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The Effects of Educational Game-Integrated Group Research Method on Academic Achievement, Attitude towards School, and Retention of Knowledge in Teaching Regulatory System

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ABSTRACT

The purpose of this research was to find out the effects of educational game-integrated group research method of "regulatory system" issue in 7th grade on students' academic achievement, attitudes towards schools, and retention of knowledge. The sample of this study consisted of a total of 54 students in two intact groups at 7th grade students in a middle school in the 2015-2016 academic years. One of these groups was assigned as an experimental group with the educational game-integrated group research method (n=27) and the other was assigned as control group with traditional teaching design (n=27). The experimental and control groups were randomly attributed. Within pretest-posttest control group quasi-experimental design, data were collected via Prior Knowledge Test (PKT), Academic Achievement Test and Attitude towards School Scale (ATSS). The data were analyzed via descriptive statistics and independent group t-test. The experimental group indicated significantly higher academic achievement, more positive attitudes towards school scores and higher permanent learning levels in comparison to the control group.

Keywords: Academic achievement, Attitude towards school, Cooperative learning, Educational games, Retention of knowledge.

INTRODUCTION

In our age witnessing rapid changes in science and technology, individuals can keep up with the times only if they have a quality development (MEB, 2006; Şimşek, 2007; Çavuş, Kulak, Berk & Öztuna-Kaplan, 2011; Çepni, 2011; Bayat, Kılıçaslan & Şentürk, 2014). Making individuals competent in understanding the current science and technology is only possible with a good science education.

A good science education depends on methods and techniques that can provide students scientific thinking skill, enable them to do research in this field, have a positive effect on their attitudes towards science lessons, move them away from rote learning, and provide real learning through concretizing the knowledge (Bozkurt & Olgun, 2005; Gök,

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Doğan, Doymuş & Karaçöp, 2009; Koç, Şimşek & Fırat, 2013). Such methods and techniques exist in practices involving active learning.

In active learning, students get more effective outcomes in terms of academic and social skills by acquiring knowledge through thinking, questioning, experiencing, and actively participating in learning process via their own experiences (Akar, 2012; Çalışkan 2005). Using these methods and techniques facilitate learning by increasing the understandability of abstract and complex subjects and thus contribute to the realization of the aims of science lessons (Sökmen et al., 1997; Uzuntiryaki, Çakır & Geban, 2001; Rollnick et al., 2002; Bayat, Kılıçaslan & Şentürk, 2014). In these methods and techniques, students actively participate in learning process and learn via their own experiences.

Cooperative learning model, which is part of active learning, is a widely preferred model with its many methods and techniques (Siegel, 2005; Doymus, Karacop & Simsek, 2010). Cooperative learning model is a model in which small heterogeneous groups are formed out of students inside and outside the classroom based on a common goal, and students are be responsible for learning of each other and play an active role in learning environment (Açıkgöz, 1992; Hennessy & Evans 2006; Koç, Şimşek & Fırat, 2013; Okur Akçay & Doymuş, 2014).

Motivation levels, critical thinking, problem-solving, cooperation, and verbal communication skills of students in addition to positive views regarding themselves and their friends are improved in the cooperative learning model in which individuals having various skills, interests, needs, social skills, and learning styles are brought together, given a chance to work together, and required to participate in learning environment actively (Christison, 1990; Koç, 2014; Genç & Şahin, 2015).

It is reported that the cooperative learning method contributes to improve academic achievement and social skills of students (Hsiung, 2010; Carpenter, 2003; Johnson & Johnson, 1999; Önder & Sılay, 2015). Students achieve academic development through the active learning environment set in the classes where the cooperative learning model is implemented which is motivating and exploratory, allows students to defend their ideas, encourages them to work together and win together rather than triggering them to compete with each other, and prevents teachers from being regarded as the only source of information (Şimşek, 2007; Önder & Sılay, 2015; Leikin & Zaslavsky 1997; Cooper et al., 1984; Nelson Legall 1992). Through cooperative learning, students have opportunity to do research by working together, make trials, and improve some of their social skills such as expressing one's opinions, listening to each other, discussing with others, and making a shared decision on a specific issue (Genç & Şahin, 2015).

