Educational Games in Science Center: Experiences of Pre-Service Science Teachers

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Abstract

Educational games are fun teaching tools prepared in line with the aims of the lessons and facilitate the understanding of the subjects. Due to these features, they can be used in science centers to both discover exhibits and provide understanding of concepts. In this study, it was aimed to determine the opinions about the educational games prepared for the science center. For this purpose, the games prepared for Kocaeli Science Center were played and the opinions of the pre-service teachers who played the games were determined. The study is a phenomenological research in which the opinions of the participants are investigated. The study group consists of 30 pre-service science teachers. The participants played the games prepared in relation to science lesson subjects in groups. After playing the games, their opinions on playing in the science center, the effect of playing in the science center on learning, discovering the science center and exhibits were asked based on their experiences. The data were collected through a form with open-ended questions and observations. The collected data were analyzed using the qualitative content analysis. The pre-service teachers emphasized that they understood the subjects in the exhibits better. They stated that the science center visits supported by educational games will positively affect learning. Based on the results of the research, it can be said that educational games should be among the educational tools that can be used to discover the science center and to understand the exhibits.

Keywords
educational games, out-of-school learning, pre-service science teachers, science centers

Introduction

Science centers are institutions that aim to make science and technology understandable and accessible to society by bringing together different age groups and individuals with different experiences with science. Unlike museums (history, archaeology, etc.), science centers are not places containing objects that are forbidden to be touched behind glass showcases, but they are dynamic places where visitors touch and interact with exhibits and objects (Bozdoğan, 2019). These centers offer visitors the opportunity to experiment, explore, and acquire new experiences. In this process, individuals direct their experiences according to their interests, curiosities, and choices (Falk & Dierking, 2000; Falk & Storksdieck, 2005; Griffin & Symington, 1997; Gutwill & Allen, 2012; Rennie & McClafferty, 1996).

Science centers, which are an informal environment, are mostly regarded as an entertainment environment, the educational side is neglected (Atwood-Blaine & Huffman, 2017; Morag & Tal, 2012; Rennie & McClafferty, 1995). This situation does not change during the school trips to science centers, most of the time the visit is carried out by allowing students to move around freely (Bozdoğan & Yağış, 2006; Griffin, 2004; Rennie et al., 2010). However, exhibits in science centers are prepared using facts and principles associated with different disciplines. These centers, which present scientific laws, principles in a fun and surprising manner, offer very rich opportunities for effective learning (Laçin Şimşek, 2020). These exhibits can easily be associated with many lessons. For this, visits to science centers should be organized in a planned and scheduled manner (Bozdoğan & Yağış, 2006; Laçin Şimşek, 2019; Rennie et al., 2010). The teacher should ensure that the students are thinking, discussing, and are active by asking questions during the visit and

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should include activities that enable students to make observations and interact with the exhibit. For this, the teacher can use many different learning and teaching techniques. One of them is educational games.

A game is an activity that is carried out for a specific purpose and is often based on rules. In most cultures, games are used for learning common rules, ensuring social cohesion between children and adults (Muwanga-Zake & Wycliffe, 2010). Games encourage children to try new ideas and help them nurture their innate curiosity (Pellegrini & Smith, 1998; Russ, 2003). Through games, children expand their language/literacy and communication abilities, learn numerical and spatial concepts, use their imagination and creativity, develop problem-solving skills, practice memory skills and the ability to sustain their attention, rehearse social roles, and develop the ability to regulate their behavior and emotions (e.g., Kington et al., 2018; Wenner, 2009). The games are enjoyable, spontaneous, and optional (Rennie et al., 2003). Although they are associated with children, games can take place in every stage of human lifecycle. Studies have shown that there is a direct relationship between games and learning (e.g., Arslan et al., 2011; Hewitt, 1997; Petrovskaya, 2019; Thiggarajan, 1992; Wouters & van Oostendorp, 2013). Due to this relationship, educational games are included in educational activities. Educational games are designed for the purposes of teaching (Shaffer et al., 2005). Educational games can be defined as activities that ensure the reinforcement of acquired knowledge and repetition of information in a comfortable environment (Demirel, 2000).

Games have many positive educational results (Connolly et al., 2006): increase academic achievement and interest for the course, embody abstract subjects, make learning environment enjoyable, develop a positive attitude, facilitate understanding of concepts, provide an active learning environment for learners, improve students’ various abilities and skills (e.g., Barzilai & Blau, 2014; Bayat et al., 2014; Boyraz & Serin, 2016; Coşkun et al., 2012; Demircioğlu & Akdemir, 2019; Karamustafaoğlu & Kaya, 2013; Karamustafaoğlu et al., 2018; Shaffer et al., 2005; Shute et al., 2019; Wouters & van Oostendorp, 2013; Yazıcıoğlu & Çavuş-Güngören, 2019; Yenice et al., 2019; Yıldız, Şimşek & Araz, 2016; Yıldız, Şimşek & Aşdaş, 2017). Prensky (2003) claims that educational games will have an important place in the 21st century education.

