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The use of educational games within the structure and properties of matter unit in science class

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Given the rapid pace of science today, we can feel the influence of it in all aspects of our lives. Therefore, it is aimed to raise individuals with advanced thinking skills who learn and use knowledge in science class and can combine science and technology. In line with such purposes, it is believed that different methods and techniques are required to be used within classes. In this study, educational game techniques have been used in teaching of the "Structure and Properties of Matter" unit in science class and the effects of this teaching technique have been researched to measure the academic success of students as well as the opinions of students and teachers. Mixed research design has been employed within the study. Control group pre-test - final test model has been preferred for the quantitative dimension of research. "Academic success test on the structure and properties of matter" developed by the researcher has been used for the collection of the quantitative data. In the qualitative dimension of the research, semi-structured interviews, researcher's observations and diaries, and science journals of students have been utilised. According to the findings obtained, educational game has positively affected the students, increased the course success ($p<.05$) and participation in the course. A significant change has been observed in the success levels of the students and a positive change has been found in their views on the Science lesson.

Introduction

Science education should encourage scientific literacy, help improve daily life skills of individuals, let people understand their self-nature and that of others and should contain curricula that is valid in different countries of the world (Reiss & White, 2014). Through the prepared science curricula, it is aimed to enable students to see daily life phenomena from a scientific perspective and notice their natural environment. Another objective of the science

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class is to develop the thinking skills of students and make them individuals who do research and question (MEB, 2013). Given the objectives, the plan is to raise individuals that learn and use knowledge in science class, are aware of the formation process of scientific knowledge, can combine science and technology and have advanced thinking skills. However, teachers are not often able to achieve the level of success they desire due to intense but complex nature of science class (Cengiz, Uzoğlu & Daşdemir, 2012). It is believed that this problem could be overcome with the use of new methods and techniques in classes by science teachers. Therefore, success should be integrated with methods and techniques (authentic learning, cartoons and others) that will increase students' interest and positively affect their attitudes towards science. Educational games are among the approaches that attract the attention and interest of children (İneç & Akpınar, 2017; Turkay, Hoffman, Kinzer, Chantes, & Vicari, 2014; Rule, & Schneider, 2009).

Throughout history, children have played games by imitating adults and everything around them. Thus, it might be concluded that children use what they learn in games. Playing games and learning process are interrelated concepts. In history, Plato used to give apples and small toys to his students to teach them arithmetic. Aristo, Comenius, Rousseau, Pestalozzi, and Frübel used to emphasize the requirement of encouraging kids to play games (Ormanlıoğlu Uluğ, 1997). games have mostly been considered as suitable only for kids. However, new developments in education have brought about alternative learning methods. Teaching with games is one of the most important student-oriented methods used in education and is applicable to all age groups (Boghian, Cojocariu, Popescu & Mâţă, 2019). Teachers think that the use of games within lessons is necessary and useful, the fear for lessons can be reduced in a fun learning environment and thus lessons can become more concrete and comprehensible (Usta et al., 2017).

Educational games are useful for children to repeat and reinforce what they have learnt at class and enable them to have fun and relax while using their cognitive skills (Demirel, 2009). They add dynamism to the class environment, increase participation and attract the attention of all children to the lesson (Clark, Tanner Smith, Hostetler, Fradkin & Polikov, 2018). By materializing the learning experience of students, they enable internal motivation and pull them in (Peirce, Conlan & Wade, 2008; Yenice, Alpak Tunç and Yavaşoğlu, 2019). Students experience the possible future incidents through practical applications whose boundaries are determined beforehand (Doran & Watson, 1973). These applications contribute to the social, psychological, physical, linguistic, and intellectual development of children (Godwin-Jones, 2014; İnal & Korkmaz, 2019; Şenel & Akman, 2016) and provide opportunity for students to learn via structured experiences. Besides, educational games give an idea to individuals about their own behaviors and thus allowing for self-assessment at the end of peer interaction. They provide characteristics such as decision-making, evaluation, problem solving, negotiating, innovating, and taking incentives within a risk-free environment (Lynee, 2004). Moreover, they help develop the values of respect for diversity, independence, and responsibility (Çalışkan & Biter, 2019) aswell as improving self-confidence, relationship with peers and the learning of students (Nemerow, 1996). Children mostly manifest their internal conflicts, anxiety, anger, and distress in games, and reflect the negative situations they encounter in their family or environment as well as their distress to the games (Gifford, 2002).

According to the findings of pediatric development studies, it has been stated that games should be designed with a content suitable for childrens' development so that they could be provided with socially rich learning experiences and a balance between learning experiences in real world can be assured. It is possible to make subjects more interesting, encourage students and even

enable those that are not very active to participate in the class using the educational games prepared accordingly (Miller & Kocurek, 2017). Furthermore, the rules of games must be flexible since not all kids have the same interests, knowledge, or skills. No matter how long it is, teachers must utilize educational games in each class and guide the process well (Demirel, 2009).