Another active learning activity employed in the present study is the educational games method. For students, the meaning of games is not only having a good time but also making important contributions to learning and creativity (Adıgüzel, 2010; Kaya & Elgün, 2015). An educational game refers to an active learning process which is conducted with or without specific rules and for or not for a specific goal, to help students in physical, cognitive, affective, psycho-motor, and social development and to help students eagerly participate (Dönmez, 1999). Games are one of the most important components of educational development for children where they express their views and establish an interaction with their environment (Şaşmaz Ören & Erduran-Avcı, 2004; Karamustafaoğlu & Kaya, 2013).

Educational games provide students social skills such as collaboration, cooperation, sharing, respecting to thoughts of others, obeying to the rules, protecting individual rights and freedoms, and establishing friendship relations in addition to improve their levels of motivation, creativity, critical thinking, problem-solving, self-confidence, and attitude towards lessons and school (Coşkun, Akarsu & Karaiper, 2012; Savaş & Gülüm, 2014; Karamustafaoğlu & Kaya, 2013; Önen, Demir & Şahin, 2012; Bayırtepe & Tüzün, 2007).

Since the "regulatory system" issue in 7th grade science curriculum involves a lot of abstract concepts, it is quite difficult for students to achieve active learning instead of memorizing. Therefore, the two active learning activities implemented cooperative learning model as the group research method and educational games method were implemented in the present study in an integrated way so that the students could actively learn the "regulatory system" issue containing a lot of abstract concepts instead of memorizing and achieving affective, social, and psychological development while learning.

The present study was conducted to explore the effects of teaching the "regulatory system" issue which is covered in the 7th grade science course through the educational game-integrated group research method on academic achievement and attitudes towards school as well as the retention of knowledge.

This research seeks an answer to the following question: "Does the teaching through educational game-integrated group research method for 'regulatory system' issue covered in the 7th grade science course have any effect on academic achievement and attitudes towards school as well as the retention of knowledge?" In this regard, an attempt was made to answer the below-mentioned sub-problems:

1. Is there any significant difference in academic achievement between the students subjected to the educational game-integrated group research method and those subjected to program-based learning?
2. Is there any significant difference in attitudes towards school between the students subjected to the educational game-integrated group research method and those subjected to program-based learning?
3. Is there any significant difference in the retention of knowledge between the students subjected to the educational game-integrated group research method and those subjected to program-based learning?

METHODS

The quasi-experimental design with pretest-posttest control groups was adopted to determine the effectiveness of the educational game-integrated group research method and of the existing teaching implementation in the teaching process of "regulatory system" issue in 7th grade science course (McMillan & Schumacher, 2006; Christensen, 2004; Büyüköztürk et al., 2012). Prior Knowledge Test (PKT) and Attitudes towards School Scale (ATSS) were administered as a pretest before the implementation. While one of the research groups was assigned as the educational game-integrated group research method, the other group was assigned as the current curriculum proposed by the Ministry of Education method. The Academic Achievement Test (AAT) and ATSS were administered to both groups as a posttest after the implementation. AAT was re-administered as a delayed-posttest 8 weeks later following the end of the implementation. The implementation schedule is given below in Table 1.

Table 1. *Pretest-posttest control group quasi-experimental design schedule*

Groups	Pretest	Experiment	Posttest
Experimental	PKT, ATSS	Educational Game-Integrated Cooperative Learning Model	AAT, ATSS, AAT - retention
Control	PKT, ATSS	Existing teaching implementation	AAT, ATSS, AAT - retention

a) The Study Group

The study group of this research consists of 54 students attending in two different groups of 7th grade in a middle school in rural area of Erzurum Providence in Turkey during the 2015-2016 academic years. The half of the students were assigned as the experimental group (n=27) who had educational game-integrated research method while the others were assigned as the control group (n=27) who had traditional method. Gender, economic income level of the family, and game playing time per day for students participating in research are given below.

The distributions of the students in experimental and control groups according to gender variables are given in Figure 1.

