

AN ACTIVITY EXAMPLE CONCERNING LEARNING OF ELEMENTS AND PERIODIC TABLE

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ABSTRACT

This study aims to introduce the “Activity of Elements” that was designed by the researcher and to investigate the effect of this activity on student performance about elements and periodic table. The research was carried out with 15 students in the 8th grade. The activity consists of two stages: project preparation and competition. In this article, the activity steps were explained, its effectiveness on the students’ success was evaluated and the students’ opinions about the activity were examined. It was determined that the students’ performance increased on recognizing the groups and periods in the periodic table, and learning the names, symbols, atomic numbers, usage areas and place of the first 18 elements and commonly used elements in the periodic table. Moreover, the students expressed that they enjoyed the lesson and learned in fun during the activity and they stated that the most enjoyable stage was the competition stage.

Keywords: element, periodic table, project, science education, science activity.

ELEMENTLER VE PERİYODİK SİSTEMİN ÖĞRENİLMESİNE İLİŐKİN ETKİNLİK ÖRNEĐİ

ÖZ

Arařtırmada, geliştirilen “Elementler EtkinliĐi”ni tanıtmak ve bu etkinliĐin öğrencilerin elementler ve periyodik tablo ile ilgili başarılarına etkisinin incelenmesi amaçlanmıştır. Arařtırma ortaokul 8. sınıfta öğrenim gören 15 öğrenci ile yürütülmüştür. Etkinlik proje hazırlama ve yarışma olmak üzere iki aşamadan oluşmaktadır. Etkinlik tanıtılarak uygulama basamakları anlatılmış, öğrenci başarısı üzerinde etkililiĐi deĐerlendirilmiş ve öğrencilerin etkinlik hakkında görüşleri alınmıştır. Etkinlik sonunda öğrencilerin periyodik tablodaki grup ve periyotları tanıma, periyodik tablodaki ilk 18 element ve yaygın olarak kullanılan elementlerin isimlerini, sembollerini, atom numaralarını, kullanım alanlarını ve periyodik tablodaki yerlerini bilmedeki başarılarının arttığı belirlenmiştir. Ayrıca öğrenciler etkinlik esnasında hoş vakit geçirdiklerini, eğlenerek öğrendiklerini ve etkinliĐin en çok yarışma kısmından hoşlandıklarını ifade etmişlerdir.

Anahtar kelimeler: element, periyodik sistem, proje, fen eğitimi, fen etkinliĐi.

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INTRODUCTION

We frequently witness to classification of some events, objects, concepts, or circumstances according to a particular systematic in our daily life. Similarly, we come up against many classifications that facilitate learning in courses. Classification of living creatures in biology, types of energy in physics and elements in chemistry are examples of such classifications. Certain properties of the variables are taken into consideration and they are classified in line with the predetermined strategies. Chemical elements are classified according to their properties in the form of periodic table. Periodic table is a table in which elements are arranged according to their atomic numbers and grouped considering their chemical properties. The elements are classified in the periodic table considering their properties such as conductivity, stability, hardness-softness and physical states. Knowing the location of an element in the periodic table provides information about that element. This facilitates the work of those who are interested in chemistry.

The periodic table is composed of 7 rows indicating the periods and 18 columns indicating the groups (Petrucci, Harwood, & Herring, 2010). Periodic table is one of the topics of chemistry, which is one of the fields of science. Although chemistry contains concepts that we frequently encounter in daily life, the students perceive chemistry as a world of abstract knowledge (Koçak & Önen, 2012). The students perceive the elements in the periodic table as hazardous chemicals and inclusion of these elements in many items we use in our daily life is surprising for them. Particularly the existence of carbon, nitrogen and sodium in the structure of living creatures and of oxygen and hydrogen in water is hardly believable for the students.

The fact that the contents of course topics do not attract students' interest is one of the important problems in chemistry education (Gilbert, 2006). In order to overcome this problem, the topics should be taught in a way that they would attract the attention of students. This fact necessitates the development and renewal of the methods and techniques in the curriculum.

There are research studies on different methods and techniques used to teach the names, properties and places of the elements in the periodic table during the teaching process. Vlasov and Trifnov (2001) wrote a book titled "107 Stories about Chemistry" to ensure students to learn the names, symbols and properties of the elements entertainingly. The information in the book is presented through various analogies and stories. Dreyfuss (2000) used an old car to teach the periodic table and the elements. The car was divided into 92 squares and the squares were painted in nine different colors according to similar chemical properties. The car was prepared by 63 students in the age range of 13-19 and they participated in chemistry week activities. In the research, it was stated that they attracted the interest of the public, local newspapers and news and made an impression in the society.