Educational games can be used as an effective learning tool in schools as well as out of school settings such as museums and science centers. The fun side of the science centers and the fun side of the games are overlapping features. The educational side of educational games is in harmony with the fact that science centers are a rich learning environment. Therefore, the opportunity to have fun and learn will be provided through visits to the science center, which coincide with the content of the lessons through educational games that will make the visits more efficient. In the study conducted by Gutwill and Allen (2012), it was determined that students performed better and spent some time next to their teachers in their well-structured questioning game-based science museum visits. In studies involving games at museums and science centers, it was determined that students focus more on the subject, understand what is meant more easily, try to observe the environment more carefully and enjoy the visit more (Soga et al., 2018; Sollins, 1972). However, it is important that the games are well-structured (Gutwill & Allen, 2012) planned carefully and meticulously to achieve positive results through games prepared for out-of-school learning environments such as science centers. In order to achieve the expected learning outcomes through games, it is necessary to make connections with the lessons. In order for educational games prepared for out-of-school environments to be effective, it is recommended to pay attention to the following criteria (Öztuna Kaplan & Laçin Şimşek, 2020):

- The game should require interaction with the visited environment and should not be independent of the environment.
- The environment visited through the game should be observed.
- The game should make the students aware of what needs to be learned during the visit.
- The game should be played in line with the observations and information obtained in the out-of-school learning environment, not only by using the existing knowledge of the students.
- The game should require teamwork, preferably.

### Aims of the Study

It has been determined that studies on museums and science centers focus more on visitors and students’ behaviors, emotions and experiences, understanding concepts and their impact on various skills, etc. (e.g., Anderson et al., 2003; Beiers & McRobbie, 1992; Falk & Dierking, 2000; Hannu, 1993; Henriksen & Jorde, 2001; Hofstein & Rosenfeld, 1996; Öztürk & Laçin Şimşek, 2019), but studies on educational games are limited (Jahreie et al., 2011; Rowe et al., 2017). Although there are works related to games in the museum, these are mostly limited to museums or art museums. In the studies, it is seen that the games are mostly entertainment-oriented. However, in this study, educational games were used. The games prepared are directly related to the science lesson concepts and aim to be noticed/repeated/used the subjects to be taught in the lesson. In games, learning is more prominent and this learning can be realized by interacting with the visited environment.

In this study, it was aimed to identify opinions about playing games in the science center. The pre-service teachers’ opinions who played educational games in the science center were asked. Because, the feedback of pre-service teachers about whether the games mediate the learning of science concepts and the careful examination of the exhibits is important in terms of determining the effectiveness of the
games. For this reason, it can be argued whether educational games can be an effective tool in line with the opinions of preservice teachers who personally experience educational games and provide an idea for future research.

**Sub-Problems**

1. What are the pre-service teachers’ opinions about playing games at the science center?
2. What are the pre-service teachers’ opinions about the games developed for the science center?
3. What is the contribution of playing educational games in the science center to discovering the science center, understanding, and examining the exhibits?

**Method**

**Research Model**

The study, which aims to determine the opinions about the games prepared for the science center, was a phenomenological research. In phenomenological studies, it is aimed to reveal and interpret the perceptions of individuals about a case (Yıldırım & Şimşek, 2005). In this way, it is focused on the situations that are aware of the fact, but we do not have an in-depth and detailed understanding (Holstein & Gubrium, 1996). Thus, the meanings that individuals attribute to the activities will be revealed through their subjective experiences (Baş & Akturan, 2008). Experience is essential in phenomenological research. This situation distinguishes phenomenological research from other qualitative research conducted through interviews (Ersoy, 2017). In the present study, the games prepared related to the science lesson for a science center were played to pre-service science teachers in another project. As a result of their experiences, their opinions about playing games in the science center and its educational value were determined. An open-ended questionnaire, whose details are given in the data collection tools section, was used in order to determine their opinions. Data collection in phenomenological studies is usually collected using in-depth and multiple interviews with participants. However, other data collection tools such as observations and diaries can also be used (Creswell, 2013). In this study, the data were collected with an open-ended questionnaire, as the opportunity for individual and multiple interviews with the participants was not created due to the intense work schedule of the project, but the findings were supported by the observations of the observers.

**Study Group**

The study group of this research consists of 30 fourth grade pre-service science teachers from 15 different universities. Participants are between the ages of 21 and 23, 17 are females and 13 are males. All participants have done their internship at schools.

The project participants were formed in line with the criterion sampling. In order to identify the participants, the project was announced through social media and applications were received. There were 342 applications for the project. Pre-service teachers who are fourth year science teaching students from different universities, who have not been involved in such a project before and who have completed their internship, were selected. About 30 [thirty] participants were selected in line with the budget allocated to the project. Thus, the project tries to provide maximum diversity by selecting students from 15 different universities located in different regions of Turkey.

