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Effects of Virtual Experiments Oriented Science Instruction on Students' Achievement and Attitude

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ABSTRACT. This study was conducted to identify the effects of virtual experiment technique on seventh grade students' electricity achievement and attitudes towards science laboratory. The subjects were 69 seventh grade students in two classes of the same teacher. Randomly assigned experimental group students received virtual experiments oriented instruction, whereas control group students performed physical experiments. Achievement test and attitude scales were given as pretests prior to instruction and as posttests after four weeks of instruction. Two separate covariance analysis were conducted in this study and both of them indicated statistical significant differences. In accordance with these significant results, it can be concluded that virtual experiments have a substantial role in education by providing safe medium and interactive genuine models for students. Therefore, it is suggested that virtual experiments can be used in different contexts and various steps of education whenever possible.
Key Words: virtual experiment technique, electricity, achievement, attitude toward science laboratory

INTRODUCTION

Due to the rapid changes in science and technology of today's world, new methods and techniques are used in science teaching. One of the most important of these is the experiment technique. This technique appeals to multiple senses and makes learning maintained to a greater extent over time. According to Kinder (1973), people remember 10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they see and hear, 80% of what they see, hear and say, 90% of what they see, hear, touch and say. Especially some difficult concepts become more concrete in students' mind with laboratory activities. As a result of this concrete experience, students can learn the relations between principles and concepts of science more permanently.

According to Dewey (1972), one of the founders of constructivist approach, education depends upon action and knowledge and opinions are only arising from testing the situations that seem logical to the learners. The learners are oriented with various learning materials in the classroom and they built their knowledge together like being in a group. Moreover, the child solves the problems caused by the environment and child's continuous interaction with the world causes effective formation of knowledge (Piaget, 1985). Furthermore, activities are the principle factors for providing cognitive development. All these information indicates the importance of experiment technique.

Experiment Technique

Laboratory activities in science teaching have begun to be discussed after the second half of 1850s. In the beginning stages, including laboratory activities in science lessons has been considered as a waste of time. At the following stages, it became an integral part of the science lessons when it is found to be useful in terms of giving independent study opportunities, developing problem solving skills, understanding the nature of science, and developing scientific process skills. Today, in science teaching, the experiment technique is one of the most preferred techniques used for providing effective and permanent learning, for attracting students' attention, and for learning by living. As a consequence of teaching with experiment method, more purposeful and permanent learning emerges and students can use methods of reasoning.

In order to measure the levels of achievement in science and mathematics lessons internationally, TIMSS (Trends in International Mathematics and Science Study) and TIMMS-R researches were conducted with the participation of 38 nations including Turkey. The data about laboratory use in science lessons has attained from teachers and students in one practice and the countries ranked among themselves. In terms of including laboratory activities in lessons, Turkey took place at the last rows of the list. Also in TIMSS–1999 Project, Turkey took place at the bottom of the

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list with regard to science achievement (Earged, 2003). Thus, it may be concluded that laboratory activities are not performed as intended in Turkey.

The types of experiments conducted in laboratory courses can be divided into two as open and closed experiments in terms of their results. In open experiments, students know only the purpose of the experiment and the tools which will be used. The student follows trial and error method and finds himself what will happen at the end of the chosen way. In this type, induction approach is used. As for closed experiments, the student knows the purpose, the names of the tools that will be used and sequence of actions. The student is asked to collect data by benefiting from those and to reach an outcome that fits for the described purpose. In closed experiments, the expectations of the students are satisfied; the answers of what, where and how questions are clearly explained.

Like every method, these two experiment techniques have both positive aspects and some limitations. These limitations can be listed as follows:

- Laboratories are deficient in terms of tools and sources that may restrain performing experiments as required (Harmandar & Ceyhun, 1994).
- It was indicated that teachers generally prefer performing demonstration experiments and they are incapable of keeping students' attention and of making students criticize the results of experiments (Güven, 2001).
- Especially during demonstration experiments, teachers perform the experiment in which students stay only watching. Moreover, students talk about extra-curricular topics while the teacher is busy with preparation of experiment (Şahin, 1996).
- Experimental teaching with laboratory activities takes time. This may cause problem for teachers (Kalkan, Şahin, Savcı, & Özkaya, 1994).
- Teachers consider preparing materials and supplies, collecting together experiment materials, positioning materials and such additional works as over load and prefer theoretic teaching which is more simple (Tezcan & Günay, 2003).
- It is very difficult to perform experiments in crowded classes (Akgün, 2000).
- It is not always possible to obtain result from experiments (Akgün, 2000).
- Sometimes experimental teaching may be luxurious and expensive (Akgün, 2000).
- Experiments performed with traditional experiment tools presents limited test opportunities to the students and this situation can prevent students from performing experiment with a questioning view (Rogers & Wild, 1996).