Teaching process through educational games in science class

While the content of science class is related to daily life and could easily be learnt, students think that it is one of the most difficult classes. Research suggests that the attitude of students towards science gets more negative as they grow older (especially at the ages of 11 and 12). Researchers are of the opinion that the reason behind this fact could be ineffective education methods and techniques (Ural Keleş & Aydın, 2017).

Educational games within the scope of science class could be used as a method for students to acquire cognitive and affective acquisitions. The students realizing the problem within the game and analyzing the factors affecting the game have a higher possibility of being successful. A student should observe, collect, classify, and evaluate the data in order to be able to identify the variables. All students could gain these skills through educational games (Doran & Watson, 1973). Previous studies indicate that children correlate the science class with games and enjoy the class as a result at early ages, however; as they grow older, the level of this correlation and pleasure decreases. Accordingly, if the science class is given through games, students find it easy and continue to enjoy the class and thereby, the level of success could increase (Kozcu Çakır, Şenler & Taşkın, 2007).

Within this study educational games have been applied to 7th grade students, who are at their early stage of puberty, by considering their physical, cognitive, and social development level. According to Demirel (2005), games provide an enjoyable and relaxed environment for students and bring positive changes to in-class activities. Within this context, sample games applied within the study bear importance in that they have made the class student-oriented rather than teacher-oriented. Besides, this study is of importance since the science class will be more comprehensible, more enjoyable and become the one in which students will be able to express themselves in an easier way thanks to the games planned to be used as an alternavitve method for reaching the goals of the class. In line with all these studies, in this study, the effects of educational game activities towards students' academic success, attitudes and opinions by using educational games in teaching "Structure and Properties of Material" unit in Science have been investigated.

Methodology

Mixed research design has been used in the study. This research design requires the combination or integration of the quantitative and qualitative methods as well as their data in a study (Creswell, 2013). Within mixed research design, the strengths of methods are combined. Therefore, generalization is possible in mixed research design; precise measurements are performed, and perspectives are examined in detail (Creswell, 2017).

Participants

The population of this study consists of 7th grade students attending science class in Turkey during the 2017-2018 academic year. 7/A (test group, 14 students) and 7/B (control group, 14 students) classes of a public school have been selected as samples in the study.

However, 12 students from the experimental group and 13 students from the control group have participated in the activities and the other 3 students have not participated in the activities due to absenteeism. The application has been performed by the researcher. The researcher is a teacher with 8 years of teaching experience.

Group equalization

In order to ensure the general success equalization, the weighted success grades of the students at the end of 6th grade have been analyzed through independent samples t-test. The result has been found as 0.647 for the value of p>.05. Since the value of 0.647 is bigger than the value of p>.05, it has been concluded that there is no significant difference between the groups, and it could be stated that the two groups are identical. As a result, the control and experiment groups have been randomly designated.

Data collection tools

The quantitative or qualitative collection of data varies with regard to the type of the problem (Arlı & Nazik, 2003). Since both quantitative and qualitative data have been required for this study, quantitative and qualitative data collection methods have been used together.

The researcher notes and diary, science journals and semi-structured interviews have been utilized in the qualitative dimension of the study. "Success Test on the Structure and Properties of Matter" developed by the researcher has been used for the quantitative dimension of research. A semi-structured interview form and a success test related to the matter and its properties unit has been developed by the researcher. The collected quantitative data and qualitative data have been analyzed through a statistics package program and content analysis, respectively.

Qualitative data collection tools

The data and methodology have been diversified while the qualitative data collection tools are being prepared. The data has been asked before and after the application and collected at various times to perform the data diversification. Since the data has been collected through multiple data collection tools, diversification has also been performed. Science teachers and academicians have also been consulted while preparing the interview form, researcher journal and student journals. The required adjustments have been made in line with expert views. The qualitative data collection tools prepared accordingly are valid and reliable (Kelecioğlu & Göçer Şahin, 2014).

Quantitative data collection tools

The success test developed by the researcher has been used for the collection of quantitative data and expert view has been consulted for the test. The content validity has been ensured through the amendments in line with the expert view and the necessary items have been added in order to measure all the acquisitions that students should comprehend, understand and carry out. The pilot applications have been conducted and various calculations have been made with the necessary item statistics. The average item difficulty index, average item distinctiveness index and reliability coefficient of the test with 25 items have been 0.55, 0.51 and 0.81, respectively. The success test has been applied twice as the pre-test and final test. Having undergone such processes, the test could be considered as valid and reliable (Kelecioğlu & Göçer Şahin, 2014).

Data collection

The necessary approvals have been obtained before starting the data collection process within the study. The application period has lasted for a total of 8 weeks. At the beginning of the application, "Success Test on the Matter and its Properties" has been applied to the experimental and control groups as a pre-test. Furthermore, semi-structured interviews have been made with the experimental group. These interviews have been recorded in video files and then the application has been started after the preparation stages.

