posing skills of prospective physics teachers?
4. What are the views of prospective physics teachers about problem posing?

2. METHODOLOGY

2.1. Participants

The study was performed with the participation of 12 students from the Department of Physics Education. Since a measurement of the knowledge level or a comparison through various variants was not aimed, the participants were chosen from those who were willing to participate.

2.2. Data Gathering

Within the context of the study, prospective teachers were given study sheets which consist of scenario-type problem situations and various problem posing activities designs by the researchers. In the work sheets, there were 2 item related to free problem posing situation, 6 item related to semi-constructed problem posing situation (2 items for each sub-heading), and 2 item for constructed problem posing, and in total 10 items presented to the prospective teachers. In order to check if the problem situations in the work sheets are appropriate to the aim, the views of mathematics and two physics experts were consulted; thus, the reliability of the problem posing situations' language, level, content and context was realized. The situations in these activities were prepared in accordance with the headings in Figure 1. Some examples to the problems posed by students were given as follows:

An example to free problem posing situation: *“Pose a problem that calculates the moment constant of a spring by using a weight hanging on the spring. Expand the same question by asking for the system period of different weights of the hanged object.”*

An example to semi-constructed problem posing situation: *“You suddenly see an object while driving on a rainy day. In this case, pose a problem that states how early you should pull the brakes to prevent hitting the object according to your speed and stopping distance, and discuss if there is a crash according to your problem.”* (Open-ended problem posing situation)

“You want to determine the resistance of a conductor in an electric lab experiment. Pose a problem that includes the methods you can use for this. Do you think each method gives you the same result? Discuss.” (Problem Posing Situation with Simulation)

“Pose a river problem appropriate for the Figure 2” (Mathematical Situations)

An example to constructed problem posing situation: “Since the kinetic energy of an automobile is equal to the heat occurring in the brakes, pose different problems in order to find the calories cars of different weight and speed would spend. Can you make a generalization for the weight-speed and calories spent?”

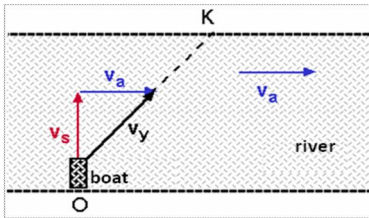


Figure 2: Figure for Posing a River Problem

In addition to work sheets, focus group meetings were done with prospective teachers after the application, and the prospective teachers were asked if they thought whether problem posing or problem solving were easier, if they thought whether problem posing skills could be improved, if so in which ways they could be improved, and they were asked about the role of problem posing skills on teaching.

2.3. Data Analysis

The descriptive analyze technique was used for analyze data. Data on the work sheets were quantified so as to only attain knowledge (without comparison). In this study, was derived benefit from interview and observation to support the findings, which are obtained at the end of analysis of work sheets and to increase the reliability and validity of study. The data, which were obtained by using different methods such as observation, interview and analysis of document is used for support each other. In this way, the reliability and validity of findings are increased (Yıldırım & Şimşek, 2006: p. 267).

The problems posed by students in accordance with the items in the work sheets were evaluated by the criteria determined by the researchers. These criteria were gathered under the titles of Appropriateness to Problem Situation (2 Point), Solvability of the Posed Problems (2 point), Scientific Correctness (4 point), and Language Appropriateness (2 point). According to this, free problem posing situation and constructed problem posing situation were given 20 points each (10x2), and semi-constructed problem posing situation was given 60 points (10x6). It was thought that if the prospective teachers posed a meaningless or impossible to solve problem, or if they used out-of-field problems or statements, they would not be able to succeed in the given situation, so, these parts were given zero points. The scoring was presented to the field experts, and necessary arrangements were made. In addition to the scoring, during the evaluation of the problems posed by prospective teachers, too, field experts were consulted so that the validity of the study could be proven. An example to the evaluation of the problems posed by prospective teachers is given below:

Problem Situation: *You think that your electricity bill is too high. Pose a problem with which you can control if your counter works properly.*

Posed Problem: *In the experiment you did, it was seen that when a properly working counter turns 10 a minute, it spends 100 W/h energy. The television in your house spends 20 W/h energy in a minute. When no other electrical device works, when the television works for an hour, the same counter makes 125 turns. Can we say that this counter works properly?*