Aycan, Türkoğuz, Arı, and Kaynar (2002) aimed at teaching the elements in the periodic table and their symbols to prospective elementary teachers and secondary school students with computer games and bingo. The research concluded that the sixth graders were interested in bingo and puzzle game created on computer, while the seventh graders were more interested in computer game. In addition, it was observed that the secondary school students were more interested in bingo than prospective elementary teachers and had fun playing the game. Joag (2014) aimed in his research to teach the properties of the periodic table to the students in the age range of 12-13 by way of puzzle solving game. Gögebakan-Yıldız, Kıyıcı, and Altıntaş (2016) carried out a research on teaching the "electronic structure of the atom, properties of periodic table and the atom" to science prospective teachers by using flipped classroom model. The research study found that the flipped classroom model created a significant difference in the achievement of prospective teachers with respect to the topic and the prospective teachers had positive opinions about the model such as it ensured learning with fun, using technology and reinforcing the knowledge. Azizoğlu, Aslan, and Pekcan (2015) tried to help the eighth graders comprehend the periodic table with analogies while Aymen-Peker and Taş (2017) used an objectively and digitally generated

material they called "Apply Learn Periodic Table" for a similar purpose.

These studies in the literature conducted on teaching periodic table and elements intend to teach the topic by using various activities and are based on learning with fun. The present research is different from prior research because it enables the students reach the information by experiencing the project preparation process which is part of the activity and encourages the students to make investigations. Moreover, the absence of any studies that use the project method for teaching this subject reveals the authenticity of this research. In addition, the knowledge contest it includes enables the students to experience the pleasure of success, increases their self-confidence and creates a contest environment and it is also different from other studies in this respect.

One of the standards in the *"Pure Matters and Mixtures"* unit in Science Curriculum of the seventh grade is *"Refers to names, symbols and some areas of use of the first 18 elements in periodic system and common elements (gold, silver, copper, zinc, lead, mercury, platinum, iron and iodine)."* while two standards of the *"Matter and Industry"* unit in Science Curriculum of the eighth grade are *"Explains how the groups and periods are formed in periodic system."* and *"Classifies the elements as metals, semimetals and non-metals in periodic table."* (Ministry of National Education, 2018). The first 18 elements in the curriculum are Hydrogen (H), Helium (He), Lithium (Li), Beryllium (Be), Boron (B), Carbon (C), Nitrogen (N), Oxygen (O), Fluorine (F), Neon (Ne), Sodium (Na), Magnesium (Mg), Aluminum (Al), Silicon (Si), Phosphorus (P), Sulfur (S), Chlorine (Cl), and Argon (Ar). The elements commonly used in daily life are Iron (Fe), Copper (Cu), Zinc (Zn), Silver (Ag), Iodine (I), Platinum (Pt), Gold (Au), Mercury (Hg), and Lead (Pb). The topics of elements and periodic table in the curriculum are addressed with a cyclical approach in the seventh and eighth grades. Therefore, the research was conducted with the eighth-grade students who learn the topic in full.

The activity plan designed in this study included group work to give the students the opportunity

to collaborate. Collaborative learning is a learning process in which the students get together by forming heterogeneous groups to achieve a common goal, influence each other's learning and learn collectively (Açıkgöz, 1992). Collaborative learning which is based on team learning is an active student-centered learning method that carries the targeted teaching into effect, provides the individuals in the team with a chance to help each other's learning and socially interact (Güvenç & Açıkgöz, 2007). In this study, the designed activity also aimed to enable the students reach the information directly in the process of project preparation by investigation and to develop the students' project production skills.

The aim of this research was to enable the students to learn the names, symbols, areas of use of the elements and their places in periodic table with the *"Elements Activity"* as they have difficulty to understand the topic and keep them in mind. The activity included in the research will enable the students to learn the topic which is hard to understand and easily forgotten as it is based on memorization without getting bored. The activity is an important practice because it gives an opportunity to students to have an investigative mind, develop their project preparation skills, and learn with fun by way of knowledge contest. It is considered that the research will contribute to science education with these aspects.

ACTIVITY IMPLEMENTATION

The research was conducted with 15 eighth grade students who receive education in a socioeconomically medium-level public middle school in a county of Samsun province in Turkey. Before starting to teach the topic of periodic system in "Matter and Industry" unit in the eighth grade, topic of pure matters taught in the seventh grade was repeated in two periods. "Elements Achievement Test" (Appendix 1) was applied as a pre-test before the seventh-grade subject repetition. The same test was applied one week after the end of the activity and four weeks after the pre-test as the post-test. The test prepared by the researcher includes questions about the groups and periods in the periodic table, the first 18 elements and commonly used elements' symbols, atomic numbers, usage areas and their places in the periodic table. The test was examined by two

science education experts and two science teachers and it was stated that the test provided the content validity and it was appropriate to the students' level. Moreover, in order to determine the thoughts of the students about the activity, they were asked to fill-out a semi-structured interview form composed of eight questions (Appendix 2). Approval for the research was obtained from the school directorate.