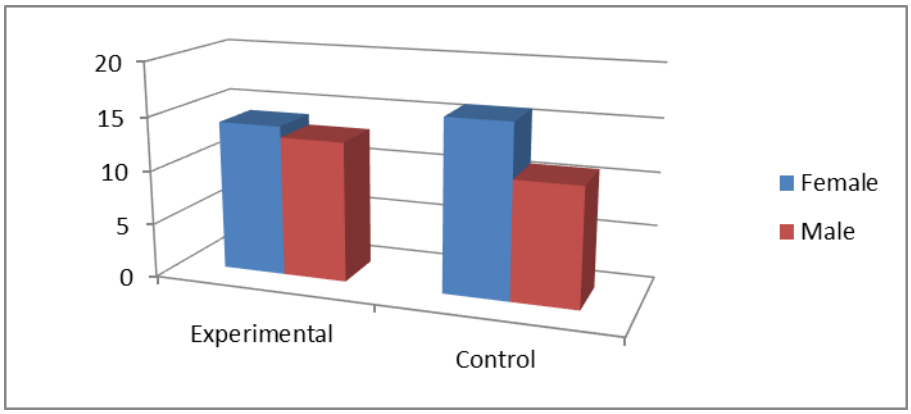

Figure 1. *Gender distributions*

According to Figure 1, the experimental group consisted of 14 female and 13 male students while control group consisted of 16 female and 11 male students. Income levels of students' parents are given in Figure 2.

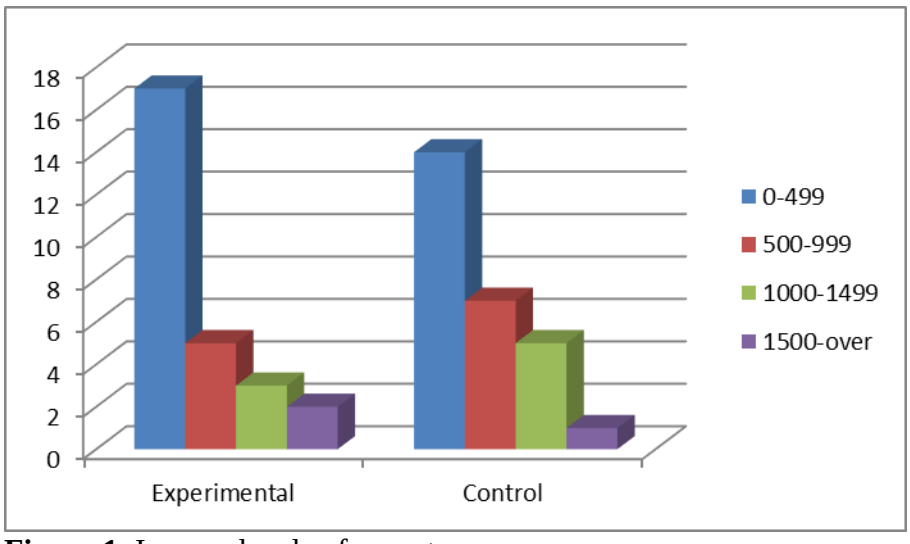

Figure 1. Income levels of parents

According to Figure 2, many of the students come from low-income families. In addition, most of the families have a monthly income of less than ₺500. Since it is important to select individuals for the groups to have different characteristics from each other while

forming the cooperative learning groups, it will be beneficial to consider the variables such as gender and socioeconomic structure in addition to the academic achievement variable during formation of the groups. Intra-group diversity will be increased in this way.
Game play times of students per day are given Figure 3.