Even though experiment technique is a favorable and useful technique for students, there are also some limitations in implementing it. Hence, in order to avoid limitations and troubles in experiment technique, alternative techniques that allow getting data in a shorter time can be used without changing the concept of curriculum. One of these techniques is virtual experiment technique (Büyüközer, 1990; Demirel, 1996; Eggen & Kauchak, 2001; Finkelstein et al., 2005; Güven, 2001; Sharp et al., 2009; Uşun, 2000).

Virtual Experiment Technique

Virtual experiment technique is a simulation based technique performed with virtual experiment tools in computer environment (Liu, Lin, & Kinshuk, 2010). This technique is performed by students in computer environment with virtual tools, virtual people, virtual materials, and virtual liquids (Lefkos, Psillos, & Hatzikraniotis, 2005). Figure 1 shows a simulation example including an electrical circuit prepared with virtual materials provided by PhET (Physics Education Technology) project which is interactive, animated, and game-like environment (PhET, 2012).

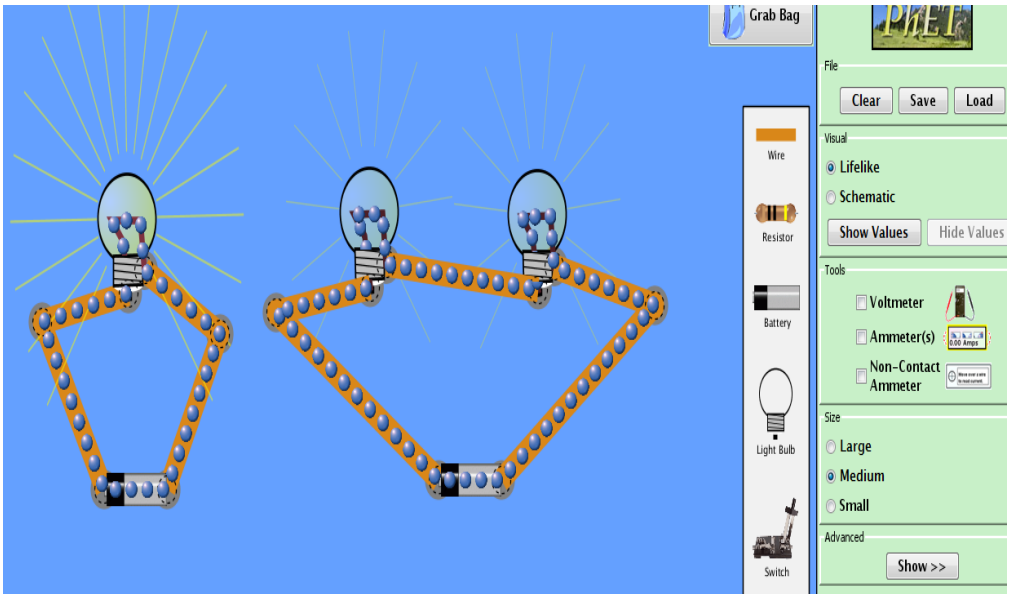

Figure 1. *Simulation used in virtual experiment technique*

This technique is introduced to solve some problems encountered in experiment technique. With this technique, some of the limitations of experiment technique can be removed and performing experiments becomes easier. This issue can be summarized as follows:

- With simulation technique which can easily be applied to the computer, the required information can be provided. The real experiments may be long lasting, expensive, dangerous and impossible to perform. This technique allows performing such experiments in fast, cheap, and safe way (Bernadatte, 1983).
- Some students may not like doing experiment because of their personal characteristics. The students, who cannot show their ability because of this situation, may be more successful with this technique (Demirel, 1996).
- Students can study comfortably in their personal study environment (Büyüközer, 1990).
- It develops concrete thinking ability (Uşun, 2000).