Evaluation: The power spent is expressed in kWh in home counters. In this problem, it is given W/h, and there is a failure in expression because of “per minute 20 W/h”. For this reason, the point of scientific correctness is 2 point. The problem posed by the prospective teacher was examined by the researchers, and it was seen that the solvability of problem was negatively affected from these scientific mistakes (1 point). When the scientific mistakes were disregarded, it was calculated that the counter should make 120 turns, and when the data in the problem was taken into consideration (i.e. the counter

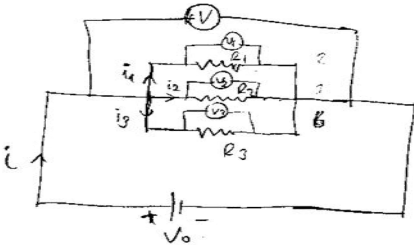
makes 125 turns), it was concluded that the counter was not working properly and hence the high electricity bill (appropriateness to problem situation: 2 points). In terms of field and language appropriateness, the prospective teacher got 2 points and he got a total of 7 points.

The interviews with prospective teachers were video-recorded, then they were thoroughly examined after the application, and they were written down. When the findings are present, was quoted verbatim from opinions of participants. In the descriptive analyze, direct quotations are often used so as to reflect the opinions of observed or interviewed participants (Yıldırım& Şimşek, 2006: p. 224).

3. FINDINGS AND INTERPRETATION

3.1. Findings on the Problem Posing Cases of Prospective Teachers

The problems posed by prospective teachers on each situation were evaluated according to the evaluation criteria above. Below is given some examples of the problems posed by prospective teachers:

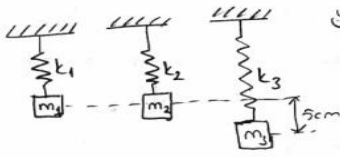


Devrede V_1 voltmetroasının gösürdür değeri $6V$, I_1 değeri $3A$. R_2 değeri 3Ω olduğuna göre I_2 değerinin $6A$ olması için R_3 değeri kaç ohm olmalıdır? (Bos tel ve Voltmetrelerin direnci 0 dir)

(Problem: In this circuit, voltmeter V_1 shows $6V$, I_1 is $3A$, and R_2 is 3Ω . What should be the value of R_3 for $I=6A$? (The resistance of wire and voltmeter is zero.))

2-) Elinde bir su ısıtıcısı var ve bu su ısıtıcısı 1000 Watt'lık bir güçte sahip. Her gün elektrikli aletlerden sadece su ısıtıcısını 1 saat kullandığına düşünün. Ay sonunda elektrik faturanızda toplam kullanım $= 3000$ kW/h ise sayacınız doğru çalışıyor mu?

(Problem: You have a water heater which its power is 100 Watt. You consider that every day, you use only water heater from other devices during one hour. At the end of the month, the total power consumption is 3000 kW/h in your bill. Does your counter works correctly?)



Yanda üç farklı yaya üç farklı cisim asılmıştır. m_1 kütlesi $10g$, m_2 ve m_3 kütlesi $20g$ 'dir. m_1 ve m_2 kütlesinin ağırlığı olduğu yayların uzama miktarı aynı, m_3 kütlesinin ağırlığı olduğu yayda uzama miktarı diğerlerinden $5cm$ fazladır. Buna göre k_1 , k_2 , k_3 kuvvet sabitlerini bulun. Eğer her bir kütleye $-y$ yönünde $5N$ kuvvet uygularsak oluşan salınımın periyodu bulun.

(Problem: In Figure, there are three different springs with three different body. m_1 is 10 gr. m_2 and m_3 are 20 gr. The springs with m_1 and m_2 bodies have same extensions. The extension of spring

with m3 body is much 5 cm from other springs. Accordingly, find the constants k_1 , k_2 , and k_3 . When you apply a force which is 5 N in $-y$ direction to each spring, find the number of periods in oscillation.)

Figure 3: Examples of Problems Posed by Prospective Teachers

The points and the average of prospective teachers after the evaluation of the problems posed by them for the given situations are as Table 1.

Table 1: Points Taken by Prospective Teachers for the Problem Situations

	FP		SCPPS						CP	
	PS		MS		OE		PP		PS	
	1	2	1	2	1	2	1	2	1	2
S ub- average	.5 /10	.75/ 10	.75/ 10	.5 /10	.5 /10	.0 /10	.0 /10	.5 /10	.5 /10	.0 /10
A verage	3.1 25		5.208						8.25	

When the average of prospective teachers are taken into consideration, the average of free problem solving situation is 3.125, the average of semi-constructed problem solving situation is 5.208 and the average of constructed problem solving situation is 8.25.