**The Place of Research and the Educational Games Used in the Research**

The project included in this study is a project supported by The Scientific and Technological Research Council of Turkey (TUBITAK) within the scope of the Scientific Education Activities Support Program. The aim of these projects is to bring students from different universities together and provide training from experts. The project was carried out in Kocaeli Science Center. Kocaeli Science Center, which is located in one of Turkey’s metropolitan cities. Kocaeli Science Center was established in partnership with Kocaeli Metropolitan Municipality and TUBITAK. Kocaeli Science Center is located on an area of 8,500 m² inside the Seka Paper Factory, which was built in 1934. Seka Paper Factory has been restored and continues to serve as Kocaeli Science Center and Seka Paper Museum. The science center was established under the consultancy of the Exploratorium Science Center in San Francisco. In the science center, there are four different galleries: Gallery of Perception and Reality, Dynamic World Gallery, Sultans of Science, and Water Area Gallery. In the Gallery of Perception and Reality, where the games are played, there are exhibits related to optics, sound, and senses; in Dynamic World Gallery, there are exhibits on climate events, natural disasters, DNA, molecules, elements, space, etc.; there are exhibits on scientists and their inventions in the Sultans of Science. In the science center, there are 250 exhibits, as well as a show stage where scientific demonstrations and interviews are held, a library, a science cafe, and an Industry 4.0 Inventor World Laboratory (www.kocaelibilimmerkezi.com).

The games used in the research are educational games prepared by science teachers at another project (The name of the project is Science Teachers at The Science Center) conducted by the same researchers, previously supported by TUBITAK. Attention has been paid to prepare the questions and tasks included in these games in such a way as to enable students to carefully examine the science center and exhibits, and to require the use and understanding of science concepts. The games that were prepared were organized many times and tested by both project team and science center employees. In
this research, four different games were used. These games are related to the subjects and concepts in the science lesson and have been prepared in line with the 2018 National Science Lesson Curriculum.

Before the game, the groups visited the science center freely. The participants played the games by setting up six different groups of five. (The games are available at www.bilimnerkezinde.sakarya.edu.tr). The game forms contain instructions on how to play. The groups read these instructions first, then examined the relevant mechanism and fulfilled the tasks to answer the questions in the game. The general features of the games are as follows:

- I'm Visiting the Science Center, Cracking the Password: This game is played among three galleries. Based on the clues given, the visitors must find the right exhibit and answer the questions in the task sheet by trying the mechanisms in the exhibit. In this game, they have to examine six different exhibits. There is a locked chest in the latest exhibit. They must first open the lock according to the instructions on the label. A new mission paper comes out of the chest. They must answer the question in the task sheet by examining the relevant poster. The answer creates the required password for the game. The final stage of the game, in the form of a competition, is flying a plane made from the password paper to the farthest distance from the tower. The science subjects in the game are the image formation in the hollow mirror, sound, force, earthquake, and simple machines.

- Visit the Dynamic World Gallery, Crack the Secret: In this game, a crossword puzzle is completed, and the password is reached. In the game, the names of the exhibits that should be visited are given. Questions need to be answered by trying the mechanisms in these exhibits. Thus, they will be able to access the password in the puzzle. Eight different exhibits must be visited in the game. The questions in the crossword puzzle are related to the solar system, molecules, microscope image examination, ecosystem, and earthquakes.

- I'm Exploring the Science Center with Square Code: There are five exhibits in this game. Participants are asked to fill in the task sheet given to them. Six QR codes were used to direct these exhibits. Riddles are created in QR codes to give clues about exhibits. They have to reach the exhibit through riddles and answer the question by making the observation in the task sheet. Exhibits are about colors, refraction of light, image formation, and sound.

- I'm Discovering Colors: This game is played through the exhibits about colors in the Gallery of Perception and Reality. The participants are asked to find the right exhibits and answer questions step by step, performing the assigned tasks.

The common features of these games are that they are directly related to secondary school science lesson subjects, the exhibits need to be examined carefully and there is a worksheet to fill. Questions can not be answered without fulfilling the tasks in exhibits at the science center. Participants must examine the exhibit carefully.

The features that make the games useful and different are that they are well structured, specially prepared for the science center, are related to the concepts in the science program, the worksheets in the games are not long and complex, contain clear and simple questions, and consist of certain steps. In order to carry out the steps in the games, the exhibits must be observed and examined well. Questions can only be answered by making observations. For example, in one game students have to find the exhibit with the spring inside. In the exhibition, it is requested to touch the spring. Although the spring is visible in the exhibition, it cannot be touched. Because the spring that actually appears is the reflection of the spring in the mirror. Students need to discover this, remember what they learned about mirrors and reflection during their lessons, and explain the reason for their observations. They cannot move on to the next task without completing this task.

Data Collection Tools

In the study, an open-ended questionnaire and semi-structured observations were used as data collection tools.

Open-ended question form. In the open-ended question form, participants’ opinions on playing games in the science center, questions about the contribution of the educational games in discovering the science center and understanding exhibits were included. Attention was paid to ensure that the questions were clear and understandable. Questions were answered individually. The open-ended questions are the following:

1. What are your opinions on playing games in the science center?
2. What are your opinions on the games developed for the science center?
3. Did the games affect you in discovering the exhibits in the science center? How?
4. Did the games contribute to your understanding of the exhibits? How?

The participants answered the questions in the activity hall located in the science center. In this area, there are large tables prepared separately for each group. While answering the questions, group members sat away from each other and there was no communication between them. Since this area was reserved only for the project group, there weren’t elements such as crowds or noise, etc. that would distract the participants. Participants wrote their answers.
Semi-structured observations. Data were also collected through observations in the research. These observations took place in two stages. In the first stage, the participants were observed while visiting the science center freely. In the second stage, they were observed while playing games. Photographs and videos were taken during all activities and observations in the project. A consent form was obtained from the participants for the use of the photographs, indicating their permission.

