Elementary Education Online, 2019; 18(1): pp. 112-126
İlköğretim Online, 2019; 18(1): s. 112-126. [Online]: http://ilkogretim-online.org.tr
doi: 10.17051/ilkonline.2019.527170

The Effect of Station Technique Used in Science and Technology Class on Students' Achievement and Retention[1]

Fen ve Teknoloji Öğretiminde Kullanılan İstasyon Tekniğinin Başarıya ve Kalıcılığa Etkisi

İbrahim Benek, *Istanbul University-Cerrahpaşa, ibrahimbenek11@gmail.com*
ORCİD: 0000-0002-7124-4905
Serhat Kocakaya, *Yuzuncu Yıl University, skocakaya@yyu.edu.tr*
ORCİD: 0000-0002-5576-3780

Abstract. In this study, the effect of station technique used in Science and Technology course on students' achievement and retention investigated. The research was conducted with 79 students in the 7th grade from two different primary schools located in the east of Turkey on the 2nd term of 2010-2011 educational year. For the study, an experimental group and two control groups were randomly selected by the researchers. The research was conducted according to the pretest-posttest model with control group. During the application process, the students in the experimental group were learning the subjects by station technique while the students in the control groups were learning the subjects by the activities planned in the science and technology course curriculum. In this study, an "Optics Achievement Test" consisting of 23 multiple-choice questions was developed by the researchers to measure changes in student achievement, and this test was applied to all groups as pretest and posttest. Also 6 weeks after posttest, "Optics Achievement Test" was reapplied to experimental group as retention test. According to the findings, it is concluded that station technique is more effective than existing curriculum activities on students' achievement, and it enables retention of the learnt subjects ($p<0.05$). In addition, in this study, John Henry, and Hawthorne effects, the most important factors threatening internal validity in experimental studies, were tried to be controlled.

Keywords: Station technique, science and technology, optics

Öz. Bu çalışmada, istasyonlarda öğrenme tekniğinin öğrencilerin Fen ve Teknoloji dersindeki başarılarına olan etkisi araştırılmıştır. Araştırmanın örneklemini, 2010-2011 eğitim-öğretim yılı II. döneminde, Türkiye'nin doğusunda bulunan iki ilköğretim okulunun 7. sınıfında öğrenim gören toplam 79 öğrenci oluşturmaktadır. Araştırmada biri deney, ikisi kontrol grubu olmak üzere toplam üç ayrı grup ders öğretmenleri tarafından rastgele olarak seçilmiştir. Araştırmada, ön-test son-test kontrol gruplu model kullanılmıştır. Uygulama sürecinde, kontrol grubu öğrencileriyle dersler fen ve teknoloji dersi öğretim programında öngörülen etkinlikler yapılarak işlenirken, deney grubundaki öğrencilerle bu konular istasyonlarda öğrenme tekniği kullanılarak işlenmiştir. Bu çalışmada, öğrenci başarılarındaki değişmeleri ölçmek için araştırmacılar tarafından çoktan seçmeli 23 sorudan oluşan "Işık Başarı Testi" geliştirilmiş ve geliştirilen bu test tüm gruplara ön-test ve son-test olarak uygulanmıştır. Ayrıca "Işık Başarı Testi", deney grubuna son testten 6 hafta sonra kalıcılık testi olarak yeniden uygulanmıştır. Veriler analiz edildiğinde, istasyonlarda öğrenme tekniğinin öğrenci başarılarına, kontrol gruplarına oranla daha fazla katkı yaptığı ve kalıcı öğrenmeyi sağladığı sonucuna varılmıştır ($P<0,05$). Ayrıca bu çalışmada, deneysel çalışmalarda iç geçerliliği tehdit eden en önemli etkenlerden olan John Henry ve Hawthorne etkileri kontrol altına alınmaya çalışılmıştır.

Anahtar Kelimeler: İstasyonlarda öğrenme tekniği, fen ve teknoloji, ışık

[1]*-A part of this study was presented at the 12th National Science and Mathematics Education Congress (September 28-30, Trabzon 2016). This article is derived from İbrahim Benek's master dissertation entitled " The Effect of Learning Technique at the Station on the Success of 7th Grade Students in Science and Technology Course ", conducted under the supervision of Assoc. Prof. Dr. Serhat Kocakaya. This study funded by YYU scientific research projects with the 2011-FBE-YL013 number.*

Geliş tarihi: 06.02.2018 Kabul tarihi: 11.12.2018 Yayımlanma tarihi: 31.01.2019

INTRODUCTION

The retention of the learnt subjects is not possible with the traditional teaching methods which let teacher to be more active than students. In traditional teaching, teacher is an active narrator and students are passive listeners. In this situation, students have to be contented with the knowledge transferred by the teacher. Thus, students cannot use learned knowledge and skills in real life effectively. On the contrast, modern teaching models are student centered and students are responsible for their learning actively. On modern teaching methods, teacher responsible for providing a learning environment with rich materials and guiding students to learn by self. Thus, teacher is planning activities and guiding students in modern teaching models. With leaving traditional teaching models for modern teaching models, students will take responsibility in learning process, self-evaluation and self-regulation, curiosity, motivation, research, and questioning.

In today's world, countries are in a serious economic competition. This economic competition places countries in search of better education. Because they are aware that more qualified people can be trained with better education. Countries that are aware of this are investing more in education. Because the investment in education is made to the individual and the investment to the individual is made to the future of the country. Individuals who are the future of the country should have critical, creative, entrepreneur, design and innovation skills. Students with these skills can be trained with various contemporary teaching methods, techniques, and models.

One of the modern teaching methods is Station Technique Method that provides students to work with collaborative groups in different learning centers, to be responsible for their learning, to use various materials, to do experiments, to create products (poster, slogan, poetry, painting etc.), to participate in enriched activities, to do research and inquiry.

Station Technique

Station technique benefits collaborative learning, multiple intelligence theory and constructive learning approach to provide active learning with collaborative group activities appealing all intelligences. Students work in-class or out-of-class (laboratory, workshop, hall, e.g.) in specially determined areas (table, desk, e.g.) with groups. There are learning centers that include learning materials (prism, light source, radiometer, crayons, colored papers, e.g.) appealing different intelligence areas to let students learn by their own effort in a thematic way.