Besides these aforementioned characteristics, virtual experiment technique removes the cases defined as limitations in the experiment technique. If issues related to natural events are taught, without being absorbed from the event, by establishing connections and by showing them; students may enter into the topic without hesitating, establish connections between events and explain the results of these connections (Eggen & Kauchak, 2001). The virtual experiments performed in computer environment, create a media that provides those mentioned above (Zacharia, 2007).

Several studies (Bernadatte, 1983; Georgiou, Dimitropoulos, & Manitsaris, 2008; Klahr, Triona, & Williams, 2007; Zacharia, Olympiou, & Papaevripidou, 2008) have been done in science teaching to compare virtual experiment technique and experiment technique. Zacharia et al. (2008) studied the effects of experimenting with physical and virtual manipulatives on students' conceptual understanding in heat and temperature. First they analyzed the differences between the physical experiment technique and physical experiment technique assisted with virtual experiments, and then they analyzed the differences between virtual experiment method and physical experiment method. This study was conducted with 62 undergraduate students that attended to an introductory physics course. Consequently, experimenting with the combination of physical experiment and virtual experiment techniques enhanced students' conceptual understanding more than experimenting with physical experiment alone. In some other studies, it has been remarked that virtual experiments performed with computer based simulations have positive effects (Finkelstein et al., 2005; Hsu & Thomas, 2002; Huppert & Lazarowitz, 2002). In the related literature there are also some studies (Finkelstein et al., 2005; Triona & Klahr, 2003; Winn et al., 2006; Zacharia, 2007) that states that

physical experiments should be integrated with virtual experiments and should be reconstructed. According to Klahr et al. (2007) computer must be included in teaching process however it must not completely take the place of the experiments performed by the students themselves.

Despite all those studies, there are some imperfections persist about how to integrate experiment technique and virtual experiment technique into science education. Which topics will be taught with these techniques and how, is undefined and this remains being an imperfection. Therefore, educational need for both of these techniques must be ranked and the benefits of the two techniques must be determined (Zacharia, 2007). In this study, Zacharia applied both experiment techniques (physical experiment at first and then virtual experiment) to the experimental group. Therefore, the success of experimental group depends not only on the virtual experiment but also to both techniques. According to the purposes of this study only the module of Electric Circuits was used (McDermott & The Physics Education Group, 1996). The participants of the study were 90 undergraduate students ranging from 20 to 22 years in age who attended to an introductory physics course. The study results showed that experimental group was more successful than the control group. According to Zacharia (2007), the reasons of this situation can be stated as follows:

- The results of virtual experiments obtained faster.
- There is more opportunity exists for students for repeating the experiment.
- Experiments can be performed more frequently.
- More time remains for conceptual views.

In Triona and Klahr (2003)'s studies, the influence of virtual experiments and physical experiments on students' experimental design ability was analyzed. In this study, it was found that both techniques have equal influence. The researchers stated that the physical experiments were not indispensable to make students learn concepts and teaching with virtual experiments was easier. After that, Zacharia and Constantinou (2008) did a similar study about heat and temperature and showed that physical experiments and virtual experiments have similar effects on students' understanding of concepts. Sharp et al. (2009) performed real and virtual magnetic resonance experiments and obtained similar results by comparing the outcomes of the experiments.

Purpose and Research Questions

During the last years, there have been many ideas about the virtual reality to enhance science laboratory teaching and learning. In fact, virtual experiments have a positive impact on students' evolving skills and attitudes towards educational use of computer simulations and computers (de Jong, 2006; Hançer, 2005; Hsu & Thomas, 2002; Huppert & Lazarowitz, 2002; Ronen & Eliahu, 2000; Tao & Gunstone 1999; Zacharia, 2003). But in this study, students' attitudes towards science laboratory were tried to be investigated.

In previous studies, virtual experiment technique was usually tested with undergraduate students who study at physics education. The effects of virtual experiment technique was generally tested in the subjects of force and motion, heat and temperature and generally positive results were obtained in terms of achievement at the end. In this study, virtual experiment method was integrated into the instruction for 7th grade students to teach the unit of "electricity in our life".

