Prospective Science Teachers' Views about the Process of Preparing Problem Scenarios and Designing Experiments to Produce Solutions: An Action Research*

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Abstract

This study focuses on identifying the difficulties encountered and experiences gained by the prospective teachers as they worked in the process of preparing problem cases and designing experiments to solve those problems. It was planned to carry out this study as an action research in order to identify the views of prospective teachers regarding the preparation and application process of problem scenarios and the experiments designed to solve scenarios and the guidance of an academician. The study sampling is a total of 44 prospective teachers, who are in the 3rd grade in Science Education Department of Education Faculty in a state university in northwest Turkey and took the course of Science Education and Laboratory Applications-II in the spring semester of 2014-15 school years. Study data was collected by using a questionnaire to identify the views of prospective teachers regarding the preparation and application process of problem scenarios and the experiments designed to solve scenarios and a questionnaire to identify the views of prospective teachers regarding the guidance of an academician in the preparation and application process of problem scenarios and the experiments designed to solve scenarios. Prospective teachers' responses to open-ended questions were analysed by using content analysis technique from among qualitative analysis techniques. According to the results of this study, the prospective teachers had difficulties mostly in the areas of preparing original scenarios, designing original experiments for solutions and correlating scenario-gain-experiment-fiction; they thought that more attention should be paid to those subjects and they mainly had experiences in those areas during the process. In addition, another study result is that the use of PBL method at secondary school level depends on the suitability of gain-subject.

Keywords

Problem based learning, PBL, prospective teachers, science education

•Received 1 November 2017 •Revised 12 December 2017 •Accepted 27 December 2017

Introduction

The most important reason underlying the developments in the science and technology is without doubt scientific research. Educational institutions in modern societies are expected to raise individuals who are able to think scientifically, and research, investigate, produce knowledge and share the knowledge they produce. Also, teachers of modern societies must have enough knowledge and skills about scientific research, and a positive attitude towards scientific research (Korkmaz, Şahin, & Yeşil, 2011). The teachers are expected to develop classroom settings and create effective learning-teaching processes considering the scientific research results obtained in respect to changing programme (Ekiz, 2006). Classroom applications of active learning methods are needed both for raising students in conformity with required qualifications and for enabling teachers to create effective learning-teaching processes.

Problem Based Learning (PBL), which is an active learning method, is one the most suitable methods for use in equipping students with features such as developing hypothesis like a scientist, making research to test it, producing knowledge and sharing the produced knowledge in order to give students the skill to generate solution suggestions for daily life problems. If the teachers learn the preparation, application and evaluation process of this method in the best way, this will help them in creating an effective learning-teaching process and develop classroom settings.

PBL was started to be applied approximately half a century before in the education of medical students studying at the Case Western Reserve in the USA and at McMaster University in Canada (Uden & Beaumont, 2006). PBL originated from an inquiry about how to make the lectures in clinics more functional in order to ensure that the physicians are problem solving and lifelong learning people, and today it is applied in many domains including health sciences, physical sciences and social sciences. While the theoretical basis for PBL, which emphasizes that learning can begin with a doubt, a problem waiting to be solved or a riddle, goes over to the studies by John Dewey (McDonald, 2002), it systematically took its place in the curriculum in 1992 during the revision of some lectures in the medical education of the Delaware University (Duch, Groh & Allen, 2001).

We encounter the application of PBL in many areas including health sciences, sciences and social sciences, and in the sciences it has many applications in different levels from primary to higher education (Gallagher et al., 1995; Peterson & Treagust, 1998; Ram, 1999; Soderberg & Price, 2003; Tosun & Taskesenligil, 2013; Uden & Beaumont, 2006; Ward & Lee, 2004). Those studies looked into the effectiveness of PBL for different learning products.

According to Tosun & Yaşar (2015), studies made in sciences gained weight in one of every two studies on the basis of subject area among the studies made on PBL in science education in Turkey. In addition, it is reported that, in PBL applications made in science education, the focus is on the studies made with undergraduate students and secondary school students (Tosun & Yaşar, 2015). On the other hand, it is seen that, in a majority of studies made on PBL, sampling groups between the populations of 31-100 are preferred.

Moving from the idea of turning our schools into project and research centres to give a research culture to the students of our country, it is important to introduce our students to the daily life problems within the scope of science lesson. Another important topic is the education of teachers, who will apply such problem cases, in the preparation, application and evaluation stages of problem cases.

https://doi.org/10.12973/ijpce/81587
* This paper was previously presented at 1st International Academic Research Congress (INES-2016), Antalya, Turkey, 3-5 October 2016.

In PBL, the problems are different from the ordinary problems asked at the end of the lesson or during the class. Problem cases are formed with formulating intriguing cases from daily life situations within the scope of learning objectives. In PBL, the problems must have certain features as outlined by Duch (2001):

- Must be able to draw students' attention, and problem must motivate students to seek out a deeper understanding of concepts,
- Must be related to a daily life situation as much as possible,
- Must enable students to make judgments and decision based on information, logic and causes,
- Must be complex enough to require the collaboration of group members and must have more than one solution,
- Must be based on the information background of students,
- Must attract students in groups to discuss subjects,
- Must cover the lesson's gains,

Preparing problem cases is quite difficult, time consuming, and requires expertise. There is a need for problem cases which can be easily applied in learning settings, which are well organized and whose applicability is tested. Because it is a difficult situations for our teachers to try to prepare problem cases by using the theoretical knowledge that they read from sources they and evaluating the process with traditional and complementary evaluation techniques. As a result of this, PBL applications are mainly limited to the studies made with university level students or the studies focusing on the effectiveness of PBL made by teachers, who are graduate students, for different learning products. It is seen that the problem cases in those studies remain in the thesis of the researchers that want to complete their graduate education.