Learning stations are the activity centers that students use various teaching materials and follow instructions (Güneş, 2009). In these learning centers, students work according their learning speed, self-control, and their interest (Hepp, 1996, 1999; Schaal & Bogner, 2005). Learning centers are the special areas in the class that included activities with written guidelines, various sources (book, journal, etc.), and other materials (Kaplan, 1999). Station technique, which is an open education method (Bauer, 2003) and it is accepted as an in-school movement, raises active participation and brings movement in class (Morgil et. al, 2002). There can be one or more station centers equipped with learning materials by teacher (Greogory & Hammerman, 2008). Students work in these centers for specific goals in teams. Since each team works in a center for a limited time (15-20 minutes), the work may not be completed. But the other teams come to that center to complete the work (Gözütok, 2007). This gives the students the ability to complete an unfinished work. Each station center has a chief (leader) who has the guidelines of the activity (Fraling, 1982). In a learning station, students perform the appropriate activities prepared by the teacher to reach goals (Ocak, 2007). By this way, students work actively in learning centers, and they get rid of the monotonous of the traditional classes (Demirörs, 2007).

It is found that students work in small groups (3-4 people) learn better than traditional approaches, keep the knowledge in memory longer, and conform with environment (Beckman, 1990; Cohen, 1994; Collier, 1980; Sharan, 1980; Slavin, 1980).

Stages to be Followed When Creating Station Centers

1-Aims: In each station center; there must be a specific aim, such as conducting experiments, creating a slogan, creating a product, composing, solving puzzles, taking pictures.

2-Preparation and Planning: In order for the students to achieve the created goal and achieve the achievements, the activities in the stations (activity, experiment, product creation, etc.) should be planned. The station technique creates a more effective learning environment if applied with correct and careful plans (Sears, 2007).

3-Time: The time in the station centers should not be kept precise and unchanging, in other words, should be flexible (Breyfogle et. al., 1976). This flexibility may vary depending on factors such as course, subject, acquisition, number of students, number of stations.

4-Evaluation: After the studies in the station centers are finished, the studies are evaluated. In this stage, students' such products as puzzles, slogans are evaluated. The teacher also completes the deficiencies with a general assessment and reviews the studies (Gregory & Hammerman, 2008; Schmidt & Harriman, 1998).

What to Be in a Station Center

1. Name: Each station center should have a name that can attract the attention and interest of the students.

2. Instruction: At each station centers, there should be instructions in which the students are going to continue their studies and how to do the activities (Breyfogle et. al., 1976; Dosch, 1988).

3. Timeline: Timeline is that indicates the time in which the work at the station centers should be completed (Demir, 2008; Fox, 2004; McClay, 1996).

4. Tools: The equipment must be left to the stations where the students can use them comfortably. It is also important to note that these tools and equipment can be used by students, they can help them to learn effectively and they can be more than one sensory organ (Schmidt & Harriman, 1998).

5. Product Box: It is a material that should be kept in Product Stations in order to keep the product of the groups during the works (Benek & Kocakaya, 2012, 2016).

6. Working Papers: These are the papers that the studies are reported, a mini test consisting of 3-4 questions, graphs/tables/figures and the studies are summarized (Benek & Kocakaya, 2012, 2016; Kryza, Stephens & Duncan, 2007).

There are many studies carried out about the station technique both national and international literature. When the studies are examined, it is seen that these studies are mostly done in Turkish Language Course, Mathematics, Language Teaching, Preschool, Science, Chemistry, Geology, Life Science, Social Studies, Computer and Physics courses. When these studies are examined, it is observed that the attitudes of the students towards the application and the technique of the station are investigated (Albayrak, 2016; Arslan, 2017; Avci, 2015; Demirörs, 2007; Eilks, 2002; Lebak, 2005; Maden & Durukan, 2010; Morgil et al., 2002; Porter, 2004; Roberts, 1999; Tofte, 1982; Tseng, 2008). In most of the studies, it is seen that the station technique makes positive contributions in developing students' interests and attitudes. In addition, there are studies examining students' academic success of the course by the techniques of station technique (Albayrak, 2016; Arslan, 2017; Avci, 2015; Demirörs, 2007; Eilks, 2002; Erdagi, 2014; Furutani, 2007; Howatson, 1971; Korsacılar & Çalışkan, 2015; Mergen, 2011; Roberts, 1999; Tseng, 2008). In these studies, it is seen that station technique has an important role to increase the academic success of students. In addition, there are studies examining the effect of station technique on high-level skills (Demir, 2008) and achievement and permanence (Avcı, 2015; Güneş, 2009; Mergen, 2011; Tofte, 1982). Apart from all these, there are also studies that examine the effect of station technique on creativity, social development, critical thinking,

reading comprehension skills, concept learning, attitude towards astronomy, writing skills and effective learning (entertainment, joy, enjoyment, etc.).

John Henry Effect

In experimental studies, as students in control group being aware of they are in an experimental study, they compete with experimental group with studying more and they increase their achievement. In this situation, the data revealed may not be correct (Kocakaya, 2011; Saretsky, 1972a, 1972b & 1975). To prevent that it is suggested to have more than one control group and at least one of them should be from a different school (Kocakaya, 2011).

Hawthorne Effect

This effect is known as increase in students' achievement as a result of changes in teaching methods, teachers, and educational environments. With these changes, there is a temporary increase in the success of the students. Because students may be interested with learning process more than usual with this newness (Cook, 1967; Kocakaya, 2011).Thus studying more than their usual performance is negatively affected the findings of the research. Since Hawthorne effect cause a temporary increase in the success of the students for a while (Gillespie, 1991; Mayo, 1933; Roethlisberger & Dickson, 1939), it can be tested with some cautions after the study ends. The simplest way of it is to reapply the same achievement test to the experimental group one or two months later to see the retention of their knowledge (Kocakaya, 2011).

Purpose of the Study

The aim of the study is to investigate the effect of station technique used in Science and Technology course on students' achievement and retention.

Problem Sentence

Is there any effect of Station Technique used in Science and Technology course on 7th grade students' achievements?

Sub Problems

1. Is there any significant difference between the mean pretest and posttest scores of experimental group applied station technique and the control groups applied current curriculum?
2. Is there any significant difference between the mean posttest scores of the experimental group applied station technique and the control groups applied current curriculum?
3. Is there any significant difference between the mean posttest and retention test scores of experimental group applied station technique?

METHOD

Research Design

In order to analyze the effects of station technique in science and technology course on students' achievement an experimental design with pretest - posttest control group was applied in the study. This design is frequently used in educational sciences and behavioral sciences and it has two groups with random assignment. One of these groups is used as an experiment, the other as a control group. Measurements are made before and after the study for both groups with the same data collection tools. During the application, the experimental process is only applied to experimental group (Büyüköztürk et. al., 2013; Karasar, 2015).