The observations were made by three researchers. During these observations, the participants' behaviors, examination status of the exhibit, and the social interactions were examined. The researchers made their observations by standing at a certain distance from the exhibits where the games were played. In line with the titles given, they took notes independently of each other regarding their observations.

All three researchers participated in the process as participant observers. One of the researchers is the coordinator of the project, the other is one of the instructors, and the other is one of the guides. All three researchers have been with the participants throughout the project, got to know and observed them closely.

Data Analysis

Data collected through open-ended questions were evaluated by content analysis. Content analysis is the systematic review of communication materials (these materials do not necessarily have to be in a written form but can be musical, pictures, etc.). The important thing is to record the material to be analyzed (Mayring, 2005). In the study, written data was collected by a form containing questions asking the opinions of the pre-service teachers after playing the games, and these data were supported with observation data and photographs. The answers given by the teacher pre-service teachers to the related questions and the analysis process of the observation data are as follows:

1st Step: By examining the data in line with the sub-problems, the researchers made a classification as to which questions will answer which sub-problems. The basic code draft list was created by examining some of the open-ended questionnaires and observation records. For example, in the list of pre-service teachers' opinions about the games developed for the science center, a code list of being educational, enabling discovery, social interaction, permanence, being fun, exciting, being effective-successful, being useful was determined. (1st Meeting).

2nd Step: The researchers examined all the forms individually and coded based on the basic code list. New codes were added to the list as the forms were examined.

3rd Step: A meeting was held to compare the first versions of the codings made separately by the researchers. At the meeting, data that were out of harmony in coding were discussed and consensus was reached. For example, while learning by having fun, which is not included in the list exemplified in the 1st step, was under educational code by some researchers, while other researchers added it to the code list as a new code. After the discussion, it was decided to consider it as a separate code. Likewise, 'being creative', which was not in the code list in the 1st step but was seen in the answers of two pre-service teachers afterwards, was added to the list (2nd Meeting).

4th Step: The researchers re-analyzed the out-of-compliance data using the agreed code list.

5th Step: After the researchers completed their final coding, they re-gathered and created the themes from the codings. At this stage, some changes were made in the way codes are expressed. Codes with similar content were brought together and renamed, and then themes were created from codes that provide semantic unity in terms of content. For example, the ‘being educational’ code in 1st Step has been changed to ‘instructive-educational’. The codings that express the benefits of the game are themed under the name of ‘contributions of the game’, and the codings for the content of the game under the name of ‘quality of the game’ (See Table 3) (3rd Meeting).

Created themes and codings are presented in tables in the Findings section. In order to keep the identities of the pre-service teachers confidential, each pre-service teacher was named P1, P2 with the sequence number assigned to them.

The measures taken to ensure the validity and reliability of the research are as follows:

- The data were examined and evaluated separately by the researchers. Researchers first read the data without any evaluation. They then took a second reading to identify common phrases and created codes from them. Then, the codes created by coming together to comply with the codes were compared, discussed, and agreed upon. As a result of a total of 8 hours of work in three different sessions, common codings, and themes were reached. In the meantime, at the points where the agreement was not reached, the data were returned and re-evaluated.

- After the games were played and the open-ended questionnaires were filled, while the project activities continued, the researchers asked the groups their opinions about playing games in the science center and received their verbal opinions. Thus, it was ensured that the written responses were confirmed. Thus, the reliability of the research has been increased.

- Encodings are highlighted by making exact quotations from the answers of pre-service teachers. No corrections or changes have been made in the quotations; the expressions are presented with all typographical errors. The participants were given nicknames according to their sequence numbers. For example, the first participant is named as P1 (Pre-service teacher 1).

- The expressions of the participants representing the code are shown in italics.
Observation data were supported with photographs to increase its reliability.

Results

Findings obtained as a result of content analysis were grouped under three themes: “Pre-service teachers’ opinions about playing educational games in science center,” “Pre-service teachers’ opinions about the educational games developed in the science center,” and “Contribution of educational games to discovering the exhibits.”

Findings Related to Pre-Service Teachers’ Opinions About Playing Games at Science Center

The analysis of the data related to the pre-service teachers’ opinions about playing games in science center are presented in Table 1.

| Theme       | Code                                      | Frequency |
|-------------|-------------------------------------------|-----------|
| Instruction | Learning through fun                      | 14        |
|             | Permanent learning                        | 9         |
|             | Being instructive                         | 8         |
|             | Being efficient-effective-useful          | 8         |
|             | Learning through doing and experience     | 6         |
|             | Reinforcement                             | 5         |
|             | Motivate                                  | 5         |
| Entertainment| Entertaining                              | 22        |
| Skill       | Group work                                | 8         |
|             | Communication-interaction                 | 6         |
|             | Using time effectively                    | 2         |
|             | Developing scientific process skills       | 2         |
| Exhibit     | Make exhibit noticed                      | 6         |
|             | Ensuring careful-appropriate view of the exhibits | 6         |
|             | Ensuring exhibits to be discovered-to be understood | 4         |

In P1’s response, it is also emphasized that games provide exploration and comprehension. These statements were coded in the theme of the exhibit under the exploration-comprehension of the exhibits.