3.2. Findings on the Views of Prospective Teachers on Problem Posing

Firstly, the main categories were determined to make interviews with prospective teachers and after this stage were determined sub-questions to each category. At this determination, it was aimed to learn the opinions of prospective teachers about their experiences and their impressions during the problem posing. Findings and the answers given by prospective teachers on their views on problem posing are as follows:(R: Researcher, P: Prospective Teacher)

3.2.1. The Opinions on Problem Posing

According to the findings on interviews, %83 of prospective teachers has used problems they have seen before. 66 % of them argued “problem posing is not merely preparing questions”. All of them argued “problem posing skills can be improved”. Lastly, when the students were asked “How should be pose a good problem?” % 33of the answers was “the posed problems must keep the students away from rotting”, 50 % of answers was “question should not be off-topic.” 16 % of answers consisted of different opinions.

R: Have you ever made use of the problem types you have encountered before when posing a problem?

P2: Yes, unavoidably, you tend to pose questions based on what you already know.

P11: I think we do this subconsciously. Even before we started our university education have we been solving questions of the same kind.

P12: I have. Actually, because I was afraid of making a mistake or of not being able to come up with a good problem, I have used problems I have seen before.

R: Do you think problem posing is merely preparing questions? Or can it be generalized into different situations?

P1: I also think that it does not have to be in the question form. Any situation that a student cannot solve is a problem. Thus, a problem can be posed by using examples from daily life as well.

P7: There must be a problem that could be appropriate for any given situation. It is necessary to make them appropriate for students.

R: Do you think problem posing skills can be improved? If so, what ways do you suggest doing this?

P10: I think it can be improved. In order to do this, we must be in command of the other topics we are going to use within the topic.

P4: I also think that it can be improved. We may need to be knowledgeable on the question types by solving as many questions as possible. How a question is prepared, what we should pay attention to ... such knowledge would be helpful.

R: What should be taken into consideration when posing a problem?

P7: You should not be off-topic when preparing a question.

P2: the question should be original but preparing an original question requires skill. Just like a good footballer or basketball player ...

P9: The problems we pose must keep the student away from rotting

3.2.2. The Opinions on Problem Posing and Problem Solving

At the literature, the relations between the problem posing and problem solving were mentioned by a lot of studies (Silver& Cai, 1996; Christou et al., 2005). In this category, when the students compared the difficulties of the problem posing with problem solving, was determined that %58 of students argued "problem posing is more difficult". %33 of students argued "problem solving is more difficult. %8 of students argued "both of them are difficult".

R: Which do you think is more difficult, problem posing or problem solving?

P3: I think problem solving is better; problem posing is more difficult because ... there is a result in problem solving. When I see that I solve a problem, succeeding in something makes me happy. However, problem posing is not to my benefit, it is to another's. I would be taking a risk when preparing that ...

P7: I think problem posing is more difficult. When solving a problem, you immediately remember what it is about and on what topic, we only think of what the question demands. We have to think more comprehensively when posing a question.

P4: I think when posing a problem, you only think about what is needed for that problem. But when solving a problem, you have to know every subject that can be related to it, that's why problem solving is more difficult and it takes more time ...

P9: I mean, I agree with my friends, you have to have a good command of the topic, but when solving a problem, we only deal with the, say, equations. When we solve a problem, we even have the chance to try the answers but there is no such thing with problem posing.

P6: I think both of them are difficult. In any case, you have to be a good problem solver in order to be a good problem poser ...

3.2.3. The Opinions on Problem Posing in Professional Life

In this category, the opinions of the students about the important of problem posing in professional were taken into consideration. Accordingly, %66 of students emphasized the importance of problem posing their professional life. % 33 of students explained that field knowledge and formation are more important.

R: What do you think is the importance of problem posing skills in teaching?

P11: In teaching, ready-made questions can be used; when elucidating situations within a topic it is very helpful but in a written exam, test technique is not really necessary. Problem posing is more important when we use it for elucidating a topic.

P5: I think topic knowledge is more important in teaching. We can evaluate students with tests; we do not have to pose problems.

P8: I think it is quite helpful for the students both in teaching and learning. Students can be thought easily the subjects by the virtue of problem posing because it makes to the subjects more understandable.