This study has two purposes. The first one is analyzing the influence of virtual experiment technique supported by PhET Simulations (PhET, 2012) on students' achievement in electricity concepts, while the second one is examining the influence of the teaching techniques used in this study on students' attitudes towards science laboratories. In short, the restated research questions addressed in this study are as follows:

1. Are there any differences between experiment technique and virtual experiment technique based teaching on students' achievement in the unit of "Electricity in our life"?
2. Are there any differences between experiment technique and virtual experiment technique based teaching on students' attitude towards science laboratories?

METHODOLOGY

Population and Sample

The convenient sample of this quasi-experimental study consists of 69 seventh grade students from two classes of a public school in Sincan district. Thirty three students took part in control group while 36 students were in experimental group. Thirty two of the participants were girls and 37 of the participants were boys. All of the students were 14 years old.

Data Collection Tools

The Achievement Test for the Unit of "Electricity in our life". The achievement test used in this research was developed by Yıldız (2004). This test was consisted of 25 multiple choice questions. In the development of the test, the researcher applied the test to 219 students from six elementary schools and found KR20 reliability coefficient as .71. In the pilot study of this research, the same achievement test was applied to 110 eight grade students of a public school in Sincan district and Cronbach alpha reliability coefficient was found as .80. In the main study, this test was applied as pretest and posttest to both groups. Cronbach alpha reliability coefficient for the pretest was calculated as .78, whereas it was found .83 for the posttest.

Science Laboratory Attitude Scale (SLAS). In this study, a measuring tool including items of five-point Likert type response format was used to investigate students' attitude towards science laboratory. It was composed of 20 items. The scale was originally developed by Hofstein, Ben-Zvi and Samuel (1976) and then adapted by Yıldız (2004). Ten items of the SLAS were positive and the remaining ten items were negative. After recoding the negative items of the SLAS into positive, all of the items were rated over 5 points. Therefore, it provides a score of minimum 20 and maximum of 100 points. Sixty points might be regarded as the cut off point. It can be said that students who take higher than this point and converging to 100 had more positive attitudes, whereas students who take less than 60 points and converging to 20 had more negative attitudes. The reliability studies of the original form of the SLAS were conducted with 172 sixth grade students and Cronbach alpha reliability coefficient of the test was found as .81. With the help of factor analysis which was used as an evidence for content validity, it was also found that the scale was one dimensional. In the pilot study of this research, the SLAS was applied to 92 elementary school students and Cronbach alpha reliability coefficient was found as .73, whereas in the main study reliability coefficients were calculated as .74 for the pretest and .77 for the posttest.

Practice

After the pilot study, achievement and attitude scales were applied to all of the students as a pretest. The main study conducted with two separate seventh grade class including 69 students. Sixteen course hours were spent in both experimental and control groups. Students in a group which is randomly assigned as control group (CG) were taught with experiment technique, while students in experimental group (EG) were instructed with virtual experiment technique by the same teacher. In that stage, experimental and control groups were selected randomly. The students performed experiments in science and technology lessons which were four hours in a week. Each group received the same eight closed experiment sheets about electricity which were prepared by one of the researchers, the experiments were performed under the supervision of teacher. In the implementation period, all of the possible confounding factors and conditions were tried to be fixed for both groups.

During the instruction in the control group, at first, students received closed experiment sheets that covered all the acquisitions of "Electricity in our Life" unit. The name of the experiment was written on the board and the purpose of the experiment was read by the teacher. Students were encouraged both to discuss the topic for 5 minutes and state examples from daily life. Then, each student was asked to analyze the experiment materials on their desks. With teacher's help, experiment apparatus were set up and experiments were performed in accordance with both the steps shown in the sheet and the diagrams. At the end of each experiment, the related questions were answered by the students and the result of the experiment was written and discussed again. In this group, the experiments were done individually by each student in science laboratory.