Considering that our teachers are far away from education studies, cannot benefit sufficiently from existing studies, do not make studies during teaching practices, and even have negative attitudes towards existing studies (Costa, Marques, & Kempa, 2000; Çepni & Küçük, 2003; De Jong, 2004; Ekiz, 2006; Greenwood & Maheadly, 2001), it is difficult to say that the problem cases in those theses can guide teachers. In a few PBL applications in secondary schools and high schools, the researchers are active in the process instead of teachers, and the teachers remain as passive listeners or non-attending teachers.

In this study, we tried to prepare problem cases within the scope of the gains included in the science education programme updated in 2013 for the secondary school students by prospective teachers under the guidance of an academician. For solving those problem cases, experiments are designed by using materials from daily life. This study focuses on identifying the difficulties encountered and experiences gained by the prospective teachers as they worked in the process of preparing problem cases and designing experiments to solve those problems.

Research Problems

1. What do the prospective teachers think regarding the preparation and application process of problem scenarios and the experiments designed to solve scenarios?
2. What do the prospective teachers think regarding guidance of an academician in the preparation and application process of problem scenarios and the experiments designed to solve scenarios?

Method

It was planned to carry out this study as an action research in order to identify the views of prospective teachers regarding the preparation and application process of problem scenarios and the experiments designed to solve scenarios and the guidance of an academician. Action research is different from the qualitative and quantitative research methods in terms of its basis theory, and is addressed within critical theory (Ekiz, 2003; Mills, 2007). The people affected by a situation have a typical characteristic to affect the situation. In action research, the researcher tries to solve the problem he faces in classroom in line with the action plan he prepares.

Sampling

The study sampling is a total of 44 prospective teachers, who are in the 3rd grade in Science Education Department of Education Faculty in a state university in northwest Turkey and took the course of Science Education and Laboratory Applications-II in the spring semester of 2014-15 school years. All prospective teachers that participated in the study were voluntaries. While determining the sample, we used convenience sampling technique from among non-random sampling techniques (Fraenkel & Wallen, 2006; p.99). For this purpose, we considered closeness of the participating prospective teachers to researchers and their suitability to study objective.

Data collection tools

Study data was collected by using a questionnaire to identify the views of prospective teachers regarding the preparation and application process of problem scenarios and the experiments designed to solve scenarios and a questionnaire to identify the views of prospective teachers regarding the guidance of an academician in the preparation and application process of problem scenarios and the experiments designed to solve scenarios. The questionnaire used to identify the views of prospective teachers regarding the preparation and application process of problem scenarios and the experiments designed to solve scenarios included eight open-ended questions. The questionnaire used to identify the views of prospective teachers regarding the guidance of an academician in the preparation and application process of problem scenarios and the experiments designed to solve scenarios included four open-ended questions. In line with study objective, expert views are used for the validation of the questionnaires prepared by the researcher.

Procedure

The study was made in the scope of the course of Science Education and Laboratory Applications-II. The course took four hours a week including two hours of theory and two hours of practice. The application continued for 14 weeks. In the first weeks, the prospective teachers received various seminars on the introduction to PBL. The seminars informed prospective teachers on topics such as: what is PBL? What are teachers' roles in PBL? What are students' roles in PBL? How are problems cases prepared in PBL? This process took approximately two weeks.

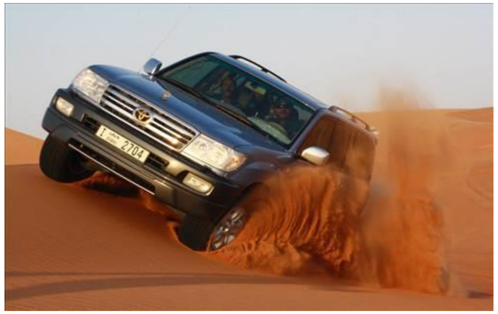
Prospective teachers worked in groups while preparing scenarios and designing experiments for solutions. The implementation was executed with participation of a total of 44 prospective teachers in 17 groups (groups of 2 and 3 people). The grouped prospective teachers tried to prepare problem scenarios within the framework of gains included in science education programme. The selection of gains was left to the will of prospective teachers. While selecting gains, the groups are recommended to pay attention to the possibility of formulating problem scenarios and designing experiments for solutions within the framework of the relevant gain. Each week, the academician gave feedback to the problem scenarios prepared by groups. The prospective teachers revised the problem cases in line with the feedback and tried to decide on the final version. This process took approximately five weeks.

After preparing problem cases, the prospective teachers were asked to design experiments to solve the problem cases they prepared. While designing experiments, they were asked to pay attention to ensure that the experiments require the use of materials, tools and supplies that are easily accessible by students, low-cost, easy to use and without any safety risk. In the experiment design stage, the prospective teachers were led to design experiments as original as possible. Reviews were made in relevant research sites for ideas while designing experiments. This process took approximately four weeks.