The two-stage activity developed by the researcher was called the "Elements Activity." The first stage of the activity was the project and the second stage was the contest. The students were given 2 weeks to prepare for the project and the part of the activity in the classroom was completed in 4 periods. The projects were presented in 2 periods and 2 periods were spared for the contest stage. Project reports were submitted at the end of the project stage. The project stage was partaken of the contest stage.

The students were divided into three heterogeneous groups of five according to the results of the pre-test made before the activity. Groups were named as Group A, B, C. In order to comply with draft contest, lots were drawn among the groups and groups A, B, and C were determined. Members of each group have discussed amongst them and selected a spokesperson for the group. Responsibilities of the group spokesperson are as follows:

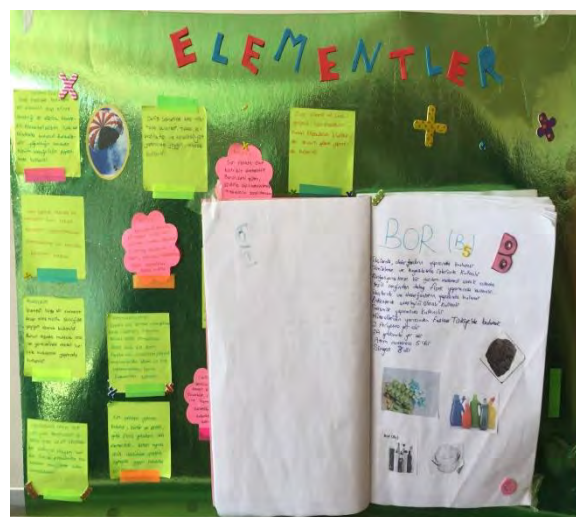
- Presents the project.
- Organizes his/her group.
- Interacts with the group and conveys their joint decisions.

First Stage: Project

The groups were given the names of the first 18 and commonly used elements in the periodic table 2 weeks in advance and they were asked to investigate their atomic numbers, places in the periodic table and usage areas. Each group was asked to prepare a project to facilitate the recognition of these elements. The groups have carried out their investigations in this process by taking advantage of sources such as books, magazines, and the internet. At the end of the first week, the teacher met with each group separately for a lesson period. The groups informed the teacher about the progress of their research and consulted the teacher in order to plan their studies in the last week. The teacher

guided the students in this process. The members of each group have shared the tasks among them for their joint project and completed their preparation. At the end of the process they presented their projects and submitted the project reports.

The projects of Group A, B, and C were named *the Elements Magazine*, *Periodic Library*, and *House of the Elements* respectively. In the project designed in the form of a magazine, A4 papers were used and a leaf through magazine was prepared. Properties of a different element were provided on each page of the magazine adhered to background cardboard and pictures depicting their areas of use were attached. Photograph 1 shows the Elements Magazine.



Photograph 1. The Elements Magazine Project

In the project designed in the form of a library, shelves were created with different color papers on a large background cardboard. Small booklets were created for each element. Properties and atomic numbers of the elements were inscribed on the front covers of the booklets and pictures related to their areas of use were attached inside. In the library design, different colored papers were used for each group to distinguish metals, nonmetals, semi-metals and inert gases according to the types of the elements. Photograph 2 shows the Periodic Library Project.

In the house design, colored papers on which the properties of the elements were inscribed and pictures showing their areas of use were adhered to the exterior and roof of the house. During their presentation, they stated that they placed the properties of zinc on the roof because of

drawing attention to the use of zinc in the construction of roof. Picture of this project is given in Photograph 3.



Photograph 2. Periodic Library Project



Photograph 3. House of the Elements Project

Preparation of Contest Cards

A total of 27 contest cards, one for each element, were prepared to be used in the contest. Contest cards were prepared by the researcher so that the questions were not seen by students. The questions were prepared in accordance with the properties specified in group reports. Accuracy of the properties specified for the elements was checked by the researcher. Then, a list of properties was made and common properties expressed by all three groups were marked. Eight questions for each element based on these common properties were prepared for the contest. The questions were intended to enable the students find the given element. The questions were sorted in a sequence so that it

would be easier to find the element when they come to question 8. The element Oxygen is given below as an example. All three groups have specified the following properties of Oxygen.

- It constitutes about 21% of the atmosphere.
- It is gas phase.
- *It is used in steel production.*
- *Its symbol is O.*
- It is a molecular element.
- It is used for welding.
- *It is in the group of 6A.*
- *It participates in the structure of water.*
- It is used in the construction of concrete.
- *Its atomic number is 8.*
- Used in water purification.
- It is in the oxygen tube used by divers and astronauts for breathing.
- *It is nonmetal.*
- *It has burning feature.*
- *It is vital for living creatures' respiratory.*
- It is in the second period.
- *It takes part in corrosion event.*
- *It is colorless and odorless.*
- *It is used in the treatment of patients with respiratory disorders.*

Eleven out of 19 different properties specified for element oxygen (*in italic*) were included in the reports of all three groups. Eight of these common properties were selected and the expressions to be written on the cards were prepared from hard to easy as shown below.