In experimental group, students received the same closed experiment sheets and applications similar to those handle in control group's sections. The unique difference of the implementation in experimental group was the use of virtual experiments in computer environment. In this group, experiments were performed with computers in the computer laboratory on PhET simulation program. Each student performed the experiment in his own computer and individually interpreted the results of the experiment. There are 20 electricity animations in the program. However, only eight of them were suitable to seventh grade elementary school students. An example of a simulation used in virtual experiment oriented class is given in Figure 1. A week after the completion of four weeks of treatment period, posttests were given to both groups. The obtained data were transferred into SPSS program and have prepared for the data analysis after data cleaning.

FINDINGS

The data obtained from both pretest and posttests are summarized in Table 1. As seen from Table 1, the mean score of the CG was higher than that of the EG in the pretest, whereas it was lower in the posttest. The mean scores of both groups were increased to some degree from the pretest to the posttest. The mean increase for the EG (8.30 to 14.77) was 6.47 and the mean increase for the CG (9.03 to 11.87) was 2.84. All skewness and kurtosis values were in the acceptable range.

Table 1. *Basic descriptive statistics related to achievement scores*

	Experimental Group		Control Group		All	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
N	36	36	33	33	69	69
Mean	8.30	14.77	9.03	11.87	8.65	13.39
SD	2.49	4.66	2.50	3.40	2.50	4.33
Skewness	0.09	0.28	-0.15	0.35	-0.01	0.53
Kurtosis	-0.52	-0.83	-0.04	-0.20	-0.41	-0.30

Pretest and posttest data for the SLAS are given in Table 2. As seen from Table 2, the mean score of the CG were higher than that of the EG in both of the testing. However, mean score of both groups were higher than the average point of 60 indicating slightly positive attitudes for both of the groups. The mean scores of all groups were increased to some degree from pretest to posttest. The mean increase for the EG (65.11 to 67.55) was 2.44 and the mean increase for the CG (68.27 to 69.00) was 0.73. All skewness and kurtosis values calculated for the SLAS scores were also in the acceptable range.

Table 2. *Basic descriptive statistics related to attitude scores*

	Experimental Group		Control Group		All	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
N	36	36	33	33	69	69
Mean	65.11	67.55	68.27	69.00	66.62	68.24
SD	8.80	8.17	8.05	7.91	8.54	8.02
Skewness	-0.53	-0.71	-0.14	-0.29	-0.39	-0.51
Kurtosis	1.07	1.24	-0.91	-1.07	0.38	0.20

Before performing inferential analysis, independent variables that may threaten the study were determined. These variables were pre knowledge, preliminary attitudes toward electricity, and gender. Students' scores obtained from first implementation of the achievement test constituted pre knowledge variable and scores gained from first application of the SLAS constituted pre attitude variable. Correlation coefficients between these variables and two dependent variables (post achievement and post attitude) were calculated. According to the obtained values shown in Table 3, there is a significant correlation between the variables pre knowledge and post achievement and also between preliminary

attitude and post attitude. Therefore, these independent variables were taken as covariates while other variables were not included in the rest of the analyses. Thus, two separate ANCOVA were performed for two dependent variables.

Table 3. *Significance test of correlations between two dependent variables and independent variables*

	Correlation Coefficient	
Variables	Post achievement	Post attitude
Pre knowledge	0.56**	0.13
Pre attitude	0.02	0.97**
Gender	0.37	0.46

** Correlation is significant at the .01 level (2-tailed)

The results of covariance analysis performed for analyzing the achievements of students about electricity are shown in Table 4. All of the assumptions of ANCOVA (normality, homogeneity of variance, and homogeneity of slopes) were tested and verified before doing the analysis. As seen from Table 4, the result for the independent variable ($F(1, 66) = 23.609$, $p < .001$, $\eta^2 = .263$) is statistically significant. This $\eta^2 = .263$ denoted that 26.3% of variance of the post achievement was associated with the method factor. And the observed statistical power for the post achievement was .998.