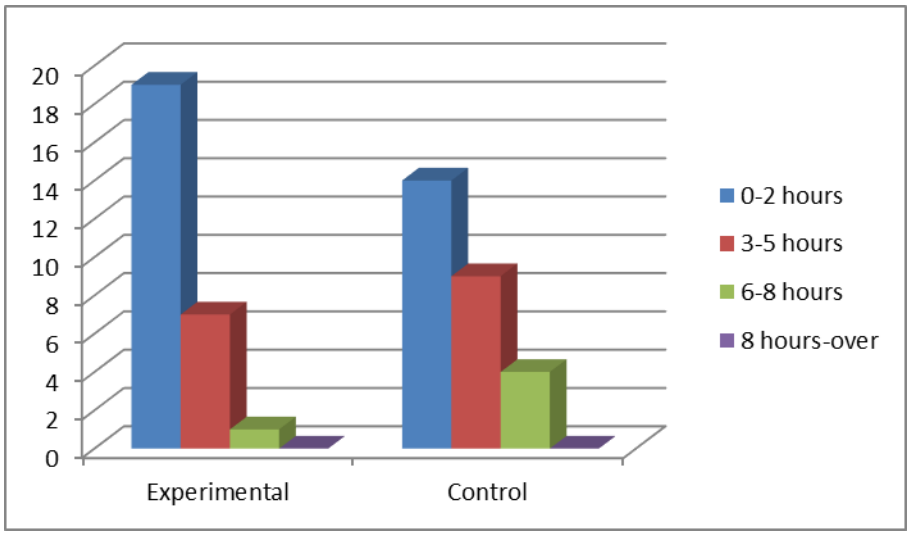

Figure 2. Game play times of students per day

According to Figure 3, students spend very little time for playing digital games in both groups. Since the game is a basic development for children, the short playing times are not sufficient to meet these needs. In addition, digital games are more inadequate than other games in terms of sharing, cooperating, respecting to different thoughts, freely defending their own ideas, and being active. Considering the play times, less playing students were taken in experimental group to play more. There are also special education students with learning disability and adaptation problems in both groups. Students in both groups have a similar problem of learning difficulty. The students feel that they don't have proficiency as much as other students because of this problem. Because of their isolation by their teachers and friends, they have a problem of adaptation to their classes and lessons.

b) Data Collection Tools

PKT was employed to determine the prior knowledge levels of students. ATSS was used to observe any possible change in attitudes towards school. Finally, AAT was implemented to identify academic achievement.

Prior Knowledge Test (PKT)

The Prior Knowledge Test was prepared by the researcher which was created through the questions asked in the Ministry of National Education 6th grade open middle school exams in order to measure the prior knowledge levels students. The test items were presented to 3 experts in science education to ensure content validity. The experts stated that there was no problem with the content of the test but suggested some arrangements only for the font punctuation and the page layout. After the completion the necessary adjustments, a pilot experiment was carried out with 98 seventh grade students. The test was finalized after the pilot experiment with the 25 items. While 4 points were given to correct answers, 0 point was given to incorrect answers and the questions left unanswered. KR-20 reliability coefficient was calculated to be 0.88.

Academic Achievement Test (AAT)

The Academic Achievement Test (AAT) used in the present study was prepared based on the acquisitions of the "regulatory system" issues which is covered in the 7th grade, in order to determine the effectiveness of the methods implemented in the groups. A table of specifications was prepared to ensure the content validity of the test. Expert opinions were taken to ensure its construct validity. After completing the necessary adjustments, a pilot experiment was carried out with 100 students at eight grades. At the end of the analyses, the Cronbach's alpha reliability coefficient was calculated to be 0.81 for the test. The final version of the test consisted of 25 items. While 4 points were given to correct answers, 0 point was given to incorrect answers and the questions left unanswered.

The Attitudes towards School Scale (ATSS)

The Attitudes towards School Scale was developed by Coşkun (2004) to identify the attitudes towards school for the students aged from 11 to 15 years old. ATSS is a 3-point Likert-type scale and made up of 5 positive and 5 negative items (i.e. 10 items in total). Cronbach's alpha reliability coefficient was calculated to be 0.74 for the ATSS. Cronbach's alpha reliability coefficient was calculated to be 0.72 for this research.

c) Data Analysis

The obtained data were analyzed via SPSS in order to find answers to the research questions. Parametric analyzes have been preferred since the data are normally distributed. Descriptive statistics and independent group t-test were used to determine whether the differences were significant between the students in experimental group and the control group in terms of prior knowledge, academic achievement, attitude towards school, and retention of knowledge.

d) Experiment

The implementation was performed by researchers in both groups and lasted in 4 weeks (16 lesson hours) including the implementation of pretest and posttest. In this study, it was targeted that students explain names and tasks of endocrine glands, show their place in body on model, explain names and functions of hormones, indicate diseases and treatments in case of hormonal disorder.