1. It is colorless and odorless.
 2. It is used in steel production.
 3. It is in the group of 6A.
 4. It has burning feature.
 5. It takes part in corrosion event.
 6. It participates in the structure of water.
 7. It is vital for *living creatures'* respiratory.
 8. Its symbol is O.
- (Oxygen – O₈)

These expressions were asked in a question format such as “It is colorless and odorless, what is this element?” The groups stated 16 properties for Hydrogen element, 15 for Helium, 10 for Lithium, 11 for Beryllium, 13 for Boron, 12 for Carbon, 12 for Nitrogen, 13 for Fluorine, 11 for Neon, 15 for Sodium, 12 for

Magnesium, 11 for Aluminum, 12 for Silicon, 10 for Phosphorus, 14 for Sulfur, 11 for Chlorine, and 12 for Argon in their reports. Regarding the commonly used elements, 12 properties for Iron, 18 for Copper, 11 for Zinc, 12 for Silver, 11 for Iodine, 13 for Platinum, 11 for Gold, 16 for Mercury, and 10 for Lead were determined. Eight of these common characteristics were selected and 27 contest cards were prepared. The expressions on the contest cards are given in Appendix 3.

Second Stage: Contest

A seating arrangement was made so that the members of each group sit together. The periodic table used to place the elements in the contest was magnetic, so that the elements can be removed and attached one-by-one at will. The elements in the periodic table were hung on some place visible to everyone. In order to minimize the probability of the group which would place the element on the table to select the right element by chance when the number of cards becomes less, 20 more elements other than those in the contest were placed into the box of elements. Element cards were mixed, turned upside down, presented to the groups and they were asked to pick a card in turns. Thus, 27 contest cards were distributed equally among three groups (nine cards for each). Spokesperson of each group held the cards in such a way that the members of other groups could not see them. After the students were informed about the rules of the contest, the contest was started.

Responsibilities of the group asking questions are as follows:

- asking questions on the card,
- time keeping,
- check the correct answer,
- and keeping the score table.

General rules of the contest are explained in the following list:

- The group members try to talk in a low voice when they discuss among themselves so that the members of other groups cannot hear them.
- The time limit to answer each question was 10 seconds.
- If no answer is received within the given time, the right to answer passes to the other group.

- The groups have only one chance to answer the questions.
- The answer is the joint decision of group members and the group spokesperson utters it.
- If the element is guessed correctly but a wrong element is selected from the box of elements or the element is placed on periodic table incorrectly, then it is the other group's turn. If the competing groups cannot select or place correctly, then it is the turn of the questioner group.
- Finding the right element after the first question means scoring more points. If they find the right element after the first question, they score 8 points and 7 points after the second question, 6 points after the third question, ... and finally 1 point after the eighth question (Appendix 4: Table 1).

In the first round Group A asks the questions and groups B and C compete. Group A asks the question on the first card to Group B and guessing time is 10 seconds. If Group B cannot give the right answer in 10 seconds, then it is Group C's turn. Group C makes a guess. If Group C cannot find the element based on the given property, the second question on the card is asked to Group C. If Group C cannot find the element, then it is Group B's turn. This process is repeated until one of the groups finds the element, the properties of which are given. If neither group finds the element after eight questions of each card, none of the groups can score any points. When the right answer is given, the points scored are recorded in the related score table (Appendix 4: Table 2, Table 3, Table 4) in accordance with the scoring criteria.

The group which guesses the element correctly tries to place the element on periodic table. If the group that finds the element cannot select the right element or cannot place it in the table on the first try, then it is the competing group's turn. The group which correctly places the element in the table scores 5 points. If either group cannot place the element on the first try, then the questioner group will have a chance to select and place the element. If questioner group places the element correctly, it scores the placement point. In this case, the competing groups cannot score placement points. After

each question, scored points of the groups are recorded in the related table and the other group is marked with an (X). Then Group B and Group C becomes the questioner group in turn. Groups A and C compete when Group B asks the questions and groups A and B compete when Group C asks the questions. In each round the groups ask all questions on one card. In this way, the contest is completed in nine rounds. Total points of the groups are calculated after the contest and recorded (Appendix 4: Table 5). The group which scores the highest points is announced as the winner.