Preparation and application of educational games

The educational games have been designed so that they could have simple and understandable instructions, grab the attention of students, provide opportunities for students to demonstrate their various skills, require collaboration and teamwork, and are suitable for the student level and school conditions. It is particularly paid attention to the fact that the educational games contain all the acquitions that students should know, comprehend and carry out at the end of the semester. Accordingly, 6 games have been prepared; 5 games structured by the researcher and 1 game by Şahin (2017). Two science teachers and an academician have been consulted to determine the convenience of the designed games. The application has started after deciding that the prepared educational games are suitable for children. Depending on their contents, the games have been used for 2 or 3 lessons during the explanation, deepening and assessment stages of the class.

Applied educational games:

- In "Who Am I" game, the aim is to learn about the scientists whose views have been taken into account in the historical development of atom. Students try to find the scientist described by their friends.
- "Who am I" game has been adapted from the game "Taboo". The aim is to learn the concepts related to the subject.
- In "Tactile Mixtures" game, the aim is to make students find and learn if the mixture they touch with their eyes closed is homogenous or heterogeneous.
- In "Element ping-pong" game, materials interesting for students are used to make them learn the names and symbols of elements.
- "Anion cation bingo" game has been adapted from the classical bingo game. The aim is to calculate the ionic charges of elements.
- The "Wheel of science" game has been adapted from the "Trivial Pursuit" game. The aim is to assess the entire unit.

The classes have been carried out in accordance with the class book in both the experimental and the control group throughout the application. The class book contains theoretical knowledge as well as experiments and tests. The classes have been supported with educational games and activities structured in detail under 6 sub-titles in the experimental group. The researcher has kept a "Researcher's Diary" after these classes and noted her observations.

After the end of the application, "Success Test on the Matter and its Properties" has been applied to the experimental and control groups as a final test. Furthermore, semi-structured interviews have been re-conducted with the experimental group. These interviews have been recorded in video files.

Data analysis

The qualitative data have been analyzed using content analysis. Firstly, children have been coded with numbers. The data has been analyzed in four stages. Yıldırım and Şimşek (2003) describe data analysis stages as follows:

- Data coding: Researcher groups and names, i.e. codes the data based on their meanings. The data used with similar meanings are gathered together.
- Identification of the themes of collected data: At the first stage, collected codes are categorized according to their common properties, and themes are created.
- Arrangement of codes and themes: Codes and themes are arranged and organized together. By this way, the data is explained and presented in an understandable way.
- Definition and interpretation of findings: Findings that are defined in detail are interpreted by the researcher and conclusions are drawn.

In the analysis of quantitative data, the data related to experimental and control group is entered in the relevant statistics software firstly. In the histogram graphical analysis performed, it has been observed that groups have demonstrated a normal distribution and the required parametric analyses have been performed. In order to analyze the data, descriptive analysis, dependent samples t-test and independent samples t-test have been used to identify the characteristics of groups, pre-test - final test analysis of groups within themselves, and the comparison of groups with each other, respectively. Influence quantity has been calculated for the outcomes that have been significant. The results of the analysis have been tabulated, and then the findings have been interpreted.

Findings

The aim of this study is to determine the views of teachers and students on the use of educational games while teaching the Structure and Properties of Matter unit in science class and identify the effect of application on the success of students. The findings obtained from the collected data have been explained through direct quotes from the student and teacher expressions as well as quantitative analysis results.

Quantitative findings

Success test results of the experimental and control groups

Before using the educational games in the experimental group, the data has been collected by using the "Success test on matter and its properties", and it has been examined whether there has been a significant difference between test and control groups in terms of success in science class.

Table 1: Pre-Test Success Score Results of Test and Control Groups

Group	*n*	$\bar{X}$	*s*	sd	t	p
Experimental Group	12	29.41	2.108	17.86	-.903	.379
Control Group	13	30.61	4.253			

According to the Table 1, independent samples t-test has been applied in order to see whether the difference between pre-test success scores of experimental and control groups has statistically been significant, and the result has been 0.379 for p>.05. Therefore, there has been no significant difference between the pre-test knowledge levels of two groups. It would be right

to say that knowledge levels of test and control groups on the "Matter and its Properties" unit has been observed as close to each other.

After the lesson with educational game activities in the experimental group and course book activities in the control group, the success levels in science class of both groups have been reassessed using the "Success test on matter and its properties".