In this study, where pretest - posttest control group was used, one experiment and two control groups was assigned. The current curriculum was applied to control groups and station technique was applied to experimental group. The experimental design of the study is presented in Table 1.

Table 1. *The experimental design of the study*

Group	Pretest	Learning Method	Posttest	Retention test
Experiment	Optics Achievement Test	Station Technique	Optics Achievement Test	Optics Achievement Test
Control-1	Optics Achievement Test	Current Curriculum	Optics Achievement Test	-
Control-2	Optics Achievement Test	Current Curriculum	Optics Achievement Test	-

Participants

The research was conducted with 79 students in the 7th grade from two different primary schools located in the city center of Van on the 2nd term of 2010-2011 educational year. The study was conducted with three separate groups. Two of the groups were chosen from the same school and the other from a different school. One group was selected as an experimental group and the other two as the control groups. In the selection of students in the experimental group, volunteers were taken as the basis and necessary permissions were obtained from their parents. The study was conducted with three different groups and two different teachers. Two of these groups were from the same school, one from a different school. The achievement test was applied to all groups as a pretest prior to study in order to determine whether groups equal or not.

In order to determine whether the obtained data shows normal distribution, kurtosis and skewness coefficients are examined. The descriptive statistics of the pre-tests of the experimental and control groups are given in the table below.

Table 2. *Descriptive statistics about pre-tests of experimental and control groups*

Group	Statistic	N	Mean	Median	Mode	S.D.	Varyans	Skewness	Kurtosis
Experiment	Pre-test	30	8.33	8.50	11.00	2.35	5.55	-.304	-1.091
Control 1	Pre-test	25	7.88	8.00	6.00	2.85	8.16	-.128	-.374
Control 2	Pre-test	24	8.20	9.00	10.00	2.62	6.86	-.358	-.386

When Table 2 is examined, it is assumed that the variables are normally distributed as skewness and kurtosis values of experimental and control groups are ranging from -2 to +2 (George and Mallery, 2010). Because of the normal distribution of the data, parametric tests were used. In order to compare the success levels of the experimental and control groups at the beginning of the study, the pre-tests of the experimental and control groups were conducted by means of the t-test of independent groups of parametric tests. The t-test results of the pretest scores of the experimental group and control groups are presented in Table 3.

Table 3. *The t-test results of the pretest scores of the groups*

Test	Group	N	Mean	SS	sd	t	p
Pretest	Experimental	30	8,33	2,682	29	,611	,544
	Control 1	25	7,88	2,804	24		
Pretest	Experimental	30	8,33	2,682	29	,172	,864
	Control 2	24	8,21	2,621	23		
Pretest	Control 1	25	7,88	2,804	24	-,423	,674
	Control 2	24	8,21	2,621	23		

p>0,05

When data in Table 3 is examined, it can be seen that the pretest scores for experimental group is 8.33, control-1 group is 7.88 and control-2 is 8.21. The significant difference between groups' initial achievement was tested with t-test at a significance level of 0.05 and it found that there was no statistically significant difference between groups (p>0.05). Accordingly, it was concluded that there is no difference between initial academic levels of groups and they were statistically equal. The experimental group and the control groups were assigned randomly and

as a result of this, class 7-A (30 students) was assigned as the experimental group, class 7-B (24 students) at the same school was assigned as the control-1 group and class 7-B (25 students) from a different school was assigned as the control-2 group. The reason of choosing a control group from a different school is to observe whether John Henry effect is revealed or not.

Data Collection Tools

The "Optics Achievement Test", which was developed by the researcher and composed of 23 multiple choice questions, was used as data collection tool. The validity and reliability of the test were verified. In order to verify content validity, a table of specification according the 7th grade curriculum on subjects "absorption of light", "is the white light really white?" and "refraction of light" under the "Optics" chapter was prepared. In accordance with the table of specification which has 23 acquisitions a question pool was created. While the questions to be included in the question pool were determined, a literature review have been done among the exams implemented in the past years by the Ministry of National Education (MoNE) like the Placement Test (SBS), Secondary Education Student Selection and Placement Exam (OKS), Free Boarding and Scholarship Examination (PYBS), Private Schools Examination (ÖOS), and various course books and test books approved by the MoNE. After that researchers wrote down 53 multiple choice questions for the question pool. The validity study of the questions have been done by the two physics teachers and two science and technology teachers who had at least five years of teaching experience and had higher education on their fields. All questions were examined in terms of content and format and a draft test consisting of 32 questions was created. The draft test was examined in terms of grammar by a Turkish Language teacher and a Turkish Literature teacher who had at least five years of teaching experience. The final draft test was applied to 120 eighth grade students who had learnt the "Optics" subjects in the previous academic year, and the validity and reliability studies were started. In addition to the expert opinion for validity studies, the answers of the 120 students to the draft test were subjected to item analysis. The multiple choice questions of the test had four options and test was evaluated over total 32 score with of points '1' for the correct answers, '0' for the incorrect or blank answers.

According to the results of the item analysis, some of the items with item discrimination indices less than 0.20 were omitted from the test, and some of them were reedited by the two experts for providing the content validity. Finally "Optics Achievement Test" consisting 23 multiple choice questions were created. Test item difficulty indices ranged from 0.13 to 0.95 with an average difficulty index of 0.56. It has been seen that the average difficulty index of the final test was appropriate for different student levels. Based on expert opinions and item analysis results, it has been decided that the validity of the final test is in an applicable level to the study. In addition, to check the reliability of the test, which is another feature that should be included in the achievement tests, the answers given by the 120 students to the 23 questions in the final test were analyzed. The reliability coefficient of the final achievement test was calculated with Spearman-Brown split-half method. The results yielded that split-half reliability coefficient is 0.69 and all test's reliability coefficient (α) is 0.82. As considering the foreseen reliability level for the measurement tools is 0.70 (Tezbaşaran, 1996), it can be said that the reliability coefficient of our test is satisfactory.