Implementation of the Program-Based Learning

In the group set as the control group, lessons were conducted in accordance with the curriculum specified by the Ministry of National Education of the Republic of Turkey (MEB). Existing teaching implementation pursues the national education program with constructivist approach. The lessons were conducted as recommended for 16 course hours set by MEB. All the recommended activities were performed. Initially, the researcher did research on the subject and prepared a work plan. The textbook, the workbook, the teacher's guidebook, and some other resources were used in that preparation stage. The researcher just carried out the activities included in the textbook as specified in the curriculum.

Implementation of the Educational Game-Integrated Group Research Method

In the group set as the experimental group, lessons were conducted through the educational game-integrated group research method during 16 course hours. Initially, the students were informed how the implementation would be performed. They were informed by their teacher that after completing the 4-hours group work, they would play a game during the 2-hours course period, and their achievement in that game would be directly

associated with the performance displayed by them in the previous 4-hours course period. These explanations were made in order to set the internal motivation of students in motion and make them effectively participate in the learning process. By this means, the pre-game preparations of students were made more meaningful for them and they were motivated to study. As a result, 4-hours educational processes conducted in the classroom were made more efficient. First, the students were divided into heterogeneous groups based on their prior knowledge and gender. The groups were asked to elect a president and find a name for their group. After that, during 4 course hours, the students in the classroom environment did research and collected information on the relevant subject in cooperative groups and then worked on the information that they had collected and run a report based on such information in group. The same procedure was implemented in all the groups. The teacher observed and monitored the groups and intervened in when necessary. Normally, the last stage of the group research method includes group presentations. However, the presentation stage was replaced by an educational game in the present study. This educational game was developed by the researchers under the name of "Know-Win". This game played with a total of 28 game cards. One face of a game card includes the introduction and functions of an organ, the characteristics of an endocrine gland, the functions of a hormone, or the explanation of a disease. The back face of the card includes the name of another organ, endocrine gland, hormone, or disease. Only one of the game cards has a 1 (in figure) on the face including explanations. Sample game cards are shown in Figure 4 and photos of the implementation are presented in the appendices.

Figure 2. *Examples of game cards*

Each student in both groups is provided a game card, and the other cards are kept by the teacher. In this way, the teacher also participated in the process. The student having the card with "1" on it starts the game by reading the explanation written on it. In response to the explanation read by this student, another student having this explanation in another group tells the name of the organ, endocrine gland, hormone, or disease mentioned in the explanation and reads the explanation written on his/her card. The student holding the card that includes what the explanation refers to tells the structure to which such explanation belongs and reads the explanation on his/her card. The cycle is completed in this way. After the first cycle completed, games are played one after another. To determine the winning group in the game, a plus (+) is given for each correct answer from the groups, and a minus (-) is given for each incorrect answer from the groups. Last, the number of minuses

is subtracted from the number of pluses, and the obtained result is divided by the number of the members in the group. Thus, the group having the highest score wins the game.

FINDINGS

The findings obtained through the analysis of the data are presented below.

PKT

Table 2 shows independent group t-test results for the data obtained from PKT that was administered to determine the prior knowledge levels of students before the experiment.

Table 1. *Independent group t-test results for the data obtained from PKT*

Group	N	X	ss	df	t	p*
Experimental	27	66.04	23.25	52	1.112	.271
Control	27	60.00	15.96			

p>0.05

According to the Table 2, there was no statistically significant difference ($t_{(52)}$=1.112; p>0.05) between the prior knowledge levels of the experimental group implemented the educational game-integrated group research method ($X_{experimental}$=66.04) and the control group implemented the program-based learning ($X_{control}$=60,00).

AAT

Table 3 shows independent group t-test results for the data obtained from AAT that was administered to determine the academic achievement levels of students after the implementation.