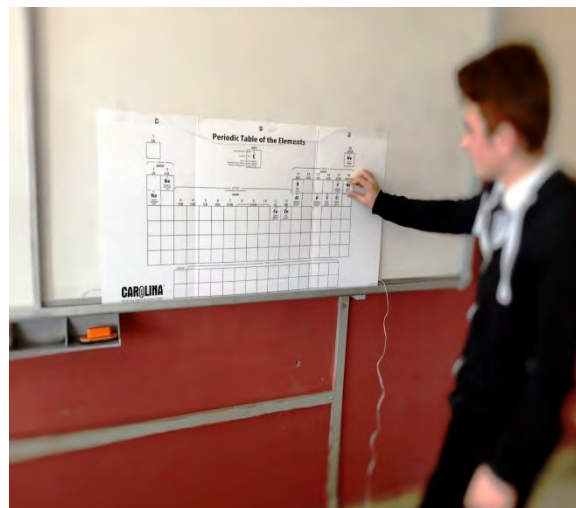
In the contest, only one element was guessed correctly after the first question and two elements were guessed after the eighth question. It was observed that the elements were guessed after the third or fourth questions. Competing groups could not place the element gold correctly and the questioner group did it. In addition, the group which had guessed the element sulfur right could not place it and the rival group did it. At the end of the contest Group A, B and C scored 92 points, 106 points, and 114 points respectively, and Group C won the contest. The photos taken during the contest are presented below (Photographs 4-6). The contest was directed by the teacher. The teacher intervened during the problem situations such as violation of the contest rules or intergroup disputes.



Photograph 4. Contest Photo I



Photograph 5. Contest Photo II



Photograph 6. Placing the Element to Periodic Table by a Student

ASSESSMENT OF THE ACTIVITY

The total score was calculated by giving 1 point to each correct answer in the Elements Achievement Test given before and after the activity. Due to the small number of students, a non-parametric test was used for the analysis. Total scores of dependent groups were analyzed by using the Non-Parametric Wilcoxon Signed-Rank Test. As a result of the analysis, a statistically significant difference was found between the pre-test and post-test scores of students [$z = -3.297$, $p < 0.05$]. The fact that the students' positive rank average (7.50) was greater than the negative rank average (0.00) shows that the significant difference was in favor of positive ranks (i.e., the post-test). In addition, it was determined that the arithmetic mean of the students in the pre-test was 32.50 and the arithmetic mean increased to 61.07 in the post-test. These results show that the activity increased the students' achievement in identifying the names, symbols, atomic numbers, areas of use, and the placement in the periodic table of the first 18 elements and commonly used elements.

It is considered that the project included in the activity, collaborative learning and the contest collectively led to this positive conclusion. It can be stated that making investigation during project preparation, collaboration in learning and the contest which created the competitive environment increased the will to learn and consequently, contribute considerably to knowledge acquisition process of the students. There are studies in the literature revealing that

these teaching methods and techniques increase the academic achievement of students. In the studies conducted on collaborative learning, it was concluded that collaborative learning increases the achievement of secondary school students in science topics (Aksoy & Gürbüz, 2012; Çavdar & Doymuş, 2016; Kozcu-Çakır, Balliel, & Sarıkaya, 2012). In a meta-analysis carried out by Camnalbur and Mutlu-Bayraktar (2018), it was concluded that collaborative learning had a positive effect on the academic achievement of students. Similarly, it was found that the project method had a significant effect on the academic achievement of secondary school students in science (Bayram & Seloni, 2014; Çakıcı & Türkmen, 2013).

At the end of the activity, opinions of the students regarding the activity were obtained with a semi-structured interview form. Interview data were examined with descriptive analysis. It was determined that 14 students gave positive answers to the question of what they think about the activity by using qualifier words such as good, nice, impressive, and entertaining. Only one student stated that he did not like it. All students presented a positive opinion when they were asked about the learning outcomes of the activity. It was determined that most of them stated that they learned the elements and periodic table better. Apart from this, a few students stated that they corrected the faulty information they had about the topic, and learned about group study and following the rules by virtue of the activity. One of the students stated that he learned the areas of use of the elements and said, "*Now I know the elements contained in many things we use in our daily lives.*"

When the students were asked which part of the activity they liked the most, eight students said they liked the contest stage the most, five students liked the team study, one student liked the project stage and one student liked the whole activity. The students, who said they liked the contest, explained that the activity was exciting due to contest. A student expressed her opinion as follows: "*The contest was very nice, very entertaining. It is exciting to compete with others.*" The students who liked group study gave justifications like collaborative study and helping each other. A student expressed his opinion as follows: "*I like studying with my friends in a group. We distribute the tasks.*

Everybody had something to do and they all performed their tasks."