In P1’s response, emphasis is put on the discovery and understanding of the games, which are coded under the theme of the exhibit under the discovery-understanding of the exhibits.

“Entertainment” has become the second theme. The majority of pre-service teachers (f=22) stated that they found it entertaining to play games in the science center. P23 responded “Playing games in the science center is, first of all, entertaining. It provides students learning through fun. Playing games increases the willingness to participate. It provides motivation.” He/she emphasized the fun nature of the game and this increased the willingness by providing fun learning.

In the skill theme, which was in the third place with the frequency of 18, the pre-service teachers included group work, communication-interaction, effective use of time, and scientific process skills, respectively, among the skills they think games improve. The pre-service teacher numbered P8 stated that they improved their group work and communication skills while playing games in the science center as follows:
“I think it was a fun environment. We had fun while learning. In this process, communication with my group friends has been strengthened. And based on each other’s ideas, we reached conclusions” (P8)

Regarding the effective use of time, P5’s “... Thanks to the games, we both improved collaborative learning and group work skills and gained the skills of using time effectively and attention.” and for the development of scientific process skills, P20’s “... It is a good opportunity for students to play games in the science center and make a great contribution to students’ scientific process skills. I think it will be a good activity for students with time management problems to use the time efficiently.” statements can be given as an example. In the statement of P20, it is seen that he also touches on using time efficiently.

Under the theme of the exhibit are the codes of playing games in the science center to draw the attention to the exhibits, to ensure that the exhibits are examined carefully-appropriately, and to discover and understand the exhibits. Pre-service teachers expressed in their statements, collected under the relevant codings, how they used the science center more effectively thanks to the games. The opinions of pre-service teachers P3 and P11 are presented below to set an example for this theme:

“The game in the science center was both very instructive and very enjoyable. At first, we did not pay much attention to some things while examining the materials, but through the games we understood better the purpose of the material and its adaptation to science, it became more efficient.” (P3)

“It allows students to realize the points that they do not notice while visiting. Since they are realized with the correct use of the mechanisms in the science center, they may realize their mistakes. I think that playing games is effective because learning is fun while visiting the science center.” (P11)

In both examples, there are expressions that the exhibits, which were not noticed during the science center visit, and which were noticed by means of games, were used carefully, accurately, and in a meaningful way.

Findings Regarding Pre-Service Teachers’ Opinions About Games Developed in Science Center

Under this heading, the distribution of pre-service teachers’ answers to the question of what their opinions on the games developed in the science center are examined by themes. Related themes and codings are presented in Table 2.

As it can be seen in Table 2, it was revealed that pre-service teachers’ evaluations of games developed for the science center were positive except for four negative comments. Various codes were obtained from 26 pre-service teachers under two themes as contributions of the game (33 frequency) and quality of the game (29 frequency). The contributions of the game are noticeable in terms of theme, and the fact that the games have the most frequency (12 frequencies) being instructive-educational is followed by providing to explore/discover the exhibits, interaction with the group, learning through fun and ensuring permanence. It is possible to exemplify the first three codings related to the contributions of the game in P3’s expressions:

“The games were suitable for observation, were found by using the mechanism, and enabled us to interact with the group and brainstorm, so it was instructive and nice” (P3)

P3 states with “found by using the mechanism” that the correct answers were reached only when the exhibit was examined with the instructions of the game. Furthermore, P8 pre-service teacher expressed his/her opinions on analyzing, discovering the exhibits and interacting with the group by stating: “I think it allows us to examine more carefully while visiting the science center. I think these games increase the interaction between the groups.”

While P9 puts emphasized on learning through fun in his/her expression “Absolutely beautiful. Very well devised games. It literally proves that students learn something while having fun. . .”, P16 stated that it made many contributions and that the information he/she learned by having fun is permanent with the following statement:

“Kinesthetic, collaborative, group-based, cognitive, psychomotor, in short, I think it contributed to me a lot in every sense. I learned with fun through the inquisitive and critical, scrutinizingly questions prepared in games and made it permanent” (P16)

When the theme of the quality of the game is analyzed, it is seen that the code of being fun-enjoyable comes to the fore with 14 frequency. The fact that the game is interesting-exciting, effective-successful, helpful-useful, and creative follows this code, respectively. In his/her expression “The games we played are generally fun and directly to the mechanism at the science center. Therefore, we cannot answer questions without seeing the mechanisms. For this reason, they are instructive, and we played without getting bored.” stated that they had fun and learned via games by visiting the exhibits. P4 emphasized that he/she found the games effective and creative in his/her statement below:

“I found the games very creative. It makes learning easier. It is a very successful activity in terms of student assessment and giving feedback to the student. Students can achieve both interaction and different types of learning thanks to collaborative work” (P4)

“Games were fun. It was blended in accordance with the science. But in some games, I think the directive is not clear (P13)” was shown as a justification that the directives were
not clear in the comments of four pre-service teachers under the title of negative. However, it was observed that these pre-service teachers made many positive comments about games besides this opinion.