Table 4. *Results of ANCOVA model for achievement test*

Source	Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Observed Power
Corrected Model	638.309	2	319.154	32.906	.000	.499	1.000
Intercept	79.038	1	79.038	8.149	.006	.110	.803
Pre knowledge	493.611	1	493.611	50.894	.000	.435	1.000
Method	228.978	1	228.978	23.609	.000	.263	.998
Error	640.126	66	9.699				
Total	13652.000	69					
Corrected Total	1278.435	68					

The results of ANCOVA performed for analyzing the attitudes of students towards science laboratories are shown in Table 5. All the assumptions of this second ANCOVA were also tested and verified before obtaining the results given in Table 5. It is seen that the result for group membership ($F(1, 66) = 12.530$, $p = .001$, $\eta^2 = .160$) is also statistically significant. This $\eta^2 = .160$ pointed out that 16.0% of variance of the post attitude was associated with the method factor. And the observed statistical power for the post attitude was .937.

Table 5. *Results of ANCOVA model for the SLAS*

Source	Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Observed Power
Corrected Model	4182.572	2	2091.286	703.348	.000	.955	1.000
Intercept	41.112	1	41.112	13.827	.000	.173	.956
Pre Attitude	4146.649	1	4146.649	1394.615	.000	.955	1.000
Method	37.254	1	37.254	12.530	.001	.160	.937
Error	196.240	66	2.973				
Total	325751.000	69					
Corrected Total	4378.812	68					

DISCUSSION, RESULTS AND RECOMMENDATIONS

In the past years several researches were done and various articles were written about virtual experiments, but it attracts more attention in recent years. In this new technology era, it is important benefiting from computer supported media and transferring into computer based teaching for keeping up with the contemporary times. Accordingly, the effects of doing experiments in virtual medium on students' achievements and attitudes compared to performing experiments in real media was investigated in this study.

In the study, virtual experiment method was integrated into the lecture by giving each student a closed experiment sheet and each student performed virtual experiments individually with the help and supervision of the teacher. The experiments in the sheets were prepared in compliance with the acquisitions of the lecture. In some experiments, several acquisitions can be gained in one experiment. Students who took part in control group performed experiments individually and students who took part in experimental group performed virtual experiments by using their own computers. The researchers tried to control the threats to internal validity throughout this study. In general, data cleaning, standardizing conditions and the procedures, using covariates and ANCOVA model, four weeks of treatment period, and the research design of the study were used as a measure to control these threats.

The results of two separate ANCOVAs showed that experimental group students' attitudes and achievements were much more positively affected than those of the students' in control group. The statistically significant results revealed the superiority of virtual experiments oriented instruction. Moreover, partial eta squared values (see Table 4 and 5) representing large effect sizes indicated practical significance besides statistical significance. Especially, it is really hard to alter attitude in short-term studies, but both significant ANCOVA results for the SLAS and large effect size (η^2 = .160) exhibited the fast and remarkable effect of virtual experiments on students' attitudes towards science laboratory. Likewise, large effect size (η^2 = .263) and significant ANCOVA results related to students' electricity achievement also pointed out the respectable impact of virtual experiments.

In related literature, several researches generating findings similar to this study can be found. All these studies stated that the virtual experiment method was more effective than the real experiment method on students' achievements (Bilek, 2010; Carmichael et al., 2010; Darius, Portier, & Schrevens, 2007; Georgiou et al., 2008; Lee, 2010; Sharp et al., 2009). In Zacharia et al. (2008)'s study, which is performed to assess heat and temperature concepts, the researchers obtained the same result. It was also found that virtual experiments have positive effect on removing misconceptions. In Darius et al. (2007) studies about real and virtual experiments, getting a significant result in favor of virtual experiments was attributed to students' attracted attention and having the opportunity of repeating their experiments again and again without wasting time. In the study of Hançer (2005), constructivist approach was supported with virtual experiments in the unit of "Force and Motion" and students' contribution to learning outcomes was analyzed. Besides determining students' contribution to learning outcomes, it is confirmed that students' attitude towards computer had developed considerably. In this study it was found that when compared with physical experiments, virtual experiments were more effective in increasing achievement. A similar study was done by Aydın (2005) in physics lessons and positive results were obtained in terms of achievement. A computer aided digital experiment tool named as "Data logger" was used in this study.