Eleven students wanted the project stage of the activity to be carried out for other science topics and 12 students wanted it to be carried out for other courses. In a study conducted by Ayan (2012), more than half of the students stated that they want to study other units in science with making projects and more than half of the students stated that they want to study other courses with such project activities. Ten students wanted the contest stage to be applied in another science topic, while 13 students wanted to have a similar contest in another course. It was determined that their reasons to want the project and contest stages to be applied in other science topics or in other courses were similar. In general, the students who wanted the project stage to be used stated that they learn better in this way and the topic becomes catchier. A student said "*I want the project stage because the topic becomes catchier.*" The students who wanted the contest stage to be used stated their reasons as the competition in the contest, repetition of topics, having a good time, having fun, and getting excited. A student said "*I would love to have contests. Because it is exciting. I loved to find the element by using clues in the contest.*"

In response to the question regarding the group study, nine students expressed positive opinions and said that studying with friends was fun and it necessitated to have responsibility. The students who expressed negative opinions complained that some of their group members were not active enough.

CONCLUSION and SUGGESTIONS

According to the results of analysis of the achievement test, it was determined that the "Elements Activity" increased the achievement of students. This result is supported by the answers of the students given to the semi-structured interview questions. The students stated that they learned the topics of periodic table and elements better. It was determined that almost all students had positive opinions about the activity and found it entertaining. The students stated that they liked the contest stage most because it was exciting due to the contest. It was concluded that the students wanted the project and contest stages to be applied in

another science topic or in another course. It is possible to use the project and contest stages in the developed activity by adapting it to another science topic or to a topic in another course.

It was observed that the students exchanged ideas at the project design stage and they were quite excited during the contest and had fun. It was also observed that the students were happy with the implementation of the activity and the only problem they encountered was the failure of some group members in performing their duties. It was determined that the students expressed this problem both orally and in their answers to the semi-structured interview questions. In order to overcome this problem, cooperative group work strategies such as individual assessment, peer assessment within the group, rewarding with a grade or physical material can be used.

In the current research, an effective and entertaining activity called "Elements Activity" which can be used in teaching the topic of periodic system in the eighth grade was developed. The conclusion shows that the targeted learning outcomes can be achieved without boring the students. Additionally, one of the advantages is the low cost of the activity.

In this study, the effect of the activity on students' achievement was investigated, but different aspects of the activity can be addressed by expanding the research. For example, a research on the effect of the project included in the content of the activity on development of creative thinking and problem-solving skills of the students can be designed.

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Appendix 2

Interview Form

1. What do you think about the activity in general?
2. What did you learn as a result of completing this activity?
3. What was your favorite part during the activity? Why?
4. Would you like the project phase of the activity to be done on other science subjects? Why?
5. Would you like the contest phase of the activity to be done on other science subjects? Why?
6. Would you like the project phase of the activity to be done in another lesson? Why?
7. Would you like the project phase of the activity to be done in another lesson? Why?
8. What do you think about your group work in the activity?

Appendix 3

Contest Cards

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| <ol style="list-style-type: none"> 1. It is colorless and odorless. 2. It is used to bind nitrogen in commercial fertilizers. 3. It is used as fuel in rockets. 4. It is environment friendly. 5. It participates in the structure of water. 6. Although it is in the group 1A, it is not an alkali metal. 7. Its atomic number is 1. 8. Its symbol is H. <p style="text-align: right;">(Hydrogen - H₁)</p> | <ol style="list-style-type: none"> 1. It takes part in very small amounts in the atmosphere. 2. Its density is lower than the density of air. 3. It is used in aircraft such as airships and balloons. 4. It is used as a refrigerant in works need low temperature. 5. It is noble gas. 6. It has the highest atomic number in its group. 7. Its atomic number is 2. 8. Its symbol is He. <p style="text-align: right;">(Helium - He₂)</p> |
| <ol style="list-style-type: none"> 1. It is used in ceramic and glass making. 2. It is used in battery production. 3. It is used in synthesis of vitamin A. 4. It causes violent explosions when in contact with water or acidic substances. 5. It is used in treatment of psychological disorders. 6. It is alkali metal. 7. Its atomic number is 3. 8. Its symbol is Li. <p style="text-align: right;">(Lithium - Li₃)</p> | <ol style="list-style-type: none"> 1. It is used in construction industry. 2. It is used in missile construction, air and space vehicles. 3. It takes part in structure of some precious stones. 4. It has high melting point. 5. It is used in nuclear power plants. 6. It causes cancer in the lung. 7. Its atomic number is 4. 8. Its symbol is Be. <p style="text-align: right;">(Beryllium - Be₄)</p> |
| <ol style="list-style-type: none"> 1. It is used for cleaning and bleaching. 2. It is used as an igniter in rockets. 3. It is used in production of heat resistant glass. 4. It is used as an insulation material against radiation. 5. Due to its green color, it is used in bullet production. 6. More than half of its minerals are in Turkey. 7. Its atomic number is 5. 8. Its symbol is B. <p style="text-align: right;">(Boron - B₅)</p> | <ol style="list-style-type: none"> 1. It is used for coloring of tires. 2. It is used in the processing of iron and alloys. 3. It is used in production of steel. 4. It is present in structure of all organic compounds. 5. It is the main element of fossil fuels such as coal and oil. 6. It is the only nonmetal in its group. 7. Its atomic number is 6. 8. Its symbol is C. <p style="text-align: right;">(Carbon - C₆)</p> |
| <ol style="list-style-type: none"> 1. It is colorless and odorless. 2. It takes part in structure of fertilizers. 3. It is used for storage of food and chemicals. 4. It is used as a freezer in works need low temperature. 5. It participates in the structure of some organic compounds. 6. It is nonmetal. 7. It constitutes 78% of the atmosphere. 8. Its symbol is N. <p style="text-align: right;">(Nitrogen - N₇)</p> | <ol style="list-style-type: none"> 1. It is colorless and odorless. 2. It is used in steel production. 3. It is in the group of 6A. 4. It has burning feature. 5. It takes part in corrosion event. 6. It participates in the structure of water. 7. It is vital for <i>living creatures'</i> respiratory. 8. Its symbol is O. <p style="text-align: right;">(Oxygen - O₈)</p> |