**Findings on the Role of Games in Exploring the Science Center and Its Exhibits**

Under this title pre-service teachers’ opinions regarding the questions are given. The questions are “Do you think that games are effective in discovering the exhibits in the science center? How?” (Table 3). “Have the games contributed to your understanding of what is required to describe in the exhibits? How?” (Table 4). In addition, this research question was tried to be answered by supporting with observation data.

When the pre-service teachers’ opinions given in Table 3 about the contribution of games to exploring the exhibits in the science center are evaluated, it is seen that the most frequent code is in the theme of interaction with the exhibits. Under this theme, discovering-understanding exhibits is often in the first place. This is followed by the detailed examination of the exhibits, understanding the information, the examination of the exhibits and the reading of tag-directive. P13, P14 and P15 mentioned the effects of the games in a very detailed and descriptive way in terms of interaction with the exhibits. The statements of pre-service teachers are given below:

“Yes. Because we can examine some mechanisms superficially or overlook them. But thanks to the games, we can examine and use the mechanisms efficiently. In order to achieve the correct result or to achieve the next task, we need to use the game/mechanism correctly. In this way, we can use the mechanism efficiently” (P13)

“Yes, I think usually, we pass by looking at the mechanisms. We are not looking for information about the purpose of the mechanism, how it works, what is done. These games allow us to explore the mechanisms in detail” (P14)

“Yes, I think because the tasks in the games enabled us to both use and understand that mechanism. Since we did not read the directives before, we both read, learned and interacted in these games” (P15)

All three pre-service teachers draw attention to the fact that they did a superficial examination and there was something they overlooked when they visited the science center before playing games. It is seen that all three pre-service teachers stated that they had a effective interaction with the exhibits...
through games. P15 also added that the content and questions of the games increased this interaction.

According to the codings in the science center theme, which came in the second place with 16 frequency, the student P12 stated “Yes. There were places we missed while trying to understand the purpose of some mechanisms, there were some points we overlooked while trying to understand its mechanism. The games not only helped us find these overlooked points, but because we played a lot of games, we understood better what was where and how it worked.”

In the theme of the quality of the game, the highest frequency (frequency 6) is seen in the good guidance of the content/questions. Then comes the suitable for observation code. The good guidance of content-questions is examined in the expression of P15. The expressions of P3 and P10 are illustrative examples of suitability for observation code:

“Yes. For example, the spring-loaded mechanism did not attract my attention much when I was walking around with my group before the game. According to the orbit in the game, I understand that the spring was actually below, that we could see the bow in front of us thanks to the hollow mirror. It was instructive and remarkable.” (P3).

“Yes, there was. Thanks to the games developed, I learned which color was mixed with which color. I learned the contributions of scientists to science. By making me examine celestial objects more carefully, they made me eliminate the information I was missing.” (P10).

It is clearly seen in the responses of both pre-service teachers that the games facilitate the understanding of the exhibits associated with the games by directing them to make observations.

In Table 4, when the pre-service teachers’ opinions on the contribution of the games to their understanding of what is wanted to be explained in the exhibits, two themes appear. The code with the highest frequency (14 frequencies) in the game-related theme is using mechanism correctly-need/provide to understand code. This is followed by recognizing the unnoticed mechanism, detailed examination of the mechanism, associating with tags-required reading, and the gradual/cycle of the game.

When the theme related to the exhibit is examined, it is seen that providing the access/understand to the information is the most frequent code (13 frequencies). The game-exhibit association code is followed.

Expressions directing to require/understand the correct use of the mechanism and providing the access/understand to the information were generally found together. The expression of the pre-service teacher coded P8, which includes these two codes, is presented below as an example:

“Yes, it contributed. For example, in the mechanism where the colors are coming from, I am of the opinion that I would open all of them first and get 3 colors, but since each game has an activity related to it, it helped to understand how the mechanism works.” (P8)

In addition, the emphasis was put on the gradual/cycle of the game in the P5’s statement “Of course. Since It was not possible to pass to 2nd stage without finding 1st stage in the games, we were able to thoroughly grasp and understand the mechanism and the event described in the game.” Beside these two codings, P25 also added the relationship between the game and the exhibit with the following statement “Yes. Because we were required to understand the most crucial point of the mechanism and how it was realized theoretically. They understood the theory and applied the mechanism and provided complete learning.” the relationship between the game and the exhibit was clarified. As seen from the statement given below, the pre-service teacher coded P11 speaks about the contribution of the games to the recognition of the unnoticed mechanism.

“Yes, it contributed. In order to find the mechanism described with the clues given, it is necessary to use and understand the mechanism correctly. Sometimes the wrong mechanism were gone, so that the correct understanding of the mechanism was provided, the mistakes were noticed” (P11)

For the codes for detailed examination of the mechanism and associating with tags, P15 said that “Yes, there was. Because we had to both read and understand those activities. Because the activities required this.” can be given as an example.