After problem cases were prepared within the framework of relevant gains and experiments are designed for solutions, the groups prepared presentations and posters to present the works in classroom. In the final three weeks, the groups presented the scenarios and experiments for solutions in classrooms. In some cases, the experiment presentations were made by directly making it in the classroom and in some cases, they were made in laboratory and its video was shown in the classroom. Below are the problem scenarios prepared and the experiment examples designed for solution in the scope of learning "Matter and Change" within the framework of the following gains:

> *5.3.4.1. Makes experiments regarding the fact that the materials expand and shrink with heat effect and discusses the results (Ministry of National Education (MNE)- Primary education institutions of science curriculum, 2013; p. 17).*
> *5.3.4.2. Realizes the relationship between expansion and shrinkage with examples from daily life (MNE- Primary education institutions of science curriculum, 2013; p. 17).*

Car Tire



Abdullah is the son of a merchant who lives in Cairo Egypt. Abdullah's father often travels to the cities beyond the desert for business. One day, he takes Abdullah with him because of the boy's insistence. His father tells him that the journey will take two days and warns him to take thick clothes with because in desert climate the nights are very cold and the days are very hot. Abdullah takes the necessary clothes and they start on the journey. Abdullah and his father arrive at the place they will stay after two days of desert journey. The air is getting dark. They have dinner and go to bed early because they will take the road before sunrise. When they wake up and go by their car, Abdullah realizes that the car tires are softened. He cannot make sense of this situation. He thinks that it will not prevent their journey and he does not tell his father about this. They continue their journey. After five hours of desert travel, Abdullah realizes that the tires are extremely hard. The tires were soft in the morning but now they are very hard. For the rest of the journey, Abdullah is confused about this situation. *What do you think is the reason for the softening and hardening of tires?*

Experiment Designed for Solution

Problem: Car tire

Tools and supplies for use: 2 glass bottles, 2 identical buckets, 2 balloons, water
Dependent variable: Inflation amount of the balloon
Independent variable: Water temperature in buckets
Controlled variable(s): Number of balloons, number of bottles, ambient pressure, amount of water in buckets, sinking volume of bottles, having identical buckets
Hypothesis: Temperature affects the expansion of the gas in the balloon.
Directions for conducting the experiment: Put a balloon to the caps of two bottles. Heat some water. Submerge one bottle in heated water and submerge the other one in cold water, then observe the outcome.

Figure 1: State of the balloon to the caps of two bottles

Data collection: Observation
Data analysis: The balloon expands with the effect of the heated water. The gas volume increases, and the balloon is inflated. The gases expand in volume. (**Figure 1** above).
Conclusion statement: Temperature and expansion have direct proportion.

Data analysis

Prospective teachers' responses to open-ended questions were analyzed by using content analysis technique from among qualitative analysis techniques. While making the content analysis, firstly codes were obtained, then categories were obtained from codes, and then themes were obtained from categories.

Results

The results related to prospective teachers' views regarding the preparation and application process of problem scenarios and the experiments designed to solve scenarios:

The first question asked to the participating prospective teachers in the scope of the study was: "*List the difficulties you faced while preparing the PBL scenarios and the experiments designed to solve scenarios in an order of importance from the most to the least difficult*". The data obtained from the views of prospective teachers were reviewed by making a content analysis, and a total of 207 codes were formed. Then, the distribution of those factors was categorized and examined, and the following categories were formed from those codes: Scenario (*f*=66), Experiment (*f*=42), Mixed (*f*=38), Other (*f*=19), Gain (*f*=16), Poster (*f*=12), Feedback/Evaluation (*f*=6), Presentation (*f*=5) and Report (*f*=3). **Table 1** shows the factors with frequency values higher than 5 (five) among the difficulties faced by prospective teachers in the preparation process of the PBL scenarios and the experiments designed to solve scenarios, based on the codes.

The difficulties faced by prospective teachers in preparing the PBL scenarios and the experiments designed for solutions by order of importance (based on the codes) are: Writing original scenarios (*f*=29), Designing experiments (*f*=29), Correlating scenario-gain (*f*=28), Scenario fiction (*f*=20), Selecting a gain (*f*=16), Preparing posters (*f*=12), Making experiments (*f*=8), Giving multiple gains in the same scenario (*f*=5) and Making research (*f*=5) (see **Table 1**,) When the distribution of the factors where prospective teachers faced difficulties most were categorized, the frequency distribution was as follows: Scenario:2, Experiment:2, Mixed:2, Gain:1, Poster:1 and Other:1.

Table 1. Difficulties faced in the preparation process of scenarios

Category	*Code*	*Frequency (f)*
Scenario	Writing original scenarios	29
Experiment	Designing experiments	29
Mixed	Correlating scenario-gain	28
Scenario	Scenario fiction	20
Gain	Selecting a gain	16
Poster	Preparing posters	12
Experiment	Making experiments	8
Mixed	Giving multiple gains in the same scenario	5
Other	Making research	5

These results indicate that in the preparation process of PBL scenarios and the experiments designed for solutions, the prospective teachers faced difficulties mostly in: Preparing scenarios, designing experiments for solutions and the mixed area, which is the process of correlating scenario-gain-experiment-fiction.

The second question that was asked to the prospective teachers in the scope of the study was: "In which cases it is proper to use PBL method instead of traditional learning methods in teaching science subjects at secondary education level? Explain the reason." The review of the prospective teachers' views about cases where it is proper to use PBL method at secondary education level resulted in 123 codes in total. The distribution of those factors was categorized, and the following categories were formed from those codes: Skill (*f*=45), Gain/Subject (*f*=41), Student (*f*=19), Other (*f*=10), Process (*f*=5) and Teacher (*f*=3). **Table 2** shows the factors with frequency values higher than 5 (five) among the views of prospective teachers regarding the cases where it is proper to use PBL method at secondary education level in codes.