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| <ol style="list-style-type: none"> 1. It is used in the production of uranium. 2. It is used in ventilation and cooling devices. 3. It is used in making teflon. 4. It is used in making toothpaste. 5. It is important in tooth and bone development. 6. It is halogen. 7. Its atomic number is 9. 8. Its symbol is F. <p style="text-align: right;">(Fluorine - F₉)</p> | <ol style="list-style-type: none"> 1. It is used in colored advertising lighting. 2. It is used in television tubes. 3. It is used in lightning rod production. 4. Obtained liquid state commercially is used as a refrigerant. 5. It is in the second period. 6. It is noble gas. 7. Its atomic number is 10. 8. Its symbol is Ne. <p style="text-align: right;">(Neon - Ne₁₀)</p> |
| <ol style="list-style-type: none"> 1. It is used in pharmacy. 2. It is used in battery construction. 3. It is white and bright. 4. It takes part in structure of baking powder. 5. It is responsible for the passage of nutrients to the cell in the body. 6. It takes part in structure of salt. 7. It is in the 1A group. 8. Its symbol is Na. <p style="text-align: right;">(Sodium - Na₁₁)</p> | <ol style="list-style-type: none"> 1. It is used in body and flash coatings of cameras. 2. It is used in pharmacy. 3. Since it is light, it is used in aircraft and missile construction. 4. It takes part in structure of chlorophyll in green plants. 5. It takes part in structure of living things. 6. It is metal. 7. Its atomic number is 12. 8. Its symbol is Mg. <p style="text-align: right;">(Magnesium - Mg₁₂)</p> |
| <ol style="list-style-type: none"> 1. It is used in construction of missiles and aircraft. 2. It is used for coating of telescope mirrors. 3. It is used for making decorative papers. 4. It is used in electric power transmission lines. 5. It is used for making metal beverage cans. 6. It is used in various kitchen tools. 7. It is in 3A group. 8. Its symbol is Al. <p style="text-align: right;">(Aluminum - Al₁₃)</p> | <ol style="list-style-type: none"> 1. It is used in production of adhesives. 2. It takes part in structure of plants 3. It is resistant to high temperatures. 4. It forms the raw material of glass. 5. It takes part in structure of human skeleton. 6. It is used for making enamel and pottery. 7. It is one of the most abundant elements in nature. 8. Its symbol is Si. <p style="text-align: right;">(Silicon - Si₁₄)</p> |
| <ol style="list-style-type: none"> 1. It takes part in structure of fertilizers. 2. It is used in toothpaste production. 3. It is important for nervous system and bone development. 4. It is used in construction of chemicals used to struggle pests. 5. It is used for making fireworks. 6. It is used for making matches. 7. Its atomic number is 15. 8. Its symbol is P. <p style="text-align: right;">(Phosphorus - P₁₅)</p> | <ol style="list-style-type: none"> 1. It takes part in structure of battery. 2. It is used in chemical and paint industry. 3. It is used in asphalt construction. 4. It is used in making gunpowder. 5. It is used for bleaching dried fruits. 6. It has yellow color. 7. Its atomic number is 16. 8. Its symbol is S. <p style="text-align: right;">(Sulfur - S₁₆)</p> |
| <ol style="list-style-type: none"> 1. It is used in textile industry. 2. It is used in many fields such as insecticides, plastic products in chemical industry 3. It is used for disinfecting drinking water. 4. It is an element with poisoning property. 5. It takes part in structure of food salt. 6. It is a halogen. 7. Its atomic number is 17. 8. Its symbol is Cl. <p style="text-align: right;">(Chlorine - Cl₁₇)</p> | <ol style="list-style-type: none"> 1. It is colorless and odorless. 2. Its state is gas. 3. It is used in Geiger meters that measure radiation level. 4. It is used in electrical lighting bulbs and fluorescent tubes. 5. It is nonmetal. 6. It is the element with the highest atomic number in its period. 7. Its atomic number is 18. 8. Its symbol is Ar. <p style="text-align: right;">(Argon - Ar₁₈)</p> |