In most of the studies related to virtual experiments conducted in Turkey, experimental group students generally facilitated from virtual experiment technique while control group students were faced to traditional techniques in their lessons. However, it may not be appropriate to compare them, because it is not unexpected that the students taught by lecturing technique are less successful than those instructed with virtual experiments. Since in lecturing technique, there are few materials used for attracting students' attention and also few stimulants contributing to deeper and permanent learning. The students are passive in control groups in which traditional techniques are used. In experimental groups in which virtual experiment techniques are used, students actively perform their experiments. Students are more successful in the lessons they actively participate in than the lessons they stayed as passive participants and this situation has already been showed in related literature comparing traditional and constructivist approach. In this study, the students were active in both experimental

group and control group, and students' interest and attention kept alive during lecture. The only difference between the groups was the distinct experimental techniques.

Liu et al. (2010) have combined virtual experiment technique and physical experiment technique in their studies. The control group was taught with traditional method and experimental method while experimental group was taught with that combined method. The results were in favor of experimental method. However, in this study, control group used one experiment technique and experimental group used two experiment techniques. For this reason it is difficult to predict whether the difference in the achievement caused by the number or the type of the techniques. Chini (2010) used virtual and physical experiments in his study about basic machines. The difference was in favor of virtual experiments like this study. High level of learning can be achieved when virtual experiments and physical experiments are combined.

In this study, the advantages of virtual experiment technique against physical experiment technique was explained and it was found that it is an effective technique in increasing both students' science achievement and attitudes towards science laboratory. Hence, teachers should facilitate from this technique and appropriately use interactive animations in their classes whenever possible. At this point, the role of educational technology research groups, computer software experts and instructional technologists is to enrich and diversify interactive animations that can be used in educational contexts. Based on the results of this study, it is also recommended that the experiment and virtual experiment techniques can be combined to increase efficiency in future researches. Other important intangible topics that students generally have difficulty in learning such as heat and temperature, magnetic resonance, dynamics and simple machines may also be chosen to be investigated with thorough researches. Furthermore, the participants in this study were seventh grade students and due to the fact that the electricity is an important issue at many learning levels and in various age groups, it is recommended that PhET simulations should also be applied to these other education levels to test its effects.

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Sanal Deneylere Dayalı Yapılan Öğretimin Öğrenci Başarısına ve Tutumuna Etkisi

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ÖZ. Bu çalışma, sanal deney tekniğine dayalı yapılan öğretimin yedinci sınıf öğrencilerinin 'Yaşamımızdaki Elektrik' ünitesindeki başarıları ve öğrencilerin fen laboratuvarına karşı olan tutumları üzerindeki etkilerini belirlemek amacıyla yapılmıştır. Katılımcılar, aynı öğretmenin iki yedinci sınıfındaki toplam 69 öğrenciden oluşmaktadır. Rastgele atanan deney grubundaki öğrenciler sanal deneylere dayalı öğretim alırken kontrol grubundakiler fiziksel deneyler yapmışlardır. Aynı başarı testi ve tutum ölçekleri önce ön test olarak ve 4 haftalık uygulamanın sonunda son test olarak iki kez verilmiştir. Yapılan iki ayrı ANCOVA sonucunda istatistiksel olarak anlamlı farklar bulunmuştur. Bulguların sonucunda, öğrencilere güvenli ve interaktif modeller sunan sanal deneylerin bu sınıf seviyesindekilerin eğitiminde önemli rolü olduğu görülmüş ve farklı kontekst ve aşamalarda kullanılması önerilmiştir.

Anahtar Kelimeler: sanal deney tekniği, elektrik, başarı, fen laboratuvarına karşı tutum

ÖZET

Amaç ve Önem: Etkili öğrenmenin sağlanması için fen öğretiminde kullanılan önemli tekniklerden bir tanesi de deney tekniğidir. Bu tekniğin olumlu yönleri yanında bazı sınırlılıklarını giderebilmek amacıyla kullanılan alternatif bir teknik ise sanal deney tekniğidir. Sanal deney tekniği ile deney tekniğini karşılaştırabilmek için alanda bazı çalışmalar da yapılmıştır. Fakat deney tekniği ile sanal deney tekniğinin fen eğitimine tam olarak nasıl entegre edileceği konusunda hala çalışmalar ve tartışmalar devam etmektedir. Bu tekniklerin başarı üzerindeki etkisini inceleme amacı olan çalışmaların çoğu ise lisans öğrencileri ile yapılmıştır. Tutuma yönelik çalışmalarda da daha çok öğrencilerin bilgisayar veya bilgisayar kullanımına karşı tutumları incelenmiştir. Bu bağlamda, bu araştırmanın sanal deney ile fiziksel deney tekniğine dayalı olarak yapılan öğretimlerin yedinci sınıf öğrencilerinin 'Yaşamımızdaki Elektrik' ünitesindeki başarıları ve fen laboratuvarına karşı tutumları üzerindeki etkisini incelemek üzere iki temel amacı vardır.