4. CONCLUSION AND SUGGESTIONS

When we look at the point averages of prospective teachers, it stands out that their highest average is in constructed problem posing situations. Then, we have semi-constructed problem posing situation, and the last one is free problem posing situations. Again, in the sub-steps of semi-constructed problem posing situations, the one with the highest point average is mathematical situations, and the one with the lowest point average is the problem posing situations with simulation. Moreover, when the problems posed by prospective teachers were taken into consideration, it was seen that almost all of them focused on similar problem types. Prospective teachers explained this situation with the fact that they were prone to problem types they have frequently encountered before.

Prospective teachers felt the need to add options to some of the problems they have posed without any steering by the researchers. This turned the problems into test question form. It is possible to see a similarity between this and the fact that prospective teachers support the idea of evaluating through testing. It is possible to see this as a result of a traditional understanding of education. One reason for this can be the class environments in which class participation is low, monotonous questions are emphasized, and in which only existing question are focused upon and creativity is hindered.

Another striking point about the problems posed is that some prospective teachers added a “Why?” question following the problem. When their views on this was asked, they said that they wanted to prevent students from doing operations without knowing and that students’ being able to explain the reasons behind their operations were more important for them in the evaluation process. Prospective teachers stated that especially problem posing situations with simulation were ones they were not really familiar with. This is a deficiency on part of prospective teachers if one takes into consideration that problem posing with simulation is an application that can both make students like physics classes and be used in this problem situation. In order to overcome this deficiency, necessary activities should be added to the physics curricula of faculties of education.

In the interview made after the application, participants stated that problem posing was a more difficult process than problem solving. A similar result can be found in Phillippou’s (2001) study. As a result, prospective teachers think that problem posing takes more time than problem solving, and that problem posing requires a more detailed knowledge and that there is a high risk of making mistakes. Moreover, in the interviews, it was seen that prospective teachers were afraid of making mistakes when posing problems and that they were influenced by the problem types they have frequently dealt before. These results may be the reasons why prospective teachers have shown low skills in free problem posing situation.

Problem solving is seen as a method to be used in improving their problem posing skills by prospective teachers. According to this, in order to create a class environment where problem posing skills can be improved, the teacher should embrace the role of a guide (as is the case with all student-centered approaches), and he should direct students towards mental activities such as problem posing.

By considering above results; it is proposed to create classroom environment for prospective teachers to present their mental activities and creativity while problem posing. Because of this, it is necessary to give the prospective teachers the role of an active participant. Although some prospective teachers think that problem posing is a gift, most of them think that it is a skill that can be improved. For this reason, in order for prospective teachers to have this skill in their prospective professional life,

problem posing activities in faculties of education should be increased and a great attention should be paid to training competent individuals in this subject.

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Genişletilmiş Özet

Matematiksel araştırmaların ve bilimsel araştırmaların en önemli kısmını problem kurma ve çözme aktiviteleri oluşturmaktadır (Ada& Kurtuluş, 2009). Xia vd. (2008), problem kurmanın matematik müfredatının önemli bir bileşeni olduğunu öne sürerken, Silver (1994) problem kurmayı verilen bir problemi yeniden formüle etmek ve yeni problemlere genellemek olarak tanımlamıştır. Problem kurma sadece verilen matematiksel durumlarla veya verilen problemlerden yeni problemlere genelleme yapmayla sınırlı değildir. Problem kurma ve problem çözme arasında bir bilişsel süreç olarak kapalı bir bağlantı vardır (Lowrie, 2002).

Problem kurma, öğretmenler açısından öğrencilerin düşünme stillerine açılan bir pencere olarak görülebilir. Bu yolla öğretmenler öğrencilerin bilişsel süreçlerine dikkat edebilecek ve kavram yanlışlarını daha erken bulabileceklerdir (Akay& Boz, 2010). Nixon -Ponder (2001), problem kurmayı eleştirel düşünmeyi öğreten bir teknikten daha fazlasını içeren bir kavram dahası bir felsefe olarak tanımlamışlardır.

Çalışma, Fizik Eğitimi Anabilim dalında öğrenim görmekte olan 12 öğrenciyle gerçekleştirilmiştir. Çalışma kapsamında bilgi düzeyi ölçülmesi veya çeşitli değişkenlere göre karşılaştırma yapılması amaçlanmadığı için öğrencilerin, çalışmaya katılmaya istekli öğrenciler olmasına özen gösterilmiştir.