Application Process

Necessary permissions were obtained from the Ministry of National Education before the starting of the study. After the necessary permissions were taken, the schools to be implemented were determined. Later in these schools, in accordance with the aim of the study, three classes were assigned, one experimental group and two control groups. The achievement test that included the 7th grade science and technology curriculum on subjects "absorption of light", "is the white light really white?" and "refraction of light" under the "Optics" chapter was applied to all groups to test their equalities. After applying the pretest, the subjects have been taught in two weeks with total of 8 lecture hours to all three groups. Throughout the application, the station technique was applied to experimental group, and the curriculum supported by constructive approaches prepared by MoNE was applied to control groups. The eleven station centers was set

and presented to students of the experimental group in two lecture hours prior to application. The activities of station centers was developed with accordance of acquisitions on subjects "absorption of light", "is the white light really white?" and "refraction of light" under the "Optics" chapter. The developed activities were presented to the experts and they were given the final shape by making necessary corrections. Eight (8) separate heterogeneous teams were formed within the thirty (30) students of the experimental group for the studies at the station centers. The teams were formed with considering for different gender, success and skills. The 8 teams were started to work in the first eight station centers at the same time. Each team has worked in their station center with the activity materials and guidelines provided by the researcher (teacher). The scheme of the station centers is presented in Figure 1.

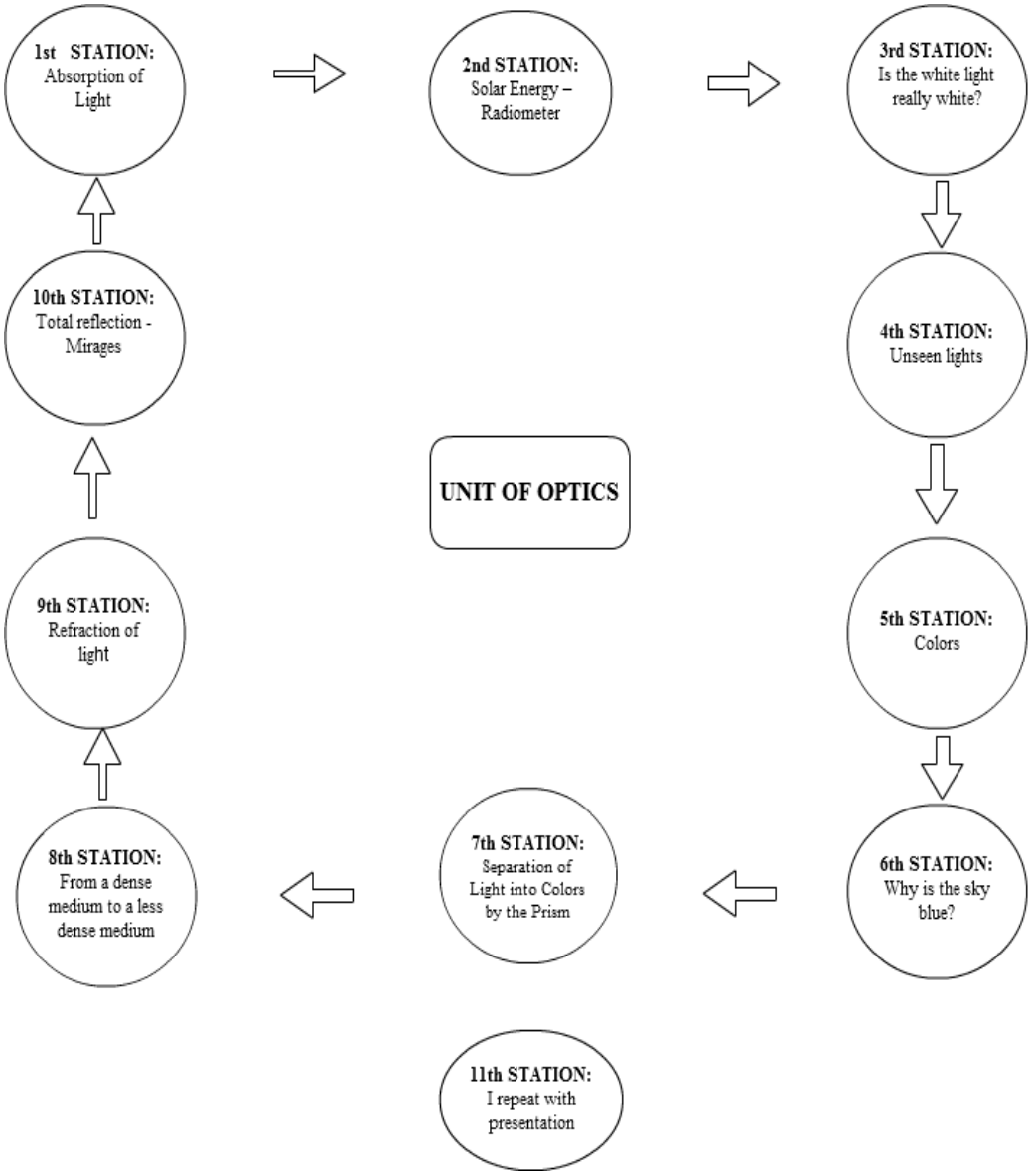

FIGURE 1. *The scheme of the station centers*

The teams have been working for the determined time (20 – 25 minutes) and they have changed their station centers with the teacher's "whistle" command. The activities on the first eight stations have been completed for five lecture hours. The teams that had completed these eight activities and had readiness level continued their works at the 9th and 10th station centers. The works at these two centers have been completed on two (2) lecture hours and the work at the 11th center on one (1) lecture hour. The timetable of the station centers is presented in Table 4.

Table 4. *The time table of the station centers*

Station Center	Time
1st station: Absorption of light 2nd station: Solar Energy – Radiometer 3rd station: Is the white light really white? 4th station: Unseen lights 5th station: Colors 6th station: Why is the sky blue? 7th station: Separation of Light into Colors by the Prism 8th station: From a dense medium to a less dense medium	5 lecture hours (20-25 minutes average for each station)
9th station: Refraction of light 10th station: Total reflection – Mirages	2 lecture hour (15-20 minutes average for each station)
11th station: I repeat with presentation	1 lecture hour

Each team had their own chief (leader), secretary, outfitter, and spokesman and so on. Each station chief had a "station guideline". Thanks to these guidelines, the transformation of the teams in the station centers has been carried out in a certain order. Each station center had a name related to the learning subject. The station names were written in large cartons and hanged in the headquarters of the centers, so that everyone could see them comfortably. The teacher provided all necessary materials for the purpose of the station center (experimental materials, poster materials, etc.) to all station centers prior to application. Each station center has had an activity guideline with 4 – 5 directives. Students have studied and argued the "knowledge cube" which has been hanged to station centers and then they have implemented the activity of the station. The teams that have completed the work have taken notes to "worksheets" about their works and they have individually answered the test including 2 or 3 questions. The teams that have completed their works at a station have been transformed to another station center by directions of the team chief, and they have completed the same processes at all stations.