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| <ol style="list-style-type: none"> 1. It is widely used in automotive industry. 2. It is widely used in construction industry. 3. It is used in ship hull. 4. It is the raw material of heavy and steel industry. 5. It is processed by extracting from underground as ore. 6. It takes part in structure of blood. 7. It is used for strengthening concrete columns, beams and surfaces in constructions. 8. Its symbol is Fe. <p style="text-align: right;">(Iron - Fe₂₆)</p> | <ol style="list-style-type: none"> 1. It is used in construction industry. 2. It is used in jewelry. 3. Its electrical conductivity is high. 4. It is an element that is easy to process. 5. It is used in coin making. 6. It is used in kitchen and ornament production. 7. It has red color. 8. Its symbol is Cu. <p style="text-align: right;">(Copper - Cu₂₉)</p> |
| <ol style="list-style-type: none"> 1. It is used in battery production. 2. It is used in automotive industry. 3. It is used in electrical industry. 4. It creates alloy with many elements. 5. It is a metal of B group. 6. It is used in production of kitchen goods. 7. It is used in roofing. 8. Its symbol is Zn. <p style="text-align: right;">(Zinc-Zn₃₀)</p> | <ol style="list-style-type: none"> 1. It is used in photography. 2. It is used in electrical connections. 3. It is used for making mirrors, jewelry and ornaments. 4. It is used in dental filling. 5. It is used in coin making. 6. It is a precious element with a bright appearance. 7. It is used in jewelry. 8. Its symbol is Ag. <p style="text-align: right;">(Silver - Ag₄₇)</p> |
| <ol style="list-style-type: none"> 1. It is used in medicine. 2. It is used in pharmacy. 3. It is used in photography. 4. It is solid state at room temperature. 5. It is used in production of iodine tincture. 6. It is abundant in seafood. 7. It is halogen. 8. Its symbol is I. <p style="text-align: right;">(Iodine - I₅₃)</p> | <ol style="list-style-type: none"> 1. It is used in space technologies. 2. It is used in production of wires. 3. It is used in tooth making. 4. It is used in jewelry. 5. It is used in oil processing. 6. It is used in the field of orthopedics in medicine because it is not oxidized. 7. It is very valuable because it is rare in nature. 8. Its symbol is Pt. <p style="text-align: right;">(Platinum - Pt₇₈)</p> |
| <ol style="list-style-type: none"> 1. It is used in coating of space satellites. 2. It is used in decoration. 3. It has high thermal and electrical conductivity. 4. It is used in dentistry. 5. It has bright appearance. 6. It is used in jewelry. 7. It is precious because it is small amounts in nature. 8. Its symbol is Au. <p style="text-align: right;">(Gold-Au₇₉)</p> | <ol style="list-style-type: none"> 1. It is used in paper making. 2. It is used in production of pesticides. 3. It is used in dental filling. 4. It is used to extract gold. 5. It is silvery white color. 6. It causes poisoning. 7. It is used in thermometers. 8. Its symbol is Hg. <p style="text-align: right;">(Mercury - Hg₈₀)</p> |
| <ol style="list-style-type: none"> 1. It is used in battery and cable manufacturing. 2. It is in the 4A group. 3. It is used in X-ray equipments. 4. It is used in sound insulation. 5. It is used as a radiation shield in nuclear power plants. 6. It is used as an additive in gasoline. 7. It is used in production of ammunition. 8. Its symbol is Pb. <p style="text-align: right;">(Lead - Pb₈₂)</p> | |

Appendix 4

Contest Scoring Tables

Table 1. Scoring Criteria

| Question | Score |
|---------------------------------|-------|
| 1 | 8 |
| 2 | 7 |
| 3 | 6 |
| 4 | 5 |
| 5 | 4 |
| 6 | 3 |
| 7 | 2 |
| 8 | 1 |
| Placement in the periodic table | 5 |

Table 2. Group A Scoring Table

| Asking Group: A | | | | | |
|------------------------|---------------------|-----------|---------------------|-----------|-----------|
| Contestant Groups: B-C | | | | | |
| Groups | B | | C | | A |
| Cards | Knowing the element | Placement | Knowing the element | Placement | Placement |
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Table 3. Group B Scoring Table

| Asking Group: B | | | | | |
|------------------------|---------------------|-----------|---------------------|-----------|-----------|
| Contestant Groups: A-C | | | | | |
| Groups | A | | C | | B |
| Cards | Knowing the element | Placement | Knowing the element | Placement | Placement |
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