Two separate observations were conducted in order to support the findings of the pre-service teachers’ opinions on

| Table 4. Opinions on the Contribution of the Games to the Understanding of What Is Wanted to be Explained in the Exhibits. |
|---------------------------------------------------------------|
| **Theme** | **Code** | **Frequency** |
| Related to game | Using mechanism correctly-need/provide to understand | 14 |
| | Recognizing the unnoticed mechanism | 4 |
| | Detailed examination of the mechanism | 3 |
| | Associating with tags-required reading | 2 |
| | Gradual/cycle of the game | 2 |
| Related to exhibit | Access-understand to the information | 13 |
| | Game-exhibit association | 11 |

Opinions on the Contribution of the Games to the Understanding of What Is Wanted to be Explained in the Exhibits.
the contribution of playing games in the science center. During the first observation, the participants walked freely around the exhibits in groups. During the second observation, they played the games given to them. Each group was given worksheets containing the tasks in the games to fill in during the games. Observations are grouped under three headings: Participants’ behavior, interactions with the exhibit, and social sharing. Findings of the comparisons made under these headings are given in Table 5.

It was observed that the participants’ opinions about playing games in the science center were supported by observation data. In their answers to open-ended questions about playing games in the science center, the pre-service teachers stated that playing educational games in the science center enabled them to examine and understand the exhibits better, to notice the exhibits, to discuss their observations among themselves and their reasons more, to make more careful examinations, to read the labels more carefully; they also expressed that they had fun and learned. In the observations, findings were obtained to support these statements. In the observations, it was noticed that the participants examined the exhibits more carefully, discussed the reasons for their observations, and all group members were involved in the process to make sure that they made correct observations. The emphasis on learning through fun, which is frequently expressed by the participants, was also observed during the observations. Some of the photos supporting these findings are presented below:

When it comes to working together with the group, it was observed that the participants sometimes present different behaviors in their free choice time [reviewing alone (Photo 1), examining with more than one group (Photo 2), etc.], but they work together with their own groups while playing games (Photos 3 and 4)

**Table 5. Observations of Pre-Service Teachers’ Interactions With Exhibits.**

| Participant behaviors | During the free trip | While playing game |
|-----------------------|----------------------|--------------------|
| Acting with the group | Group members act together. However, sometimes one or more members may turn to different setups or several groups can examine the exhibit together. | Group members act together. |
| Interest in exhibits | They are very interested in exhibits. They examine the exhibits. They make the necessary applications. Usually, one or two people practice it, and the others follow. | There is a lot of interest in exhibits. Group members behave more meticulously during the applications and repeat their observations until they are sure that they make the correct observation. The tasks included in the worksheet increase their interest and attention to exhibits. |
| Interest in labels | Group members mostly read labels. However, it has been observed that while one person is reading the label, others do the applications simultaneously. If the exhibit is an easy-to-use and understandable exhibit, it has been observed that they do not show interest in the label. | It has been observed that the labels are definitely read in order to answer correctly the questions in the worksheets. Often, more than one group member gains control by reading the label. |
| Interaction with the exhibit | | |
| Time | If the exhibit is interesting and entertaining, the time spent examining the exhibit increases. | They behave carefully and check again and again in order to make the correct observation related to the exhibit. The time to examine the exhibits has increased. |
| An attempt to make sense of observations | While examining the exhibits, it was seen that they mostly talked about what they saw, rarely about the reasons. | It was seen that they tried to make explanations based on the information they learned in the lessons in order to be sure of the accuracy of what they observed in the exhibits in the plays. |
| Social interaction | | |
| Conversation | While examining the exhibits, they talk to each other. While their conversations are sometimes about their observations, sometimes they are about themselves. Sometimes they can talk about completely different topics. They joke a lot. | They talk a lot among themselves. Discussion topics are more about what they observed and the scientific explanation of their observations. They argue among themselves in order to answer the questions correctly. |
| Entertainment | Group members are having fun. They joke with each other. They often take pictures. It is observed that the entertainment is quite intense. | Group members have an exciting and fun experience during the game. Besides, they discuss their observations and question their reasons. |
While playing the games, it was observed that the participants examined the exhibits more carefully and all group members discussed among themselves. They fill out the worksheets together. In Photo 5, it was observed that the group members could sometimes behave independently during the free trip, while they were constantly working together during the games. Photographs of three of the observed groups while trying to perform the tasks in the worksheet as a group are presented in Photos 6 to 8.

Discussion and Conclusion

When studies related to visits to out-of-school environments are examined, it is stated that these visits are mostly unplanned and are not associated with the lessons (Bozdoğan & Yalçın, 2006; Griffin, 2004; Rennie et al., 2010). However, when students visit places they have not seen before, they become more excited and more willing to learn (Braund & Reiss, 2006). Therefore, it is important to evaluate this situation well and to prepare an effective visit program (Laçin Şimşek, 2020; Orion & Hofstein, 1994; Özdem Yılmaz et al., 2018). In this study, pre-service teachers’ opinions about the use of educational games as a learning tool during the science center visits were determined. For this, first of all, the participants were provided to play different types of games in the science center. Participants gained experience by playing games in groups.