Table 2. Cases where it is proper to use PBL method at secondary education level

Category	*Code*	*Frequency (f)*
Skill	Developing research skill	14
Student	Where active student/class participation is wanted	12
Gain/Subject	Curious/interesting/attracting/joyful cases	10
Gain/Subject	Suitable subject/gain	8
Skill	Ensuring permanent learning	7
Gain/Subject	Concretizing daily life events	6
Gain/Subject	Learning difficult and complex subject	5

The most important factors regarding the cases where it is proper to use PBL method at secondary education level according to the prospective teachers (in codes) are as follows respectively: Developing research skill (*f*=14), Where active student/class participation is wanted (*f*=12), Curious/interesting/attracting/joyful cases (*f*=10), Suitable subject/gain (*f*=8), Ensuring permanent learning (*f*=7), Concretizing daily life events (*f*=6) and Learning difficult and complex subject (*f*=5) (see **Table 2**).

The distribution of the factors repeated most regarding the cases where it is proper to use PBL method at secondary education level according to the prospective teachers was categorized and reviewed, and the frequency distribution is as follows: Gain/subject:4, Skill:2 and Student:1. These results show that the prospective teachers link the cases where it is most proper to use PBL method at secondary education level to the suitability of gain/subject.

The third question that was asked to the prospective teachers in the scope of the study was: "*As a prospective teacher, what kind of knowledge and skills do you expect the students will gain after applying the problems cases, which you tried to prepare according to the secondary school student level? Explain.*" The review of the prospective teachers' views about what kind of knowledge and skills the students will gain after applying the problem cases resulted in 135 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Cognitive level skills (*f*=81), Knowledge (*f*=30), Psychomotor level skills (*f*=10), Emotional level skills (*f*=9) and Mixed (*f*=5). **Table 3** shows the factors with frequency values higher than 5 (five) among the knowledge and skills that the prospective teachers think that the students will gain after applying the problems cases in codes.

Table 3. Knowledge and skills that will be gained after applying the problems cases

Category	*Code*	*Frequency (f)*
Cognitive level skills	Cognitive process skills (classification/ measuring/ observation/ prediction/ concluding/ to produce hypothesis/ make deduction/ data collecting/ synthesis/ explore/ producing solution/ data analysis/ animation)	36
Knowledge	Content knowledge	14
Cognitive level skills	Research skill	13
Cognitive level skills	Problem solving skills	11
Psychomotor level skills	Experiment performing skills	8
Knowledge	Permanent learning	7
Mixed	Scenario-theoretical knowledge-daily life relation	5

The most important factors regarding the knowledge and skills that the prospective teachers think that the students will gain after applying the PBL method in codes are as follows respectively: Cognitive process skills (*f*=36), Content knowledge (*f*=14), Research skill (*f*=13), Problem solving skills (*f*=11), Experiment performing skills (*f*=8), Permanent learning (*f*=7) and Scenario-theoretical knowledge-daily life relation (*f*=5) (see **Table 3**).

The distribution of the factors repeated most regarding the knowledge and skills that the students will gain after applying the PBL method was categorized and reviewed, and the frequency distribution is as follows: Cognitive level skills: 3, Knowledge: 2, Psychomotor level skills: 1 and Mixed:1. These results show that according to prospective teachers the secondary school students will gain cognitive level skills most after applying the PBL method.

The forth question that was asked to the prospective teachers in the scope of the study was: "*In which elements do you suggest the science teachers, who want to use PBL methods in their lectures, need to be careful about the preparation, application and evaluation phases of the PBL method*." The review of the prospective teachers' suggestions regarding the elements one needs to be careful about during the preparation, application and evaluation phases of the PBL method resulted in 130 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Mixed (*f*=37), Other (*f*=28), Evaluation (*f*=21), Scenario (*f*=18), Process (*f*=8), Gain/Subject (*f*=5), Guide (*f*=5), Clue (*f*=5) and Plan/Organization (*f*=3). **Table 4** shows the factors with frequency values higher than 5 (five) among the prospective teachers' suggestions regarding the elements one needs to be careful about during the preparation, application and evaluation phases of the PBL method in codes.

Table 4. The elements one needs to be careful about during the preparation, application and evaluation phases of the PBL method

Category	*Code*	*Frequency (f)*
Mixed	Gain-scenario-fiction relation	27
Mixed	Experiment-gain-scenario relation	9
Scenario	Problem's suitability to student level	6
Guide	Guidance	5
Process	Using curricular/extracurricular time effectively	5
Clue	Giving clues	5

The most important factors regarding the elements one needs to be careful about during the preparation, application and evaluation phases of the PBL method in codes are as follows respectively: Gain-scenario-fiction relation (*f*=27), Experiment-gain-scenario relation (*f*=9), Problem's suitability to student level (*f*=6), Guidance (*f*=5), Using curricular/extracurricular time effectively (*f*=5) and Giving clues (*f*=5) (see **Table 4**).

The distribution of the factors repeated most regarding the prospective teachers' views on the elements one needs to be careful about during the preparation, application and evaluation phases of the PBL method was categorized and reviewed, and the frequency distribution is as follows: Mixed: 2, Scenario: 1, Guide: 1, Process: 1 and Clue: 1. These results show that according to the prospective teachers' suggestions regarding the elements one needs to be careful about during the preparation, application and evaluation phases of the PBL method, the main suggestion is the mixed one, which is paying attention to correlate gain-scenario-fiction and experiment-gain-scenario.