Çalışma kapsamında öğretmen adaylarına, araştırmacılar tarafından geliştirilen çeşitli problem kurma etkinliklerinin yer aldığı ve senaryo tipi problem durumlarından oluşan çalışma kağıtları uygulanmıştır. Çalışma kağıtlarında, serbest problem kurma durumu ile ilgili 2, yarı- yapılandırılmış problem kurma durumu ile ilgili her alt başlıkta ikişer madde olacak şekilde 6 ve yapılandırılmış problem kurma durumu ile ilgili 2 madde olmak üzere toplam 10 problem durumu öğretmen adaylarına sunulmuştur. Çalışma kağıdında bulunan problem durumlarının amaca uygun olup olmadığının belirlenmesi amacıyla bir matematik eğitimcisi ve iki fizik eğitimcisinin görüşlerine başvurulmuş, bu sayede çalışma kağıdındaki problem kurma durumlarının dil, seviye, içerik ve kapsam geçerliği sağlanmıştır.

Verilerin çözümlenmesinde betimsel çözümlene tekniği kullanılmıştır. Çalışma kağıdındaki veriler, sayısallaştırılarak öğretmen adaylarının problem kurma düzeyleri hakkında bilgi edinmek amaçlanmıştır. Çalışma kağıtlarının incelenmesi sonucunda buradan elde edilen bulgulara destek sağlayabilmek ayrıca çalışmanın geçerlik ve güvenilirliğini artırabilmek amacıyla gözlem ve görüşme tekniklerinden faydalanılmıştır. Farklı yöntemlerle (gözlem, görüşme, doküman analizi gibi) elde edilen verilerin birbirlerini teyit amacıyla kullanılması, ulaşılan sonuçların geçerliğini ve güvenilirliğini artırır (Yıldırım& Şimşek, 2006: 267).

Öğrencilerin çalışma kağıtlarında yer alan maddelere yönelik kurdukları problemler, araştırmacılar tarafından belirlenen kriterlere göre değerlendirilmiştir. Bu kriterler Problem Durumuna Uygunluk, Kurulan Problemin Çözülebilirliği, Bilimsel Doğruluk ve Dil Uygunluğu başlıkları altında toplanmıştır.

Buna göre serbest problem kurma durumu ve yapılandırılmış problem kurma durumunun her biri 20 puan (10x2), yarı yapılandırılmış problem kurma durumu ise 60 puan (10x6) olarak puanlandırılmıştır. Eğer öğretmen adayları anlamsız veya çözülmesi imkansız olan bir problemi önerirlerse ya da alana yönelik olmayan problemler veya ifadeler kullanırlarsa belirtilen durumu başaramama olarak düşünülerek bu kısımlara sıfır puan verilmiştir. Yapılan puanlama, alan uzmanlarının görüşüne sunulmuş ve gerekli düzenlemelere gidilmiştir. Yapılan puanlamaların yanı sıra öğretmen adaylarının kurdukları problemlerin değerlendirilmesi sırasında yine uzman görüşüne başvurularak çalışmanın kapsam geçerliği için kanıt sağlamak amaçlanmıştır. Öğretmen adaylarının kurdukları problemlerin değerlendirilmesine bir örnek aşağıda verilmiştir:

Problem Durumu: *Elektrik faturanızın çok fazla geldiğini düşünüyorsunuz. Sayacınızın doğru çalışıp çalışmadığını kontrol edebileceğiniz bir problem kurunuz.*

Kurulan Problem: *Yaptığınız bir deneyle doğru çalışan bir elektrik sayacının dakikada 10 dönmesine karşılık 100 W/h enerji harcadığı görülmüştür. Sizin evinizdeki televizyon dakikada 20 W/h enerji harcıyor. Evde başka hiçbir elektrikli araç çalışmaksızın, televizyon bir saat çalıştığında, aynı sürede sayaç 125 tur atıyor. Buna sayaç doğru çalışıyor denilebilir mi?*

Değerlendirme: Evdeki sayaçlarda harcanan enerji kWh cinsinden ifade edilir. Problemde W/h olması ve “*dakikada 20 W/h*” ifadesinin anlam bozukluğu oluşturması nedeniyle bilimsel doğruluk puanı 2’dir. Öğretmen adayının kurduğu bu problemin çözümü araştırmacılar tarafından incelenmiş ve yapılan

bilimsel hataların problemin çözülebilirliğini olumsuz etkilediği görülmüştür (1 puan). Yapılan bilimsel hatalar göz ardı edildiğinde, sayacın 120 tur atması gerektiği hesaplanmış ve problemdeki verinin 125 tur olduğu göz önüne alındığında sayacın doğru çalışmadığı ve dolayısıyla faturanın yüksek gelmesinin nedeni olduğu sonucuna varılmıştır (problem durumuna uygunluk: 2 puan). Dil uygunluğu açısından ise öğretmen adayı 2 puan alarak toplam 7 puana ulaşmıştır.