Table 2: Final Test Success Score Results of Experimental and Control Groups

Group	*n*	$\bar{X}$	*s*	sd	t	p	ES
Experimental Group	12	40.58	3.728	23	3.09	.005	1.245
Control Group	13	35.07	5.024				

Note. ES = effect size

According to Table 2, a certain level of learning has been achieved in both groups at the end of the unit, and it has been concluded that there has been a positive change in the final test scores. Independent samples t-test has been applied in order to see whether the difference between average success scores of test and control groups has been statistically significant, and the result has been 0,005 for $p<.05$. Therefore, there has been a significant difference between the final test success levels of two groups. Furthermore, the fact that influence quantity value has been calculated as 1.245 and since this value is statistically greater than 0.8, it indicates that the difference between experimental and control groups is great enough to consider it as significant. Accordingly, it would be right to say that the group that learnt the subject most by means of educational games is more successful.

Qualitative findings

Student views on educational games

Before and after the application, the students were interviewed through semi-structured interview technique. A part of the questions were asked beforehand while others were asked questions after the application. Some questions were asked twice; once before and once after the application. Students recorded a log at the end of each class through educational games.

Before and after the application of the game, the test group students were asked "their opinions about the educational games". Before the application, most of the students had the opinion that educational games would facilitate learning. A few students stated their expectations as more interesting lessons, positive effect of educational games on their brainwork as well as rapid and efficient learning. They also shared their expectations of permanent learning, increased success and greater attachment to class at the assessment stage of lesson. Some of the direct quotes of students about the subject matter are as follows:

> *"...I think it will affect our learning positively. My friends will pay more attention, too..." (S7).*
>
> *"...Educational games can make the ones that are not interested in the lesson start to like it, and increase the grade point average..." (S8).*

When the same question was asked after the application, most of the students said that they were able to study as a team in a nice, enjoyable and exciting way, and focused on class experiences. At the assessment stage of the class, they stated that they understood and enjoyed the subject, had permanent learning and their level of success increased. They compared the class through educational games with the previous classes. They said that participation was

higher while it was better and more interesting than plain explanations on the subject, and educational games encouraged the students to care more about the lesson and study more. Some of the direct quotes of students about the subject matter are as follows:

"…I participated more in the lesson. I was bored and did not participate when it was plain explanation. My friends also studied since we were playing games…" (S3).

"…When we had the test, I remembered the game about homogenous and heterogeneous mixtures and solved the problem. Besides, those that did not participate in the lesson before tried to focus more on the lesson;the game was very interesting for them…" (S7).

"If you had an opportunity to design an educational game, which characteristics would it have?" was the question asked to experimental group students before and after the application of game activity. The most common characteristics stated before the application were as follows respectively; fun, didactic, interesting, rules that do not disrupt the class discipline, catchy, a visual content, exciting, distinctive, ability to play in teams, suitable for student level. Some of the direct quotes of students about the subject matter are as follows:

"…If I designed a game, I would like it to be fun for my students to laugh… The games must also be didactic and bring success to them…" (S1).

"…The game I'd design would be exciting and with rules…" (S4).

When the same question was asked after the application, the views of the students changed partially. The responses of students for the question of "If you had an opportunity to design an educational game, which characteristics would it have?" after the application were as follows: the adaptation of already known games, awarded, didactic, ability to play in teams, rules that do not disrupt the class discipline, a visual content, exciting, understandable, interesting, fun games. Some of the direct quotes of students about the subject matter are as follows:

"…It would be fun, exciting, awarded, didactic and with visual content…" (S6).

"…I'd prepare games with prizes. I'd give a prize to the winner…" (S9).

The question of"Have the educational games caused any negativity in the class? If so, what negativity have they caused?" was asked to students. Four of the 11 students stated that there wasn no negativity. The remaining seven indicated insufficient time as a negativity. Furthermore, previous familiarity with the game, the disruption of the class discipline, the failure of the mediator to manage well, and the failure of some students to follow the rules are other negativities stated by the students. Some of the direct quotes of students about the subject matter are as follows:

"…Sometimes the time was not enough. I couldn't take my turn due to the noise my friends made. There was a little problem with the discipline..." (S7).

Teacher views on educational games

This section will cover the results of the analysis of researcher's diary/notes and observational data. The results have been grouped through codes under the themes of activity preparations of researcher, data related to students and learning-teaching process in which the application took place.

Preparation process of educational games: Firstly, preliminary interviews made with students have been reviewed in the preparation process of educational games. The expectations of students have been analyzed by this way. Furthermore, the preparations have started by taking the experiences of teacher into consideration. The themes related to the preparation period of educational games in line with the journal and observations of researcher have been given

below in Figure 1.