The works done at the station centers and students have been observed daily by the teacher. The shortcomings observed in the works (paint materials, pencils, cardboards, experimental materials, etc.) have been completed again until the next station works. The materials used in the activities at the station centers have been chosen from simple, understandable, and easy to find equipment.

Data Collection

The "Optics Achievement Test" has been applied to all groups as pretest prior to study and as posttest after completing the study. In addition, this achievement test has been applied to experimental group as retention test six weeks after completing the study. The purpose of the retention test is to determine whether the success achieved is due to the success of the teaching method or the Hawthorne effect.

Analysis of Data

The data obtained and rearranged were analyzed with the t-test for pared and independent samples. In order to analyze the data, firstly the normality test was performed to

determine the appropriate analysis method. In order to determine whether the data show normal distribution, kurtosis and skewness coefficients were examined. According to the results of the analysis, it was observed that all test results of the experimental and control groups showed normal distribution. When the tables below are examined, it is assumed that the variables are normally distributed as skewness and kurtosis values of experimental and control groups are ranging from -2 to +2 (George & Mallery, 2010). Because of the normal distribution of the data, parametric tests were used. Therefore, in order to determine whether there is a significant difference between the experimental and control groups, the t-test which is one of the parametrical measurements is used. The t-test for independent samples was used for comparison of pretest, posttest scores of experimental group and control groups. The t-test for paired samples was used to compare the pretest, posttest scores within each group and retention test scores of experimental group. The significance level of 0.05 was used in the interpretation. The total score of students was calculated by giving "1" point to correct answers and "0" to incorrect or blank answers, and so the maximum score can be 23.

RESULTS

Results Regarding to First Sub-Problem

The first sub-problem of the study was determined as "Is there any significant difference between the mean pretest and posttest scores of experimental group applied station technique and the control groups applied current curriculum?"

The descriptive statistics of the pretest and posttest of the experimental and control groups are given in the table below.

Table 5. *Descriptive statistics about pre-tests and post-test of experimental and control groups*

	Statistic	N	Mean	Median	Mode	S.D.	Varyans	Skewness	Kurtosis
Experiment	Pre-test	30	8.33	8.50	11.00	2.68	7.19	-.233	-1.110
	Post-test	30	14.23	14.00	10.00	4.14	17.15	.025	-1.695
Control 1	Pre-test	25	7.88	8.00	6.00	2.80	7.86	-.088	-.289
	Post-test	25	11.36	10.00	9.00	4.52	20.49	.146	-1.067
Control 2	Pre-test	24	8.20	9.00	10.00	2.62	6.86	-.358	-.386
	Post-test	24	11.95	12.00	9.00	3.44	11.86	-.212	-.934

When Table 5 is examined, it is assumed that the variables are normally distributed as skewness and kurtosis values of experimental and control groups are ranging from -2 to +2 (George & Mallery, 2010). Because of the normal distribution of the data, parametric tests were used.

The aim of this sub-problem is to determine the effect of the station technique applied to experimental group and current curriculum applied to control groups on the students' academic development. In order to test the significant difference between the achievement levels of groups the t-test for pared samples was used. The results of t-test are presented in Table 6.

Table 6. *Results of the t-test for pared samples concerning pretest and posttest of experimental group and control groups*

Group			N	Mean	S.S	sd.	t	P
Experimental	Test	pretest	30	8,33	2,682	30	-11,558	,000*
		posttest	30	14,23	4,141	30		
Control-1	Test	pretest	25	7,88	2,804	24	-6,349	,000*
		posttest	25	11,36	4,527	24		
Control-2	Test	pretest	24	8,21	2,621	23	-4,891	,000*

	posttest	24	11,96	3,445	23

*P<0,05

When the data in Table 6 is examined it can be seen that students' pretest and posttest scores are 8.33 and 14.23 for experimental group, 7.88 and 11.36 for control-1 and 8.21 and 11.96 for control-2. According these findings, a statistically significant difference can be observed between pretest and posttest scores of all groups at a significance level of 0.05 (p<0.05). Thus, it can be said that both station technique applied to experimental group and current curriculum applied to control groups has positive affect on students' achievement.

Results Regarding to Second Sub-Problem

The second sub-problem of the study was determined as "Is there any significant difference between mean posttest scores of the experimental group applied station technique and the control groups applied current curriculum?"

The descriptive statistics of the pretest and posttest of the experimental and control groups are given in the table below.

Table 7. *Descriptive statistics about post-test of experimental and control groups*

	Statistic	N	Mean	Median	Mode	S.D.	Varyans	Skewness	Kurtosis
Experiment	Post-test	30	14.23	14.00	10.00	4.24	18.02	-.281	-1.681
Control 1	Post-test	25	11.36	10.00	9.00	4.61	21.25	.191	-1.124
Control 2	Post-test	24	11.95	12.00	9.00	3.44	11.86	-.212	-.934

When Table 7 is examined, it is assumed that the variables are normally distributed as skewness and kurtosis values of experimental and control groups are ranging from -2 to +2 (George & Mallery, 2010). Because of the normal distribution of the data, parametric tests were used.

It is necessary to compare the final test scores of the groups in order to determine which method contributes more to student achievement. Thus, the posttest scores of the groups analyzed with t-test for independent samples. The results of the t-test are presented in Table 8.

Table 8. *Results of the t-test for independent samples concerning posttest of the groups*

Test	Group	N	Mean	S.S	sd.	t	P
Posttest	Experimental	30	14,23	4,141	29	2,456	,017*
	Control 1	25	11,36	4,527	24		
Posttest	Experimental	30	14,23	4,141	29	2,158	,036*
	Control 2	24	11,96	3,445	23		
Posttest	Control 1	25	11,36	4,527	24	-,519	,606
	Control 2	24	11,96	3,445	23		

P<0.05

When Table 8 is examined, it can be seen that the mean scores of the posttest are 14.23 for experimental group, 11.36 for control-1 and 11.96 for control-2. It was concluded that there was a statistically significant difference between experimental group and control groups in favor of experimental group at a significance level of 0.05 (p<0.05). It was found that there was no significant difference between control groups' achievement (p>0.05). According to these findings, it can be said that station technique applied in the experimental group was more effective in developing academic achievement of students compare to current curriculum applied in the control groups.