The participants stated that they found playing the games to be entertaining in the science center. In the studies of Atwood-Blaine and Huffman (2017) and Everett and Piscitelli (2006) it was determined that playing games in the museum was fun. In the literature, it is seen that the emphasis of entertainment is prominent in science center visits (Hakverdi Can, 2013; Kisiel, 2005; Tal et al., 2005). This finding is important in terms of ensuring that educational games continue as fun without turning the trip into a lesson. Because what is expected from field trips is that students both have fun and learn (Laçin Şimşek, 2020; Weitze, 2003). However, since the emphasis on entertainment is at the forefront, there are also criticisms that learning is in the background (Eshach, 2007; Rennie & McClafferty, 1996). The statements of the participants that playing games in science centers provide effective and permanent learning through fun are expressions that can reduce these anxieties. Because all of the games were prepared in direct relation with the secondary school science lesson subjects, and can be said that the educational games prepared in connection with the lessons have a high potential to turn science center visits into a learning opportunity.

The fact that playing games in the science center makes learning more enjoyable increased the motivation of the students, so the exhibits in the science centers attracted more attention. Museum visits and playbased learning situations are important for creating interest, motivation, engagement,
and relational thinking in science learning (Falk & Dierking, 2000; Rennie & McClafferty, 2002). The game-based learning approach, which children’s museums usually use, has been found to improve learning by providing hands-on, interactive environments that stimulate children’s motivations and interests, and it has been found that the game experiences in museum environments are an unforgettable learning platform for young children (Anderson et al., 2002; Everett & Piscielli, 2006). In this context, it is possible to say that educational games associated with lesson topics will both increase the interest of students and provide effective learning.

Unlike museums, science centers are places where visitors are expected to be active and the where the hands on and minds on approach is based. Visitors are expected to interact, touch, and try with the exhibits. However, in many studies, it has been reported that the visitors are called “novelty effect” or “ping pong” effect, running from one exhibit to another, continuing the visit and not dealing with the details of the exhibits (Falk & Dierking, 2000). In the study, the participants stated that playing games in the science center makes them active, they visit the science center more carefully through games, they need to examine the exhibits in more detail, they try to understand what they want to be told in the exhibits, they have noticed the features or exhibits they did not notice before. Purposeful manipulating of objects (Griffin & Symington, 1998; Ramey-Gassert & Walberg, 1994; Sollins, 1972) are important in out-of-school settings. In the present study, it was stated that the games prepared guided the students’ trips and provided interaction with the exhibits. This finding is supported by the observations of the researchers. In many studies examining visitor behavior, it was found that visitors were content with doing the activity, watching exhibits or other visitors, or repeating the activity and expressing their feelings, and rarely try to explain the reasons for their observations (Barriault & Pearson, 2010; Şimşek, 2019, 2020). The games prepared were organized in a way that would allow observation and the understanding and interaction with the exhibits. Pre-service teachers stated that they discovered the science center better and understood the exhibits better and stated that they had fun and learned during this time. Educational games are effective tools that can be used in science center visits. Including games prepared for the purposes of the visits will ensure that the visit is carried out efficiently. In the present study, the fact that the opinions of the preservice teachers who gained experience by playing educational games in the science center were consulted gives an idea about whether educational games will be a learning tool in science centers, and it will contribute to the studies in this field. Participants mentioned the many positive effects of playing games in the science center. In addition, the findings of the study are important for field trips to informal settings. In addition, it will be a directive for the studies to be conducted in this field. Today, there are more than 3,000 science centers worldwide and millions of visitors to these

Conclusion

It is important that the games/activities to be used in out-of-school environments are well-structured and require interaction with the environment. In the present study, the games containing the tasks directly related to the exhibits in the science center and the questions prepared in line with the achievements related to the science lesson were tested and evaluated. There are many studies stating that is important to use carefully prepared forms in such visits (Griffin, 2004; Kissel, 2003, 2006; Krombaß & Harms, 2008; Laçın Şimşek, 2019, 2020). The games prepared were organized in a way that would allow observation and the understanding and interaction with the exhibits. Pre-service teachers stated that they discovered the science center better and understood the exhibits better and stated that they had fun and learned during this time. Educational games are effective tools that can be used in science center visits. Including games prepared for the purposes of the visits will ensure that the visit is carried out efficiently. In the present study, the fact that the opinions of the preservice teachers who gained experience by playing educational games in the science center were consulted gives an idea about whether educational games will be a learning tool in science centers, and it will contribute to the studies in this field. Participants mentioned the many positive effects of playing games in the science center. In addition, the findings of the study are considered to be important in terms of directing visitor behavior and contributing to organizing a more efficient trip. These findings are important for field trips to informal settings. In addition, it will be a directive for the studies to be conducted in this field. Today, there are more than 3,000 science centers worldwide and millions of visitors to these
centers. Many of these visits are carried out by schools. This study is important in terms of both the use of the science center as a learning place and the idea and encouragement of teachers to use educational games in science centers.

In the present study, pre-service teachers were involved, and the study was carried out in the science center. Educational games that will be implemented in different informal settings will give new ideas. In addition, studies involving teachers and their students will contribute to the effectiveness of educational games in out-of-school settings. Contribution to learning can be investigated with educational games prepared on certain science subjects.

**Limitations**

During the project studies, very intense activities took place and the participants actively took part in these activities for an average of 10 hours a day. Due to the busy schedule and the fact that the participants were tired at the end of the activities, there was no separate time period for follow-up interviews with the participants. The fact that the answers to open-ended questions are not strengthened by interviews is a limitation of the study.

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