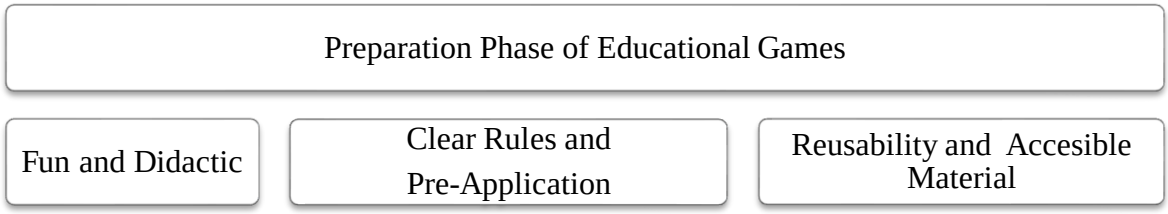

Figure 1. Preparation Phase of Educational Games

It has been found out that educational games are comprised of such features in the preparation phase as being enjoyable, didactic, having accessible material, being reusable, pre-applicable and having clear rules which are all given in Figure 1.

Fun and didactic

The didactic and entertaining quality of games has been the priority and these factors have been recorded in the researcher's journal as follows:

"...I used the preliminary interviews I made with the students while preparing the games. I prepared the games by considering what the students expected from an educational game as well as my expectations and as a teacher and other conditions..."

Clear rules and pre-application

The clarity of the rules was also an important factor for the students to willingly participate in the games. These factors were recorded in the researcher's journal you can consider changing journal into diary where approipriate. as follows:

"...It was required to set the rules in line with the class conditions. Therefore, I believe that pilot application is important in the design of educational games..."

Reusability and accessible material

Accessible and reusable materials were preferred for the game. The games that students play in daily life were incorporated in the games with the aim of raising interest and reusability. These factors recorded in the researcher's journal as follows:

"...Even though designing the game and preparing the cards are extra work, this game turned out to be economic since it can be used for years..."

Application process of educational games:

Themes related to the use of educational games have been developed in parallel with the journal and observations of the researcher and these themes have been presented below in Figure 2.

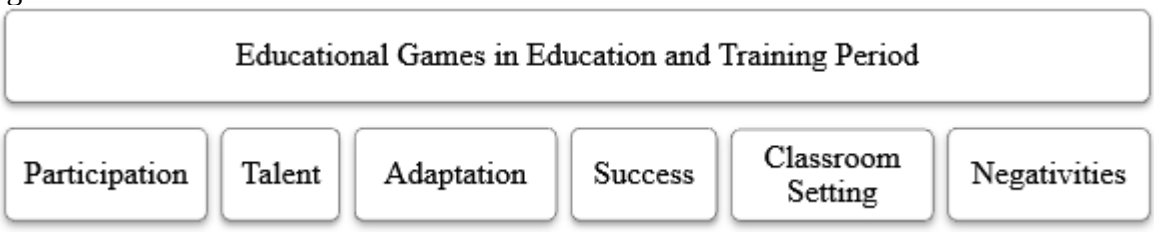

Figure 2. Use of Education Games within Education and Training Period

When the use of educational games within education and training period is examined, it has been found out that this period is comprised of such sub-themes as participation, talent, adaptation, success, classroom setting and negativities.

Participation

It could be inferred that educational game applications are among the observable findings of increased participation of students in the lesson. Students have also stated after the application that educational games have increased their participation in the lesson. In this context, the observations of the researcher and views of students support each other. This change has been recorded in the researcher's journal as follows:

> *"…What surprised me in the game called Wheel of Science was that an unsuccessful and passive student (S4) became a quite active person who ruled the group. And the student even answered the questions correctly…"*

Talent

Educational game applications might enable the students to demonstrate their different talents. This fact has been recorded in the researcher's journal as follows:

> *"…I wanted the students to make proper and correct sentences. If I had a student who was skilled in imitation or verbal description and acting, this activity would be an opportunity to notice him…"*

Adaptation

It would be right to say that preparation of educational games in the form of adaptations from known games facilitates adaptation to game and increases participation. This has been recorded in the researcher's journal as follows:

> *"…We played 'Mixtures by groping' game in this class. Participation was quite high and we had very fun moments. They were familiar with this game from the quiz shows on TV. That's why they played the game very easily…"*

Success

Demonstration of a successful performance in educational game activities is important for students. Success achieved in front of other people could support other developments of students that are in adolescence period. This fact has been recorded in the researcher's journal as follows:

> *"…There were two winners in this game. One of them was the most successful student in the class. However, the other winner was actually unsuccessful in class (S3). He said that he was happy with being the winner, but did not expect such a result. And he/she made self-criticism saying that he/she could learn better with games. I hope this student who is very silent and introvert becomes more active in the future like the way she was in this game…"*

Classroom environment

Educational games affect the class environment to a great extent. Students' will to succeed, excitement, focus on the class, enthusiasm, increased self-confidence, collaborative

attitude, and helpfulness has strengthened their communication with each other and class teacher. This has been recorded in the researcher's journal as follows:

> *"...Doing activities in this class with students and seeing their joyful and excited moods have been very satisfying in professional manner and I can say that my connection with students has strengthened..."*

Negativities

Educational game activities might cause negative situations in the classroom. These negativities might be insufficient time, focusing on the game rather than the subject, difficulty in class governance, disturbance of the students that cannot learn the subject, and failed fairness when the rules are not clear. These have been recorded in the researcher's journal as follows:

> *"...A negative aspect of the activity was that time was not set clearly at the beginning. Break time bell rang while we were playing the game..."*
>
> *"...When I entered the class with 'Bingo' game to teach ionic charges, students wanted to play the game even before listening to the explanation. I told them that we should make some preparations first, but they got flurried about playing the bingo game before trying to understand the subject fully. I believe this is the disadvantage of educational games. When we started to play the game, all class (9 students) tried to join the game. I think playing the game precluded the will to understand the subject. Because students that began to speak continued to participate in the activity when they made a mistake without asking for the correct answer..."*
>
> *"...In team play, they set a strategy in which the student that knew the subject stayed in the group and the student that was likely not to know the answer just read and asked the question. In this case I was unsuccessful at moderating and couldn't follow them. So, the moderator is also very important in the game. Even though their ability to set a strategy was useful in terms of developing their thinking skills, it led to an unfair situation in the game. One student (S3) asked for fairness when it was his/her turn and did not give up his/her turn. It made me happy. His/her awareness of personal rights brought together fairness and respect for others..."*

Discussion and conclusion

The aim of this study has been to determine the effect of activities that include educational games in teaching "Structure and Properties of Matter" unit in science class on the academic success of students as well as the opinions of students and teachers. Findings obtained from the collected data have been evaluated under two main titles as qualitative and quantitative. In quantitative findings, the aim has been to determine the effect of educational games on the academic success of students. Qualitative findings, on the other hand, have been evaluated under two titles as teacher views and student views. The views of the teacher have been grouped under two sub-themes: experiences in the preparation process of educational games, and experiences in learning-teaching process. The student views have been evaluated in line with the science journals, interviews and videos recorded during the practice.

Before using the educational games in the experimental and control groups, the data have been collected by using the "Success test on matter and its properties", and no difference has been found between the two groups in terms of success in science class. After the subject has been taught through educational game activities in the experimental group and course book activities in the control group, the success levels in science class of both groups have been reassessed using the "Success test on matter and its properties". Between the students who have been taught using educational games and current schedule, it has been concluded, in line with the

obtained findings, that success in science class has led to a significant difference in favor of the students in the group where educational games have been applied. There are many studies in the literature that support this conclusion (Bayat, Kılıçarslan & Şentürk, 2014; Coşkun, 2012; Coşkun, Akarsu & Kariper, 2012; Öztürk & Korkmaz, 2020; Vogt, Hauser, Stebler, Rechsteiner & Urech, 2018).

Views of students about the technique of teaching with educational games

Based on the students' expressions about games such as "very good, fun and I'll like it" received before the application of educational games, it could be said that they had a positive preunderstanding about educational games. Koçyiğit, Tuğluk and Kök (2007) have also stated that children play games alone or with their friends in order to have a good time, have fun and learn.

Their expectations about the teaching-learning process have been easy learning, focusing on the lesson, brainwork, fast learning and having an efficient learning process thanks to educational games. Furthermore, students have stated their expectations as increased success, permanent learning, and interest in lesson. Likewise, Altınbulak, Emir and Avcı (2006) have identified in their study that educational games ensure that students enjoy the class and increase the success level and permanence of the class.

According to the views of students about the games after the application, the majority of them have described the lesson as better and fun while others have stated that they have had an exciting teaching-learning process during which they could focus better. At the end of the activities, most of the students have thought that they have learnt the subject though others have stated that they have enjoyed the class, their success rates have increased and their learning have been permanent. Similarly, Gökbulut, Yücel and Yumuşak (2014) have found out that educational games increase success level and have an important role in enabling effective and permanent learning.

Students have made a comparison with their previous class level after the end of application and have specifically emphasized that their participation has increased. They have also stated that they enjoyed the educational game activities much more than plain explanations; that the lessons have became much more interesting, and that they have cared about the lesson more and have thus studied more. Gürbüz, Gülburnu and Şahin (2017) suggest in their study that educational games contribute to the development of a positive attitude towards class. They have also concluded that games have been interesting, enjoyable, and motivating, and have enabled students' active participation to the class.

Taking the views of students while designing games might be beneficial for the application to be interesting and effective for students. Hence, characteristics of the games that students want to design have been sought before the application. Essential care has been taken for the games to be interesting for students, and contribute both to the success in class and personal characteristics. It has been observed that students have been more active in designing of the games they know beforehand. Kaya and Elgün (2015) state that designing the educational games and setting the rules together with students take the interests and needs of students into consideration and allow the students to create new ideas.