Results Regarding to Third Sub-Problem

The third sub-problem of the study was determined as "Is there any significant difference between the mean posttest and retention test scores of experimental group applied station technique?"

With this sub-problem, the effect of the teaching method applied in the experimental group on the retention of knowledge has been tested. In fact, an important problem encountered during experimental studies is whether the topics taught during the study have become permanent in the student's mind. In situations where meaningful learning does not occur during the learning-teaching process, subjects learned after a certain period of time in the experimental process are forgotten. In such a case, the validity of the study is adversely affected. Therefore, the "Optics Achievement Test" was reapplied to experimental group as a retention test after 6 weeks (42 days) from the application in order to see whether the learnt subjects became permanent for the students.

The descriptive statistics of the posttest and retention of the experimental group is given in the table below.

Table 9. *Descriptive statistical findings of posttest and retention tests of experimental group*

	Statistic	N	Mean	Median	Mode	S.D.	Varyans	Skewness	Kurtosis
Experiment	Post-test	30	14.23	14.00	10.00	4.14	17.15	.025	-1.695
	Retention	30	13.93	14.50	12.00	4.32	18.68	-.478	-.560

When Table 9 is examined, it is assumed that the variables are normally distributed as skewness and kurtosis values of experimental group is ranging from -2 to +2 (George & Mallery, 2010). Because of the normal distribution of the data, parametric tests were used.

The t-test for pared samples was used between the retention test and posttest. The results of t-test for pared samples are presented in Table 10.

Table 10. *Results of the t-test for pared samples corresponding retention test and posttest of the experimental group*

Test	N	Mean	SS	sd	t	P
Posttest	30	14,23	4,141	29	,544	,590
Retention Test	30	13,93	4,323	29		

P>0.05

When Table 10 is examined, it can be seen that the mean scores of the posttest and retention test are 14.23 and 13.93 respectively. There was no statistically significant difference between posttest and retention test when the mean score of two tests were tested at a significant level of 0.05 (p>0.05). According to the retention test applied 6 weeks after completion of the experimental process, it was concluded that the learnt subjects were permanent for the students.

DISCUSSION

In order to compare the achievement levels of experimental group and control groups prior to study, the t-test for independent samples was used. According to independent groups t test results; The mean score of the experimental group students from the pre-test was 8.33 and the control groups were 7.88 and 7.21, respectively (See Table 3). According to t-test results, it was observed that there was no statistically significant difference between the groups (See Table 3). Thus it was concluded that the students in the study group were at the same level of knowledge and readiness prior to study.

In order to compare the significance of the achievement levels at the beginning of the study and the achievement levels at the end of the study, t-test for pared samples between pretest and posttest of the groups was used. According to the results of the dependent groups' t-test; the mean scores of the students in the pre-test and post-test were 8.33 and 14.23 for the experimental group, 7.88 and 11.36 for the control group and 8.21 and 11.96 for the control group (Table 6). According to the t-test for pared samples, it was observed that there was a statistically significant difference between groups' pretest and posttest scores (See Table 6). Based on these findings, it was concluded that both station technique applied in experimental group and current curriculum applied in control groups were effective in increasing students' achievement.

In order to compare the achievement levels of experimental group and control groups at the end of the study, t-test for independent samples between posttest scores of the groups was used. According to independent groups t-test results; the mean score of the experimental group students in the post-test was 14.23 and the control groups were 11.36 and 11.96, respectively (Table 8). According to the t-test for independent samples, it was observed that there was a statistically significant difference between the mean scores of the experimental group and control groups. However, it was found that there was no significant difference between scores of control groups (See Table 8). Based on these findings, it was concluded that the station technique applied in the experimental group was more successful in increasing students' achievement than the current curriculum applied in the control groups. The similar findings which concluded that station technique is more effective in increasing achievement of students than other methods applied in control groups can be seen in the literature and they support the findings of this study (Albayrak, 2016; Arslan, 2017; Demir, 2008; Demirörs, 2007; Farkas, 2002; Fraling, 1982; Furutani, 2007; Howatson, 1971; Korsacılar & Çalışkan, 2015; Maden & Durukan, 2010; Mergen, 2011; Morgil et. al., 2002; Ocak, 2010; Porter, 2004; Roberts, 1999; Taşdemir, 2015). When Table 8 is examined, it is seen that the achievement of both control groups are equal in both pretest and posttest. As mentioned earlier, two control groups were selected in this study and one of them was selected from a different school. The reason for the selection of control groups from different schools was to prevent John Henry effect from threatening internal validity. The control groups formed in experimental studies study more often to compete with the experimental group with more effort than usual when they realize they are in an experimental study, and so they can increase their achievement. John Henry effect influences the achievement levels of the control group students (Kocakaya, 2011; Saretsky, 1972a, 1972b & 1975). The only way to get rid of this effect is to choose the control group from a different school (Kocakaya, 2011). In this study, if the mean posttest score of the control-1 group selected from the same school as the experimental group were observed to be significantly higher than the mean posttest score of the control-2 group selected from a different school, there would be a doubt that the John Henry effect, which threatened the internal validity of experimental studies, might have emerged in this work, too. The absence of a second control group in this case could lead to serious errors in the interpretation of the study results. However, the fact that different teachers have implemented the practice in different schools can be seen as a limitation. However, comparing the posttest scores of the control-1 and control-2 groups in Table 8, it was interpreted that the John Henry effect did not occur in this study because the success levels of both groups were equal. The fact that John Henry effect, which threatened the internal validity of experimental studies, did not emerged in the study supports the finding that station technique is a successful method in teaching optics chapter of the science and technology course.