Yöntem*:* Bu yarı deneysel desenli araştırmanın çalışma grubunu Ankara'daki bir kamu ilköğretim okulundaki 69 yedinci sınıf öğrencisi oluşturmuştur. Sincan İlçesi'ndeki bu okuldaki iki adet 7. sınıf şubesinden biri deney grubu (36 öğrenci) diğeri ise kontrol grubu (33 öğrenci) olarak rastgele atanmıştır. Deney grubunda sanal deney tekniğine dayalı öğretim yapılırken, kontrol grubunda deney tekniğine dayalı öğretim yapılmıştır. Aynı öğretmen tarafından 4 hafta boyunca her iki gruba da ilgili yönteme göre öğretim yapılmıştır. Pilot çalışmada 110 öğrencinin katılımıyla test edilen elektrik başarı testi ve 92 öğrenci ile test edilen fen laboratuvarına karşı tutum ölçeği, ana çalışmada ön test ve son test olmak üzere iki kez aynı 7. sınıf öğrencilerine uygulanmıştır. Elde edilen veriler SPSS programı ile analiz edilmiştir.

Bulgular: Çalışmada elde edilen verileri incelemek için bazı temel betimsel istatistikler ve varsayımları kontrol edildikten sonra iki ayrı ANCOVA yapılmıştır. Betimsel istatistikler, hem başarı hem de tutum değişkenleri açısından ön test ile son test arasında olan artış miktarlarının deney grubunda biraz daha fazla olduğunu göstermiştir. Ön testleri ortak değişken alarak yapılan yordayıcı analizler ise bu farkların istatistiksel olarak anlamlı olduğunu göstermiştir. Başarı değişkeni için gözlemlenen güç ve eta kare değerleri sırasıyla .998 ve .263 çıkarken tutum değişkeni için .937 ve .160 olarak bulunmuştur.

Tartışma, Sonuç ve Öneriler: Yapılan ulusal çalışmaların çoğunda deney grubunda sanal deneyler kullanılırken kontrol gruplarında müfredata uygun geleneksel öğretim yöntemleri kullanılmıştır. Bu araştırma kapsamında ise sanal deney tekniği kapalı uçlu deney kağıtları kullanılarak derse entegre edilmeye çalışılmıştır. Her öğrenciye birer bilgisayar düşecek şekilde deney grubundaki öğrenciler sanal deneylerini bilgisayarda bireysel olarak yaparken kontrol grubundaki öğrenciler de fiziksel deneylerini bireysel olarak yine kapalı uçlu deney kâğıtları ile laboratuvarda yapmışlardır. Uygulama sonucunda hem fiziksel hem de sanal deneylerin öğrencilerin başarı ve tutum puanlarını arttırdığı anlaşılmıştır. Fakat bu artışın sanal deneyler lehine daha fazla olduğu bulunmuştur. Başarı ve tutum değişkenleri için ön test verileri kontrol edilerek yapılan analizler sonucunda elde edilen anlamlılık, eta kare ve güç değerleri, sanal

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deneylerin oluşturduğu farkın hem istatistiksel hem de pratik olarak önemli olduğunu göstermiştir. Bu açıdan öğretmenlere sınıflarında interaktif animasyonları kullanması önerilmektedir. Yazılım geliştirenlerin ve eğitim teknolojisi uzmanlarının sınıf içinde kullanılacak animasyon sayı ve çeşitlerini artırmak için çalışmalar yapması oldukça önemli görülmektedir. Akademisyenlerin de değişik gruplar, sınıf düzeyleri ve farklı konularda bu tekniğin çeşitli özellikleri ve etkisini inceleyen farklı çalışmalar yapması önerilebilir.