Table 2. *Independent group t-test results for the data obtained from AAT*

Group	N	X	sd	df	t	p*
Experimental	27	72.59	22.67	52	3.122	.003
Control	27	51.85	26.03			

p<0.05

According to the Table 3, the experimental group students implemented the educational game-integrated group research method ($X_{experimental}$=72.59) had statistically significant higher ($t_{(52)}$=3.122; p<0,05; η^2 =0.16) AAT scores compared to the control group students implemented program-based learning ($X_{control}$=51.85). 16% of the variance observed in the student academic achievement derived from the implemented method. According to Cohen (1988), this value represents a big effect size.

ATSS

Table 4 shows independent group t-test results for the data obtained from ATSS that was administered to determine the student attitudes towards school before the experiment.

Table 3. *Independent group t-test results for the data obtained from ATSS as a pretest*

Group	N	X	ss	df	t	p*
Experimental	27	24.81	3.57	52	1.746	.087
Control	27	23.11	3.60			

p>0.05

According to Table 4, there was no statistically significant difference ($t_{(52)}$=1.746; p>0.05) between the attitudes towards school scores of the experimental group students implemented the educational game-integrated group research method (X=24.81) and the control group students implemented the program-based learning (X=23.11) before the experiment.

ATSS was also administered as a posttest in order to determine the effects of the educational game-integrated group research method and the program-based learning on the student attitudes towards school. Table 5 below presents the analysis results for the data obtained from the scale.

Table 4. Independent group t-test results for the data obtained from ATSS as a posttest

Group	N	X	sd	df	t	p*
Experimental	27	25.41	2.79	52	2.054	.045
Control	27	23.48	3.99			

p<0.05

According to the Table 5, the experimental group students implemented the educational game-integrated group research method ($X_{experimental}$=25.41) had statistically significant higher ($t_{(52)}$=2.054; p<0.05; η^2 =0.07) ATSS scores after the experiment compared to the control group students implemented the program-based learning ($X_{control}$=23.48). 7% of the variance observed in the student attitudes towards school derived from the employed method. According to Cohen (1988), this value represents a medium effect size.

AAT-retention

To see the student levels of permanent learning, AAT was re-administered 8 weeks later following the end of the implementation. Table 6 shows the independent group t-test results for the data obtained.

Table 6. *Independent group t-test results for the data obtained from AAT-retention*

Group	N	X	ss	df	t	p*
Experimental	27	71.48	21.47	52	4.781	.000
Control	27	46.74	16.18			

p<0.05

According to the Table 6, there was a statistically significant difference between the groups in favor of the experimental group students implemented to the educational game-integrated group research method ($X_{experimental}$=71.48; $X_{control}$=46.74 $t_{(52)}$=4.781; p<0.05; η^2 =0.31) in terms of the retention of what was learned. Cohen's effect size (1988) that was calculated to see the source of the rise in the experimental group students' levels of retention was found to be r^2=0.31. In this regard, it was seen that the implemented method had an enormous effect of 31% on retention.

DISCUSSION and CONCLUSION

This study was performed to explore the effect of teaching the "regulatory system" issue, which is covered in the science course, through the educational game-integrated group research method on students' academic achievement levels and attitudes towards

school. First, the analysis of the data obtained from PKT, which was administered in the beginning, indicated that there was no statistically significant difference between the readiness levels of the students participating in the study (Table 2). In this sense, it can be said that the academic levels of the participating students were close to each other in the beginning.

According to the analysis results of the data obtained from AAT, which was administered to determine the effects of the educational game-integrated group research method and the program-based learning on the academic achievement of students, the students implemented the educational game-integrated group research method had statistically significant higher mean scores on academic achievement compared to the students implemented the program-based learning (Table 3). Based on these results, it can be said that the educational game-integrated group research method is more effective in improving academic achievement of students. The results obtained in the present study were consistent with the results of other studies focusing on the cooperative learning model and educational game method (Hsiung, 2010; Carpenter, 2003; Johnson & Johnson, 1999; Önder & Sılay, 2015; Doymuş, 2007; Evcim & İpek, 2013; Genç & Şahin, 2015; Bayat, Kılıçaslan & Şentürk, 2014; Saracaloğlu & Aldan Karademir, 2009; Uzun, 2012; Kaya & Elgün, 2015). The reasons for this kind of effect may be as follows: students have increased their levels of motivations in classes where the cooperative learning model and educational game method are implemented; they are allowed to defend their ideas freely; exploration is encouraged; and they are provided with an active learning environment where they can achieve effective learning (Şimşek, 2007; Önder & Sılay, 2015; Leikin & Zaslavsky 1997; Cooper et al., 1984; Nelson Legall, 1992; Karamustafaoğlu & Kaya, 2013; Bayırtepe & Tüzün, 2007; Coşkun, Akarsu & Karaiper, 2012).