The "Optics Achievement Test" was reapplied to experimental group as a retention test to students after 6 weeks (42 days) from the end of the study to see if the subjects learnt during the application were becoming permanent. In order to compare the significance between posttest and retention test, t-test for pared samples was used. According to the results of the dependent group's t-test; the mean score of the experimental group students from the pre-test and post-test was 14.23 and 13.93 (See Table 10). According to the t-test results, there was not observed any statistically significant difference between scores of posttest and retention test (See Table 10). Thus it was concluded that the subjects learnt during the study are permanent learning. The similar findings which concluded that station technique applied in experimental groups is more

effective in making the learning permanent than control groups can be seen in the literature to support the findings of this study (Arslan, 2017; Avcı, 2015; Güneş, 2009; Koca, 2018; Mergen, 2011; Ocak, 2010). Based on the findings obtained, it can be concluded that the Hawthorne effect, which threatens the internal validity of experimental studies, does not take place in this study. In general, the Hawthorne effect is that any changes made in the environment cause a temporary increase in efficiency. The Hawthorne effect was likely to emerge in this study as the study used station technique, unlike the currently implemented curriculum. There was a possibility that the increase in the success of the experimental group students was due to the Hawthorne effect because different environments were created, different tools and methods and techniques were used. Although the success of students has increased, this increase is an artificial increase. There is no real increase in students' success, and after a certain period of time has elapsed, this increase disappears and learnt subjects are forgotten (Kocakaya, 2011; Mayo, 1933; Roethlisberger & Dickson, 1939; Gillespie, 1991). In fact, this situation may emerge in all experimental studies and affect the internal validity of the study findings negatively. In the case of the Hawthorne effect, it is difficult to determine whether the increase in student achievement in experimental studies is due to the success of the experimental method or Hawthorne effect. A suggested way to overcome this difficulty is that the achievement test used in the study should be reapplied to the experimental groups to test the retention of the learnt subjects after a certain time interval (1-2 months later) (Kocakaya, 2011). Since there was no statistically significant difference between the scores of posttest and retention test, it can be concluded that the learnt subjects were permanent and the Hawthorne effect did not emerged. Thus, it can be said that the increase in students' achievement is caused by the station technique applied in the experimental study.

CONCLUSION and SUGGESTIONS

The station technique applied in the experimental group has played an important role in increasing students' achievement and in the retention of learnt subjects. The main reasons for having an important role include the fact that students are responsible for their own learning by working in collaborative groups and taking an active role in activities that address all intelligences. Students have the opportunity to socialize by taking role and tool responsibility in heterogeneous teams. Particularly shy students can work in these teams to participate in the process. In addition, the activities designed to address each student's different intelligence areas (experiments, posters, slogans, paintings, poems, products, etc.) have allowed them to take a more active role in the process. The reason for the success of the students and the retention of the learnt subjects in the experimental group was interpreted as that they had gained more experience throughout the application.

The following suggestions can be made for the academicians and teachers in the light of the findings of this study;

- It is thought and suggested that the station technique may be useful method of teaching for all lessons and subjects, as it was concluded that station technique was an effective in teaching "Optics" chapter of 7th grade science and technology course.
- It is believed that it would be beneficial for all teachers to use this method as it is observed that the students socialized with the station technique and enjoyed the participation during the application.
- Teachers and educational researchers who want to use station technique in crowded classrooms need to plan the activities and scheduling well in the station centers, as the application of station technique in crowded classes can reduce the control of groups.
- The station technique can be used to teach a new subject or it can be used as a useful technique in the reinforcement of subjects or subject repetition.

The results of this study are limited to the schools of application, the study group and the equipment used. The future studies with extended study group and enriched equipment will contribute to more general interpretations about the effectiveness of the station technique.

REFERENCES

Albayrak, H. (2016). *Astronomi konularında istasyon tekniğinin öğrencilerin akademik başarısına ve astronomiye karşı tutumuna etkisi.* Yüksek lisans tezi, Erzincan Üniversitesi, Erzincan.

Arslan, A. (2017). *Türkçe öğretiminde istasyon tekniği kullanımının öğrencilerde akademik başarıya, tutuma ve kalıcılığa etkisi.* Yüksek lisans tezi, Cumhuriyet Üniversitesi, Sivas.

Avcı, H. (2015). *The effect of the usage of station technique on academic achievement, attitudes and retention in teaching English.* Unpublished master dissertation, Fırat University, Elazığ.

Bauer, R. (2003). *Offenes arbeiten in der sekundarstufe I.* Berlin: Cornelsen.

Beckman, M. (1990). Collaborative learning: Preparation for the work place and democracy. *College Teaching*, *38*, 128-133.

Benek, İ., & Kocakaya, S. (2012). *İstasyonlarda öğrenme tekniğine yönelik öğrenci görüşleri.* 3 rd International Conference on New Trends in Education and Their Implications, 26-28 April, Antalya.

Benek, İ., & Kocakaya, S. (2016). *İstasyon tekniğinin öğrencilerin fen ve teknoloji dersindeki başarılarına etkisi.* 12. Fen Bilimleri ve Matematik Eğitimi Kongresi, 28-30 Eylül, Trabzon.

Breyfogle, E., Nelson, S. , Pitts, C. & Santich, P. (1976). Creating a learning environment: A learning center hanbook. California: Goodyesr Publishing Company.

Büyüköztürk, Ş., Çakmak, E., Akgün, Ö. E., Karadeniz, Ş. & Demirel, F. (2014). *Scientific Research Methods.* (18th Edition). Ankara: Pegem Akademi.

Cohen, E. G. (1994). Restructuring the Classroom: Condition for productive small groups, *Review of Educational Research, 64*(1), 1-35.

Collier, K. G. (1980). Peer-group learning in higher education: The development of higher- order skills. *Studies in HigherEducation, 5*, 55- 62.

Cook, D. L. (1967). *The impact of the Hawthorn Effects in experimental designs in educational research.* United States Office of Education, Cooperative Research Project, Washington, D. C., No. 1757.

Demir, M. R. (2008). *The effect of learning station (center) model to the achievements of high level skills in life studies lessons.* Unpublished master dissertation, Hacettepe University, Ankara.

Demirörs, F. (2007). *The development and application of learning stations on ohm law for the first year highschool students.* Unpublished master dissertation, Hacettepe University, Ankara.

Dosch, D. M. (1988). *Using stations in the elementary classroom*. Honors Thesis. Ball State University, Muncie.

Eilks, I. (2002). Learning at stations in secondary level chemistry lessons. *Science Education International, 13*(1), 11-18.

Erdağı, S. (2014). *İstasyon tekniğinin fen ve teknoloji dersinin akademik başarısına etkisi.* Yüksek lisans tezi, Kafkas Üniversitesi, Kars.

Farkas, R. D. (2002). *Effect(s) of traditional versus learning styles instructional methods on seventh-grade students' achivement, attitudes, empathy, and transfer skills through a study of the holcaust.* Unpublished PhD Thesis. St. John‟s Üniversitesi.

Fox, J. (2004). *Rotate, differentiate, and motivate: How a blend of learning stations and multiple intelligences theory can boost motivation and enhance learning in the middle school classroom.* Yayımlanmamış yüksek lisans tezi, USA, Virginia: College of William & Mary

Fraling, C. C. (1982). *A study to ımprove comprehension skills through the study of prepared reading learning stations*. Unpublished PhD Thesis, The Union For Experimenting Colleges and Universities, USA.