The fifth question that was asked to the prospective teachers in the scope of the study was: "*List the difficulties you faced while designing experiments to solve PBL scenarios in an order of importance from the most to the least difficult*." The review of the prospective teachers' views regarding the difficulties they faced while designing experiments to solve PBL scenarios resulted in 164 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Mixed (*f*=55), Design + application + video (*f*=28), Supplying Materials (*f*=21), Suitability to student level (*f*=20), Other (*f*=20), Originality (*f*=15) and Evaluation (*f*=5). **Table 5** shows the factors with frequency values higher than 5 (five) among the prospective teachers' views regarding the difficulties they faced while designing experiments in codes.

Table 5. The difficulties faced while designing experiments

Category	*Code*	*Frequency (f)*
Design + application + video	Design + application + video	28
Mixed	Experiment-gain relation	27
Material	Supplying Materials	21
Suitability	Suitability to student level	20
Mixed	Experiment-scenario relation	19
Originality	Originality/striking/simple/understandable/ realistic/ net/ interesting	15

The most important factors regarding the prospective teachers' views on the difficulties they faced while designing experiments to solve PBL scenarios in codes are as follows respectively: Experiment design + application + video (*f*=28), Experiment-gain relation (*f*=27), Supplying materials (*f*=21), Suitability to student level (*f*=20), Experiment-scenario relation (*f*=19) and Originality of experiment (*f*=15) (see **Table 5**).

The distribution of the factors repeated most regarding the prospective teachers' views on the difficulties they faced while designing experiments was categorized and reviewed, and the frequency distribution is as follows: Mixed: 2, Design + Application + Video: 1, Material: 1, Suitability: 1 and Originality: 1. These results show that while designing experiments the prospective teachers faced difficulties most in the mixed one, which is correlating experiment-gain relation and experiment-scenario.

Another question that was asked to the prospective teachers in the scope of the study was: "*As a prospective teacher, what kind of experiences you had (what you gained) while preparing problem scenarios and designing experiments for solutions as a group?*" The review of the prospective teachers' views regarding their experience in this process resulted in 92 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Mixed (*f*=16), Scenario (*f*=14), Drawing conclusions/finding solutions (*f*=13), Skill (*f*=13), Experiment (*f*=11), Group (*f*=11), Research (*f*=6), Emotional (*f*=5) and Other (*f*=3). **Table 6** shows the factors with frequency values higher than 5 (five) among the prospective teachers' views regarding the experiences they gained in the process in codes.

The most important factors regarding the prospective teachers' views on the experiences they gained in the process in codes are as follows respectively: Writing an original/effective scenario (*f*=12), Group work (*f*=11), Designing an experiment from daily materials (*f*=8), Scenario-experiment relation (*f*=7), Learning different solution ways (*f*=7), Research skill (*f*=5) and Scenario-gain relation (*f*=5) (see **Table 6**).

Table 6. Experiences they gained

Category	*Code*	*Frequency (f)*
Scenario	Writing an original/effective scenario	12
Group	Group work	11
Experiment	Designing an experiment from daily materials	8
Mixed	Scenario-experiment relation	7
Drawing conclusions/ finding solutions	Learning different solution ways	7
Research	Research skill	5
Mixed	Scenario-gain relation	5

The distribution of the factors repeated most regarding the prospective teachers' views on the experiences they gained while preparing problem scenarios and designing experiments for solutions was categorized and reviewed, and the frequency distribution is as follows: Mixed: 2, Scenario: 1, Group: 1, Experiment: 1, Drawing conclusions/Finding solutions: 1 and Research:1. These results show that prospective teachers gained experience mostly in the mixed area, which is correlating scenario-experiment and correlating scenario-gain.

The seventh question that was asked to the prospective teachers in the scope of the study was: "*What kind of contributions do you think you will get from having actively participated in this process (the process of preparing problem scenarios and designing experiments for solving scenarios, which is one of the most important elements of the PBL method) while doing your job?*" The review of the prospective teachers' views regarding the contributions they will get from having actively participated in this process while doing their jobs resulted in 122 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Experiment (*f*=18), Other (*f*=17), Experience (*f*=13), Method (*f*=12), Finding solutions (*f*=11), Skill (*f*=9), Permanent learning (*f*=9), Scenario (*f*=8), Mixed (*f*=8), Active role (*f*=7), Emotional (*f*=5) and Teacher (*f*=5). **Table 7** shows the factors with frequency values higher than 5 (five) among the prospective teachers' views regarding the contributions they will get from having actively participated in this process while doing their jobs in codes.

The most important factors regarding the participants' views on the contributions they will get from having actively participated in this process while doing their jobs in codes are as follows: Gaining experience (*f*=13), Finding solutions (*f*=11), Learning/being able to do/being able to design different experiments (*f*=10), Permanent learning/concretizing abstract concepts (*f*=9), Trying different learning methods in class (*f*=8), Being able to write scenarios suitable for student level (*f*=7) and Playing active role/active student (*f*=5) (see **Table 7**).

Table 7. Contributions they will get while doing their jobs

Category	*Code*	*Frequency (f)*
Experience	Gaining experience	13
Finding solutions	Finding solutions	11
Experiment	Learning/ being able to do / being able to design different experiments	10
Permanent learning	Permanent learning/concretizing abstract concepts	9
Method	Trying different learning methods in class	8
Scenario	Being able to write scenarios suitable for student level	7
Active role	Playing active role /active student	7

The distribution of the factors repeated most regarding the prospective teachers' views on the contributions they will get from having actively participated in this process was categorized and reviewed, and the frequency distribution is as follows: Experience:1, Finding solutions:1, Experiment:1, Permanent learning:1, Method:1, Scenario:1 and Active role:1.