Responses of students to the question "If you had an opportunity to design an educational game, which characteristics would it have?" before the application suggest that they wanted a fun, didactic, interesting, catchy, exciting, distinctive game with rules and visual content that is

suitable for team play as well as for their own levels. According to the comparison of these expectations with views of students about educational games after application, it seems that educational games were prepared in line with the desires of students. The views of students about the game they have wanted to design appeared to have changed partially after the application. For example, students have not mentioned about distinctiveness and suitability for their level after the application. However, they have stated that they want to design the educational games with such criteria as adaptation from the games they know, being awarded, suitable for teamwork and understandable. Doran and Watson (1973) have stated that through teamwork, students learn from each other and they contribute to joint creative learning. Sar, Soyer and Çolak (2015) also conclude that educational team games preferred by students are more effective than the individual games and are more effective in dealing with childhood shyness.

It could be stated that the literature usually quotes about the positive aspects of educational games; however, some students in this study have stated that the time has not been sufficient. Lack of knowledge about the game, chaos that occured in class during the game, failure to follow the rules in some cases and failure of the moderator to manage the game well have been other negativities mentioned. Bayat, Kılıçaslan and Şentürk (2014) have identified that negativities such as loss of time and chaos that might arise in the class while teaching with educational games technique, but these issues could be overcome if the lesson plan is prepared in advance in the classes where student-oriented teaching methods and techniques and constructivist teaching approach are preferred with the student having an active role. These results are in parallel with the results of our study.

Views of applying teacher about the technique of teaching with educational games

While preparing the educational games, the focus has been enjoyment and didactic characteristics which have been the priority of students, which were stated the most commonly by them. The knowledge level of the class has been another criterion considered. The activities have been prepared so that they could be used in explanation, deepening and assessment stages of the class, and would be didactic for those that have had difficulty in learning the subject. Swank (2012) suggests the use of educational games for teachers to evaluate the learning level of the lesson.

Card games are the most easily prepared educational game in terms of access to the material, and they have been preferred since they could repeatedly be utilised if used carefully. However, it has been observed that games played with interesting materials have attracted much more attention and interest. This has become obvious when “Element Ping-Pong” game has been played and, even after some time, student number four, who has not quite participated in the class before the application of the educational game, have often asked “Can we play the ping-pong game again?”.

The rules must be well designed in the preparation process of educational games. When the rules and instructions are not clear, not only unfair situations might occur but also the game could become boring rather than being enjoyable. Both the teacher and students have observed that the rules have not always been followed during the application of educational games. Accordingly, the students and teacher have warned the students who have not followed the rules. The pilot application could be carried out to prevent this and necessary precautions could be taken for unwanted situations that might arise. Karamustafaoğlu and Kaya (2013) have also found out in their interviews with students that they have realized the need to follow the rules

also in daily life thanks to educational games.

The themes related to the use of educational games in learning-teaching process have been determined as participation, talent, adaptation, success, classroom setting and negativities. The most striking effect of educational game applications for both students and teacher has been increased participation to the class. Students have participated in the class without having the anxiety of being successful or unsuccessful, being shy or active or answering correctly or incorrectly. Furthermore, teamwork in games have enabled the students to have good time together and strengthened the relationship between them. Anetta, Mangrum, Holmes, Collazo and Cheng (2009) have found out in their study that playing educational games in science class increases participation. Hacısalihoğlu Karadeniz (2017) concluded that unsociable students are very active in the lessons thanks to educational games. Gençer and Karamustafaoğlu (2014) state that students in the same group support each other and thus developing their social skills. Similarly, Yıldız, Şimşek and Ağdaş (2017) have concluded that students have gained social skills such as teamwork, sharing ideas, helping each other, following the rules, expressing thoughts freely and strengthening friendship thanks to educational games.

It has been observed in this study that educational games could be used to reveal the talents of students. Indeed, students that have good diction, have acting skills or are skilled in arts and sports can be more easily noticed thanks to educational games. Accordingly, students might have the opportunity to be recognized by their teachers in multiple aspects and could be guided accordingly. Coşkun (2012) has identified that educational games might be a good way to recognize the different talents of students. In his study on how to prepare educational games, Allery (2014) has stated that multi-purpose use of games dates back to very old times, and games are also used in business for teaching and developing various skills including decision-making, problem solving and having effective negotiations. Swank (2012) has stated that students gain the opportunity to get to know themselves, develop their creativity and assess their knowledge and skills during the application of educational games.

The fact that the researcher has also enjoyed the practice and spent efficient time in the class with the students has positively affected the classroom setting and this positive atmosphere has been reflected during the lesson. It has been observed that students have been excitedly waiting for the teacher before the class. It is thought to be a strengthening factor of the relationship between teacher and student as well as between students. Both the teacher and students have stated that classes have been more enjoyable thanks to the educational games. They have positive effects for the students in this age group to have fun in the class, love the lesson and be successful. El-Masri, Tarhini, Hassouna and Elyas (2015) have concluded in their study that the joy of students has increased thanks to the educational games which are prepared in line with the knowledge and the skill level of students have created an internal motivation to participate in the games again. Gençer and Karamustafaoğlu (2014) have found out in their study that uninterested students have also participated in the class and their level of interest for the class has increased.