The analysis results of the data obtained from the administered ATSS to determine the effects of the methods employed in the present study on attitudes towards school indicate that while there was no statistically significant differences between the two groups in terms of attitude towards school before the experiment, there was a statistically significant difference between the groups in favor of the students mplemented the educational game-integrated group research method after the experiment (Table 4-5). The reasons for this finding may be as follows: students having education in the classes where the cooperative learning model and educational games are implemented have higher critical thinking, problem-solving, and motivation levels and more positive attitudes towards science lessons, school, themselves, and their friends (Koç, 2014; Genç & Şahin, 2015 Coşkun, Akarsu & Karaiper, 2012; Savaş & Gülüm, 2014; Karamustafaoğlu & Kaya, 2013; Önen, Demir & Şahin, 2012; Bayırtepe & Tüzün, 2007).

To identify the retention of learning among the students, AAT was re-administered as a retention test 8 weeks later following the end of the implementation. The analysis results of the obtained data showed that the students in the group implemented the educational game-integrated group research method had higher learning levels (Table 6). The reason for this finding may be through the educational game-integrated group research method; the students participated in the learning process in an active way rather than passive way; understood the subject better without just memorizing the information; transferred the knowledge more easily, and achieved a higher level learning through the improvement in their cognitive structures. This result of the present study is consistent with the results of the studies in the literature that suggest the cooperative learning model and educational games lead to permanent learning (Çalıklar, 2015; Evcim & İpek, 2013; Savaş & Gülüm, 2014; Yıldırım & Girgin, 2012).

During the informal observations conducted throughout the research, it was seen that the students in the experimental group showed more interest in lessons, more willing to

participate in activities, and enjoyed a lot during the lessons. It was observed that the students did not even want to take a break, preferred the game to the break, and tirelessly wanted to play again and again. Similar results were reported in other studies conducted on educational games (Bayat, Kılıçaslan & Şentürk, 2014; Saracaloğlu & Aldan Karademir, 2009). There were two students having learning disability and adaptation problems in the classes. One of them was included in the control group, and the other one was included in the experimental group. During the informal observations, no positive improvement was seen for the student having learning disability in the control group whereas the student having learning disability in the experimental group learned majority of the concepts intended in the covered subject, wished to participate in the course activities during the game, and tried to express his opinions by asking permission to talk. The reason underlying this result may be the psychological effect of the games on children.

Based on the results obtained in this study, it is considered that implementing the educational game method through integration with active learning models and methods will improve internal motivation of students, make the employed method more effective, and bring a lot of educational contributions. Hence, it is thought that games can be implemented with different learning models and methods on different subjects. The related literature pointed out that educational games are mostly used after a subject is covered through the program-based learning or to support another teaching method that is taken as basis in the teaching process (Gençer & Karamustafaoğlu, 2014; Bayat, Kılıçaslan & Şentürk, 2014; Kaya & Elgün, 2015). Based on the measurements and observations carried out during the research, it can be stated that games eliminated a lot of concerns of students about the subject and enabled them actively participate in the learning process. It was seen that highly efficient educational outcomes were obtained through the integration of educational games into other methods and techniques. Due the fact that integrating educational games into active learning methods lead to such positive outcomes, it can be considered that using educational games as an active teaching method on its own will provide greater benefits as much as learning through games be effective. The literature indicates that mostly digital games that are played in the virtual environment are used in the educational field. However, it was thought that games which students can actively play in the classroom environment and whereby they can improve their communication with their friends, express themselves comfortably, and engage in activities related to their affective and psychomotor development may be more effective in providing students with the intended basic behaviors.

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Appendices (photos from the application process)