The last question that was asked to the prospective teachers in the scope of the study was: "*What kind of attitudes –either positive or negative- you gained after those applications (after the processes of preparing problem scenarios and finding solutions for scenarios) regarding your job?*". The review of the prospective teachers' views regarding the positive attitudes they gained after those applications resulted in 104 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Other (*f*=17), Skill (*f*=16), Finding solutions (*f*=11), Permanent/active learning (*f*=11), Group (*f*=9), Experiment (*f*=9), Scenario (*f*=9), Method (*f*=7), Teacher (*f*=6), Experience (*f*=5) and Mixed (*f*=4). The review of the prospective teachers' views regarding the negative attitudes they gained after those applications resulted in 62 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Time (*f* =16), Other (*f*=16), Scenario (*f* =10), Experiment (*f* =6), Finding Solutions (*f* =4), Mixed (*f* =4), Original (*f*=3) and None (*f* =3). **Table 8** shows the factors with frequency values higher than 5 (five) among the prospective teachers' views regarding the positive/negative attitudes they had in the process in codes.

The most important factors according to prospective teachers regarding the positive attitudes they had in the process in codes are as follows respectively: Finding solutions (*f*=11), Permanent knowledge (*f* =11), Group work (*f*=9), Designing experiments (*f*=8), Being able to write scenario (*f*=5) and Gaining experience (*f*=5). On the other hand, the most important factors regarding the negative attitudes are as follows respectively: Taking time (*f*=15), Designing scenarios suitable for the student level (*f*=6) and Designing experiments (*f*=5) (see **Table 8**).

Table 8. Positive/negative attitudes gained after participating in the process.

Category/Positive	*Code*	*Frequency (f)*
Finding Solutions	Finding solutions/ production/ productivity/ product	11
Permanent learning	Permanent knowledge/ active learning	11
Group	Group work/ cooperative learning	9
Experiment	Designing experiments	8
Scenario	Being able to write scenario	5
Experience	Gaining experience	5
Category/Negative	*Code*	*Frequency (f)*
Time	Taking time	15
Scenario	Designing scenarios suitable for the student level	6
Experiment	Designing experiments	5

The distribution of the factors repeated most regarding the prospective teachers' views on the positive attitudes they had in the process was categorized and reviewed, and the frequency distribution is as follows: Finding solutions:1, Permanent learning:1, Group:1, Experiment:1, Scenario:1 and Experience:1. The distribution of the factors repeated most regarding the negative was categorized and reviewed, and the frequency distribution is as follows: Time:1, Scenario:1 and Experiment:1.

The results related to the views of the prospective teachers regarding the guidance of an academician in the preparation and application process of problem scenarios and the experiments designed to solve scenarios:

The first question that was asked to the prospective teachers in the scope of the study was: "*What are your considerations regarding the feedbacks that you received from the academician regularly in the period? If you think they are useful/useless, please explain why*?" The review of the prospective teachers' considerations regarding the feedbacks that they received from the academician in the period resulted in 82 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Correcting errors (*f*=19), Scenario (*f*=18), Its form (*f*=13), Its importance (*f*=9), Other (*f*=9), Its role (*f*=8) and Skill (*f*=6). The review of the prospective teachers' considerations regarding the reasons of the usefulness of those feedbacks resulted in 54 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Correcting errors (*f*=24), Its form (*f*=8), Mixed (*f*=6), Scenario (*f*=5), Guiding (*f*=5), Method (*f*=4), Development (*f*=3) and Other (*f*=3). On the other hand, the review of the prospective teachers' considerations regarding the reasons of the uselessness of those feedbacks resulted in 12 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Its form (*f*=6) and Emotional (*f*=6).

Table 9 shows the factors with frequency values higher than 5 (five) among the prospective teachers' considerations regarding the feedbacks that they received from the academician in the period and the reasons why the feedbacks were useful in codes.

Table 9. Prospective teachers' views regarding the feedbacks

The evaluation of feedback by prospective teachers		
Category	*Code*	*Frequency (f)*
Correcting	Our mistakes/ errors correction, access to the right	19
Scenario	Being able to prepare complete scenarios/ improving the problem cases / renew our problem	16
Importance	Positive contribution	9
Cause to be useful		
Category	*Code*	*Frequency (f)*
Correcting errors	The occurrence of errors, false and missing/ correction/ learning/ determination/ elimination/	24

According to **Table 9**, the most important factors regarding the prospective teachers' considerations on the feedbacks that they received from the academician in codes are as follows respectively: Correcting errors (*f*=19), Being able to prepare complete scenarios (*f*=16) and Positive contribution (*f*=9). On the other hand, the factor regarding the reason why the feedbacks are useful is: Correcting errors (*f*=24).

The distribution of the factors repeated most regarding the prospective teachers' considerations regarding the feedbacks that they received from the academician in the period and whether they are useful was categorized and reviewed, and the frequency distribution is as follows: Correcting errors:2, Scenario:1, and Its importance:1. These results show that the feedbacks the prospective teachers received in the period aimed at correcting errors, completing shortcomings and providing a way to the correct answer.