Furutani, S. S. (2007). *How does one successfully implement learning centers at the third grade level* (MA Thesis). Pacific Lutheran University.

George, D. & Mallery, M. (2010). SPSS for Windows Step by Step: A Simple Guide and Reference, 17.0 update (10a ed.) Boston: Pearson.

Gillespie, R. (1991). *Manufacturing knowledge: A history of the Hawthorne experiments*. Cambridge University Pres. Cambridge.

Gözütok, F. D. (2007). *Teaching Principles and Methods.* Ankara: Ekinoks Kitabevi.

Gregory, G. H. & Hammerman, E. (2008). *Differentiate dinstructional strategies for science.* Corwin Pres. California.

Güneş, E. (2009). *The effect of learning stations instruction on gain score and retention in science and technology lesson.* Unpublished master dissertation, Hacettepe University, Ankara.

Hepp, R. (1996). Lernen und experimentieren an lernstationen. *Unterricht Physik, 7*(36), 37(257)–241(261).

Hepp, R. (1999). Lernen an Stationen im Physikunterricht. *Unterricht Physik, 10*(51/52), 4(96)–98(100).

Howatson, G. B. (1971). *An attempt to evaluate a work centers approach to teaching at the second-grade level* (MA thesis). Wyoming University.

Kaplan, S. (1999). A Learning Center Approach to Independent Study: Teaching for High Potential. *National Association for Gifted Children, 1*(1).

Karasar, N. (2015). *Scientific Research Method (28th Edition).* Ankara: Nobel Yayın Dağıtım.
Koca, M. (2018). *Altıncı Sınıf Fen Bilimleri Dersi Hücre Konusunun Öğretiminde İstasyon Tekniği Uygulamasının Öğrencilerin Akademik Başarısına, Kalıcılığına ve Tutumlarına Etkisi.* Yayımlanmamış yüksek lisans tezi. Fırat Üniversitesi, Elazığ.
Kocakaya, S. (2011). An educational dilemma: Are educational experiments working? *Educational Researchand Reviews, 6*(1), 110-123.
Korsancılar, S. & Çalışkan, S. (2015). Yaşam temelli öğretim ve öğrenme istasyonları yönteminin 9. sınıf fizik ders başarısı ve kalıcılığa etkileri. *Mersin Üniversitesi Eğitim Fakültesi Dergisi, 11*(2), 385-403.
Kryza, K., Stephens, S. J. & Duncan, A. (2007). Inspiring middle and secondary learners. California: Corwin Press.
Maden, S. & Durukan, E. (2010). The Effects of Station Technique on Creative Writing Ability and Its Attitudinal Effect on Turkish Lesson. *TÜBAR*, (XXVIII).
Mayo. E. (1933). The human problems of an industrial civilization. MacMillanCh. 3. New York.
Mergen, H. H. (2011). *İlköğretim 5. sınıf sosyal bilgiler dersinde öğrenme istasyonları uygulamasının akademik başarıya ve kalıcılığa etkisi*. Yayımlanmamış doktora tezi, Afyon Kocatepe Üniversitesi, Sosyal Bilimler Enstitüsü, Afyonkarahisar.
McClay, J. L. (1996). *Learning Centers. Professional's Guide*. Teacher Created Materials, Inc., 6421 Industry Way, Westminster, CA 92683.
Morgil, İ., Yılmaz, A. & Yörük, N. (2002). *An application about stations in science education.* Retrived from http://www.fedu.metu.edu.tr/ufbmek-5/ozetler/d082.pdf.
Lebak, K. (2005). *Connecting outdoor field experiences to classroom learning: a qualitative study of the participation of students and teachers in learning science.* Unpublished Doctoral Dissertation, Pennsylvania University, Pennsylvania.
Ocak, G. (2007). *Teaching Principles and Methods.* Ankara: Pegem Yayıncılık.
Ocak, G. (2010). The effect of learning stations on the level of academic success and retention of elementary school students. *The New Educational Review*, *21*(2), 146-157.
Porter E. J. (2004). *Classroom learning centers: study of a junior high school learning assisted program in mathematics.* Unpublished MA thesis. Pacific Lutheran University.
Robert, P. H. (1999). *Effects of multisensory resources on the achivement and science attitudes of seventh-grade suburban students taught science concepts on and above grade level* (PhD Thesis). St. John's University.
Roethlisberger. F. J. & Dickson. W. J. (1939). *Management and the worker*. Cambridge, Mass.: Harvard University Press.
Saretsky. G. (1972a). *The consequences of an innovation as determinants of control group behavior: an exploratory study.* Indiana University, Mimeo.
Saretsky, G. (1972b). The OEO P. C. Experimentand the John Henry effect. *Phi Delta Kappan, 53*, 579-581.
Saretsky, G. (1975). The John Henry Effect: Potential confounder of experimental vs. control group approaches to the evaluation of educational innovations. *The Annual Meeting of the American Educational Research Association.* Washington, D.C., USA. (Ericdocument, ED: 106309).
Schaal, S. & Bogner, F. X. (2005). Human visual perception-Learning at workstations. *Journalof Biological Education, 40*(1), 32–37.
Schmidt, M. W. & Harriman, N. (1998). *Teaching strategies for inclusive classrooms: Schools, students, strategies, and success*. Boston, Wadsworth Publishing Company.
Sears, M. E. (2007). Designing and delivering learning center instruction. *Intervertion in School and Clinic*, *42*(3), 137-147.
Sharan, S. (1980). Cooperative learning in small groups: recent methods and effect on achievement, attitudes and ethnic relation. *Review of Educational Research, 50*, 241-271.
Slavin, R. E. (1980). Cooperative Learning. *Review of Educational Research, 50*(2), 315-342.
Taşdemir, D. (2015). *The effect of teaching 6th grades social studies 'the resources of country unit' with station technique on students' academic success and their attitude.* Unpublished master thesis, Fırat University, Elazığ.
Tezbaşaran, A. A. (1996). *Developing Attitude Scale towards Science and Technology*. Türk Psikologlar Derneği Yayınları. Ankara.
Tofte, W. L. (1982). *The comparative effectiveness of learning center and traditional approaches for college introductory geology laboratory course* (PhD Thesis). Nex Mexico State University.
Tseng, Y. W. (2008). *Effects of using the learning station model as a phonics remedial program in an elementary school*. Unpublished master's thesis, National Pingtung University of Education, Pingtung.