The educational games could be used for the identification of misconceptions. In this study, the misconceptions have been identified by the teacher and other students while the students have been describing concepts to each other. The misconceptions have been corrected promptly. The priority has been built on students' checking the learning of each other. Boyraz and Serin (2016) have identified the misconceptions of students in educational game activities. They have also identified that educational games contribute to the development of science concepts.

Nevertheless, negativities arising during the application of educational games have also been mentioned. The most common one has been the insufficient time. It has been stated that time has not been enough to describe the instructions of educational game and perform the activity. This issue has often been mentioned in the researcher's journal and student interviews. However, classes lasted for 8 weeks both in the control group and experiemental group. It could be interpreted that educational games have not led to a loss of time, but the teacher and students have wanted more time to spend with the activities. Coşkun (2012) has expressed the similar negativities in their studies. Teachers have stated that the time is not sufficient to play educational games during the class; discipline issues might arise while playing the games; they might be inefficient to have the game played during the class and the classes might be more tiring with this technique. It has been observed that students have become more sensitive when there is a winner at the end of the games. Therefore, teacher must set clear rules and follow the implementation of such rules. Setting the rules together with the students according to the conditions might increase the applicability of rules. The excitement of students and failure to implement the rules may disrupt the order in the class. There are several studies in the literature supporting these identifications. Gedik (2017) has determined that the noise and disorder while playing the games are the problems brought about with this technique. Hacısalihoğlu Karadeniz (2017) has stated that students sometimes disobey the rules and make noise while playing the games.

Insufficient time, discipline issues, failure to follow the rules, failure of the moderator to manage the game well, focus of students on the game rather than the subject and the need of time to learn the games have been the negative aspects stated by students and teachers in this study. Fjællingsdal and Klöckner (2017) have stated that the lack of knowledge of students about the game could be overcome by playing the game again and this repetition would increase the success level of students. Allery (2014) suggests that educational games must be structured well with specific rules. He also suggests that the games must be prepared in a way to require high level of participation in order to promote and support active learning.

One of the negativities stated in literature is the requirement of preliminary preparation for the educational games, which is tiring for the teacher. Preliminary preparation process is tiring and costly, and has taken s a long time while carrying out this study, too. However, if the prepared materials are used carefully, they could be used for long and will facilitate teacher's work in the upcoming years. Therefore, preliminary preparation should not be considered as a negativity.

In this research, one of the expectations of students from the educational game activities has been the awards. The use of awards by the teachers to reinforce the positive behaviors of students is a long-established approach. Since students also have got used to such a practice, they have expected awards from the educational games as well. However, it is thought that educational game applications are not meant to calm and award the students but rather to make the learning environment enjoyable and increase the efficiency of classes. Hanus and Fox (2015) and Özkan and Samur (2017) have stated that the reward system can create an effect that increases competition and decreases motivation.

According to the data obtained from the videos recorded during the application of the games, researcher's observations, and interviews with students, it may be concluded that students spend their energy in the class since they are active while learning. Given the development characteristics of students in the 11-13 age group, they must use their excessive energy. Forcing the students to sit at their chairs all the time causes them to bother each other and negatively

affect the flow of the lesson. However, students are able to move freely during educational games and use their energy properly. Boyraz and Serin (2016) have stated that forcing the students to sit at their desks during whole class and teaching them science using plain explanation are not suitable for their developmental characteristics at play age since they are physically dynamic. In their study conducted accordingly, they have taught science with games in which students could be physically active. It is possible to say that educational games are useful for the teacher, too. The facts that students do not want to have a break before the game ends, wait excitedly for the teacher to come when the break is over, cannot wait for the lesson to start, and want to play the same game multiple times have positively affected the attitude of the teacher towards the class. In this study, the happy expressions of students, and the positive change in their attitude towards the class as well as increased academic success have contributed to the satisfaction of the teacher. Gedik (2017) has found out that students do not want to go out without finishing the game and they excitedly wait for the class to start.

Given all these results under the main and sub themes, the educational game technique could be said as an effective and efficient technique for both the teacher and students. It is possible to list many contributions of the games in the science class, mainly including the success level of students and the attitude towards the class (Jacob Habgood & Ainsworth, 2011).

Considering the class population and physical conditions of the school and the class, it is thought that it will be useful to refer to educational games in all classes and other units of science class. Game materials can be used over and over if they are prepared by using reusable materials. If it will be used in the assessment and evaluation phase of the course, each level should be prepared in a way that students at all success levels can participate by asking questions. Educational games can be used to detect misconceptions. Given the findings and results obtained from this study, the use of teaching with educational games technique should be increased in science classes, the games prepared by the relevant ministry must be provided for teachers and prospective teachers. Training must be given to teachers to develop themselves in this subject.

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