The second question that was asked to the prospective teachers in the scope of the study was: "*What were the feedbacks that you expected to receive in the scope of both preparing scenarios and designing experiments for solving scenarios at the beginning of the period? Were your expectations met in the period? Explain?*" The review of the prospective teachers' views regarding the feedbacks that they expected to receive in the scope of both preparing scenarios and designing experiments for solving scenarios at the beginning of the period resulted in 69 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Mixed (*f*=26), Scenario (*f*=17), Style of giving feedback (*f*=8), Guiding (*f*=5), Spelling errors (*f*=5), Experiment (*f*=4), Evaluation (*f*=2) and Other (*f*=2). As a continuation of this question, the review of the prospective teachers' views regarding whether their expectations were met resulted in 82 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Yes (*f*=25), Other (*f*=15), No (*f*=10), Evaluation (*f*=8), Partially (*f*=5), Scenario (*f*=5), Mixed (*f*=5), Guiding (*f*=4), Development (*f*=3) and Style of giving feedback (*f*=2).

Table 10 shows the factors with frequency values higher than 5 (five) among the prospective teachers' views regarding the feedbacks that they expected to receive at the beginning of the period in codes and whether those expectations were met.

Table 10. The feedbacks expected at the beginning of the period and whether they were met

The feedbacks expected at the beginning of the period		
Category	*Code*	*Frequency (f)*
Mixed	Gain-scenario/ scenario solving-experiment relation	11
Mixed	Showing scenario-experiment shortcomings and mistakes	10
Style of giving	Being unable to get positive feedback	6
Scenario	Giving ideas for preparing scenario	5
Spelling errors	Spelling errors in scenarios	5
Whether they were met		
Category	*Code*	*Frequency (f)*
Yes	Yes	25
No	No	10
Evaluation	Expecting high grade	6
Partially	Partially	5

The most important factors regarding the participants' views on the feedbacks expected at the beginning of the period in codes are as follows (see **Table 10**): Gain-scenario/scenario solving-experiment relation (*f*=11), Showing scenario-experiment shortcomings and mistakes (*f*=10), Being unable to get positive feedback (*f*=6), Giving ideas for preparing scenario (*f*=5) and Spelling errors in scenarios (*f*=5). On the other hand, the most important factors regarding whether the feedbacks expected at the beginning of the period were met are as follows respectively: Yes (*f*=25), No (*f*=10), Expecting high grade (*f*=6) and Partially (*f*=5).

The distribution of the factors repeated most regarding the prospective teachers' considerations on the feedbacks expected at the beginning of the period was categorized and reviewed, and the frequency distribution is as follows: Mixed:2, Style of giving feedback:1, Scenario:1 and Spelling errors:1. The distribution of the factors repeated most regarding whether those expectations were met was categorized and reviewed, and the frequency distribution is as follows: Yes:1, No:1, Partially:1 and Evaluation:1.

The third question that was that was asked to the prospective teachers in the scope of the study was: "*What was your role in this process considering the feedbacks you received from the academician in the period?*

Explain." The review of the prospective teachers' views regarding their roles in the process within the framework of the feedback they received resulted in 84 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Other (*f*=18), Scenario (*f*=18), Completing shortcomings (*f*=12), Researcher (*f*=7), Working in harmony with the group (*f*=7), Active individual (*f*=6), Experiment (*f*=6), Thinking (*f*=4), Reaching a conclusion (*f*=3), and Learning (*f*=3). **Table 11** shows the factors with frequency values higher than 5 (five) among the prospective teachers' views regarding their roles in the process in codes.

Table 11. The prospective teachers' roles in the process

Category	*Code*	*Frequency (f)*
Scenario	Organizing/fictionalizing/developing scenarios	18
Completing shortcomings	Acting/completing shortcoming in line with feedbacks	12
Researcher	Researcher	7
Working in harmony within the group	Working in harmony with group members	7
Experiment	Designing experiments	6
Active individual	Active in the process	6

According to **Table 11**, the most important factors regarding the prospective teachers' views on their roles in the process in codes are as follows respectively: Organizing/fictionalizing/developing scenarios (*f*=18), Acting/completing shortcoming in line with feedbacks (*f*=12), Researcher (*f*=7), Working in harmony with group members (*f*=7), Designing experiments (*f*=6) and Active in the process (*f*=6).

The distribution of the factors repeated most regarding the prospective teachers' views on their roles in the process was categorized and reviewed, and the frequency distribution is as follows: Scenario:1, Completing shortcomings:1, Researcher:1, Working in harmony with the group:1, Experiment:1 and Active individual:1.

The last question that was asked to the prospective teachers in the scope of the study was: "*Did you have any concerns in the scope of this process considering the feedbacks you received from the academician in the period? Explain.*" The review of the prospective teachers' views regarding whether they had any concerns in the process within the framework of the feedbacks they received resulted in 78 codes in total. The distribution of those factors was categorized and examined, and the following categories were formed from those codes: Other (*f*=16), Scenario (*f*=14), Mixed (*f* =12), Yes (*f* =12), No (*f* =12), Evaluation (*f* =5), Experiment (*f* =4) and Getting opposite feedbacks (*f* =3). **Table 12** shows the factors with frequency values higher than 5 (five) among the prospective teachers' views regarding the sources of their concerns in the process in codes.

Table 12. The prospective teachers' sources of concerns in the process

Category	*Code*	*Frequency (f)*
Scenario	Disfavor for scenarios/lack of adequate/no writing the desired scenario	14
Yes	I had concerns	12
No	I had no concerns	12
Mixed	Scenario-gain relation	5
Evaluation	We cannot receive a recompense for our work	5

The most important factors regarding the prospective teachers' views on the sources of concerns in the process in codes are as follows respectively: disfavour for scenarios (*f*=14), I had concerns (*f*=12), I had no concerns (*f*=12), Scenario-gain relation (*f*=5) and We cannot receive a recompense for our work (*f*=5) (see **Table 12**).