Öğretmen adaylarıyla yapılan görüşmeler video kaydına alınıp uygulama sonrasında ayrıntılı bir şekilde incelenerek yazılı döküman haline getirilmiştir. Elde edilen bulgular sunulurken katılımcıların görüşlerinden doğrudan alıntılar yapılmıştır. Betimsel analizde, görüşülen ya da gözlenen bireylerin görüşlerini çarpıcı bir biçimde yansıtmak amacıyla doğrudan alıntılara sık yer verilir (Yıldırım& Şimşek, 2006: 224).

Sonuç olarak, öğretmen adaylarının aldıkları puan ortalamalarına bakıldığında, en yüksek ortalamaya yapılandırılmış problem kurma durumlarında sahip oldukları göze çarpmaktadır. Daha sonra yarı yapılandırılmış problem kurma ve en son sırada da serbest problem kurma durumları yer almaktadır. Yine yarı yapılandırılmış problem kurma durumu alt basamaklarında en yüksek ortalamaya matematiksel durumlar en düşük ortalamaya ise canlandırma ile problem kurma durumları sahiptir. Ayrıca, öğretmen adaylarının kurdukları problemlere bakıldığında hemen hemen tamamının benzer problem türleri üzerinde durdukları dikkat çekmektedir. Öğretmen adayları bu durumu, yapılan görüşmelerde daha önce sıkça karşılaştıkları problem tiplerine karşı daha yatkın olmaları ile açıklamışlardır.

Uygulama sonrasında öğretmen adaylarıyla yapılan görüşmelerde, adaylar problem kurmanın problem çözmekten çok daha zor bir süreç olduğunu belirtmişlerdir. Benzer bir sonuca Philippou (2001) in çalışmasında rastlamaktayız. Sonuç olarak öğretmen adayları, problem kurmanın çözmekten daha uzun sürdüğünü ve problem kurmanın daha detaylı konu bilgisi gerektirdiğini ve hata yapma riskinin yüksek olduğunu düşünmektedirler. Ayrıca görüşmelerde, öğretmen adaylarının, problem kurarken hata yapma korkusuna sahip oldukları ve daha önceden sıkça çözdükleri problem tiplerinden etkilendikleri yönünde sonuçlar ortaya çıkmıştır. Bu sonuçlar serbest problem kurma durumunda, öğretmen adaylarının düşük beceri göstermesinin sebepleri olabilir.

Problem çözme, öğretmen adayları tarafından problem kurma becerilerinin geliştirilmesinde kullanılabilecek bir yöntem olarak görülmektedir. Buna göre, öğrencilerin problem kurma becerilerini geliştirilebileceği bir sınıf ortamı oluşturmak için, öğretmenin diğer tüm “öğrenci merkezli” yaklaşımlarda olduğu üzere rehber görevini benimsemesi, öğrencileri bu tür zihinsel etkinliklere yönlendirmesi gerekmektedir.

Yukarıdaki sonuçlar düşünülerek, problem kurarken, öğrencinin kendi zihinsel faaliyetlerini ve yaratıcılığını ortaya koyabileceği sınıf ortamlarının yaratılması önerilmektedir. Bu nedenle öğretmen adaylarına sınıfta aktif katılımcı rolü verilmelidir. Öğretmen adaylarından bazıları problem kurmanın bir yetenek işi olduğunu düşünse de birçoğu geliştirilebilecek bir beceri olduğunu düşünmektedirler. Bu nedenle öğretmen adaylarının meslek hayatlarına bu beceriye sahip olarak atılabilmeleri için eğitim fakültelerinde problem çözme kadar problem kurma konusunda da öğrenci aktiviteleri artırılmalı ve bu konuda yetkin bireylerin yetiştirilmesine özen gösterilmelidir.