The distribution of the factors repeated most regarding the prospective teachers' views and the sources of concerns in the process was categorized and reviewed, and the frequency distribution is as follows: Scenario:1, Yes:1, No:1, Mixed:1 and Evaluation:1. These results show that considering the feedbacks they received from the academician in the period the sources of concerns in the process has equal affects in all categories according to the prospective teachers.

Summary of all those results shows that:

In the scope of the study; regarding the preparation and application process of problem scenarios and the experiments designed to solve scenarios, it was concluded that according to the prospective teachers;

- In the preparation process of the PBL scenarios and the experiments designed for solutions, they experienced difficulties mostly in the areas of preparing scenarios, designing experiments for solutions, correlating the scenario-gain-experiment-fiction.
- The most suitable case for using PBL method at secondary school level was the appropriateness of gain/subject, and it is also possible to prefer PBL for situations wanted to give some skills to the students at secondary school level.
- While designing experiments, they had difficulties mostly in the areas of correlating experiment-gain and experiment-scenario, and also there were difficulties in designing experiments–shooting videos, supplying materials, suitability of experiment to student level and originality.
- In the process, they gained experiences mostly in the areas of correlating scenario-experiment and scenario-gain, and also they had experiences in the areas of writing original scenarios, group work, designing experiments, producing different solution ways and gaining research skills.
- In the process, they experienced positive attitudes in the categories of finding solutions, permanent learning, group work, designing experiments, being able to write scenarios and

gaining experience; and negative attitudes in the categories of wasting time, designing suitable scenario and designing experiments.

In addition, regarding the guidance of an academician in the preparation and application process of problem scenarios and the experiments designed to solve scenarios, the study concluded that, according to the prospective teachers;

- The feedback they received in the period was for correcting their errors, completing shortcomings, providing a way to the correct answer, and it also contributed to preparing complete scenarios and providing positive contributions.
- At the beginning of the period, they had expected feedbacks in the form of showing shortcomings and improving the processes of gain-scenario relation, scenario solving-experiment relation, preparing scenario and designing experiments, and they also had feedback expectations in the areas of getting positive feedbacks, giving ideas for preparing scenarios, showing spelling errors, and getting high grades.
- Considering the feedback they received from the academician in the period, their sources of concerns in the process were in the areas of disfavour for their scenarios, scenario-gain relation and evaluation.

Conclusion and Discussion

According to the results of this study, the prospective teachers had difficulties mostly in the areas of preparing original scenarios, designing original experiments for solutions and correlating scenario-gain-experiment-fiction; they thought that more attention should be paid to those subjects and they mainly had experiences in those areas during the process. This situation is consistent with the result of the study by Çelik, Yılmaz, Şen and Sarı (2013) which reported that prospective science teachers had difficulties in the effective use of gains within scenarios. In addition, another study result is that the use of PBL method at secondary school level depends on the suitability of gain-subject. This situation shows that, while the PBL method is applied at every class level from the 4th grade in primary school to university in science education and within the scope of many units (Tosun & Yaşar, 2015), it is difficult to prepare a scenario, which covers every unit and which is suitable for the gain in all subjects. It is reported that preparing suitable problem scenarios is one of the most important disadvantages faced in PBL process (Dolmans, Gijselaers, & Schmidt, 1992).

According to the study results, after applying the PBL method, the secondary schools will gain cognitive level skills most and also the method is effective in gaining knowledge. The study, which was made by Tosun & Taskesenligil (2013) and of which quantitative results were accessed, similarly reported that, PBL method is more effective in increasing the scientific process skills of university students, compared to the traditional teaching method. According to Uden and Beaumont (2006), PBL helps students in developing skills for solving problems, thinking critically, working with a team and making a logical decision. According to Jones (2006), since the subject area is limited in PBL method, the knowledge gained is less but more detailed. The relevant body of literature reported that the students, who are taught with traditional teaching methods were more successful than the students who are taught with PBL method in the knowledge test for subject area (Uden & Beaumont, 2006).

The views of prospective teachers indicated that, in the process, they gained experience in the areas of writing original scenarios, participating in group work, designing experiment, finding solutions and gaining research skills. Along with the experiences they gained, the results also indicated that the permanent learning skills, which they gained or stated that can be gained, will provide contributions and positive attitudes for trying different methods and playing active roles as they do their jobs. In addition, it was found that the teachers perceived the waste of time faced in the process as a negative attitude. According to Kaptan and Korkmaz (2001), the waste of time is an important problem in PBL applications when compared to the traditional teaching methods.

Moreover, the study concluded that the prospective teachers had feedback expectations in the areas where they faced difficulties most, namely the processes of correlating gain-scenario and scenario solution-experiment, preparing scenarios and designing experiments. It was found that the feedbacks, which were given in the process to prospective teachers for helping them in preparing complete scenarios, were mostly for correcting their errors, completing shortcomings and providing a way to the correct answer. While the prospective teachers preferred to get those feedbacks in a suggestive and warm manner, they also had expectations for high grades in the process. Lastly, it was found that the prospective teachers were concerned about whether the scenarios they prepared will be liked, whether the scenario-gain was correlated and evaluation subjects. The fact that the students, who were taught with the traditional teaching methods, were more successful than the students, who were taught with PBL method, in the knowledge test for subject area (Uden & Beaumont, 2006) might be a reason why the prospective teachers were concerned about evaluation subjects.

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