Uluslararası Eğitimde Yenilikçi Yaklaşımlar Dergisi
International Journal of Innovative Approaches in Education 2022, Vol. 6 (3), 190-202
https://doi.org/10.29329/ijiape.2022.473.5

Original article

Investigation of the Effect of the Simulation Method on Academic Achievement in Science with 7th graders in Science Course

Taner Küçük [a, *] & Mahmut Böyükata [b]

[a] Ministry of National Education, Ankara, Turkey
[b] Physics Department, Science and Arts Faculty, Kırıkkale University, Kırıkkale, Turkey

Abstract

This study aimed to investigate the effect of the simulation method on the academic achievement of the 7th-graders in secondary school in the science course. The 'Light' unit was selected as a subject. The research was carried out with the participation of 98 students (Experiment, n = 52 and Control, n = 46) at a secondary school in the city center of Çanakkale in the spring term of 2013-2014 academic year. It was an experimental study with the pretest-posttest control group. This study collected data with the Science Academic Achievement Test (SAAT) developed by Benli, Sarıkaya and Kayabaşı (2012). Since the validity and reliability studies of the SAAT were conducted in Çanakkale, it was recalculated and found suitable in terms of validity and reliability. In the control group, the constructivist approach was employed while in the experimental group, the simulation method was implemented. The pretest results showed no significant differences between the experimental and control groups in terms of academic achievement. When the SAAT posttest scores of the students in both groups, that is, in the control and experimental groups, were examined, the average score in favor of the experimental group was found to be higher. At the end of the study, when the SAAT posttest scores of the students in both groups were examined, the average score in favor of the experimental group was found to be higher.

Keywords: Academic Achievement, Simulation Method, Constructivist Approach, Pretest-Posttest with Control Group.

Received: 04 July 2022 * **Accepted:** 30 September 2022 * **DOI:** https://doi.org/10.29329/ijiape.2022.473.5

* **Corresponding author:**

Küçük Taner (A) is a science teacher in MEB. He completed Master degree Çanakkale Onsekiz Mart University, and now he is PhD student at Trakya University. He is living and working in Çanakkale, Turkey..
Email: tanerk22.te@mail.com

INTRODUCTION

Each individual has unique innate abilities. Education allows one to discover such abilities and strengths, and then improve them. Education is a process aimed at creating desired changes in human behavior. Teaching performed in a programmed and systematic way in schools is an integral part of education (Onur, 2021). There is another teaching environment apart from the school where human beings use all their senses. Each period of life presents its own stages that entail daily life skills. Education is one of the key elements necessary to proceed through these stages.

Advanced technology and diversified information impose new obligations on teachers and students while learning and presenting new information is much easier (Çevik, 2006).

Human is implicit in education. Human beings are born in a society and culture armed with specific characteristics. Social norms also contain the values that the school seeks to instill. Education emerges as one of the cultural factors in developing one's personality. Advanced societies do not leave it to chance for future generations to find a place for themselves in the new society; these societies, rather, aim to lead this process.

For this reason, they attach importance to establishing their own education systems (Gül, 2004). States benefit from education to realize social and economic changes as they wish. Because education not only allows for the transmission of values between generations and cultures and, thus, acculturation but also moves the society forward by changing its structure and contributes states' economic development by improving manpower (Tezcan, 1985).

Sciences have a key role in the development of countries. Every country attaches particular importance to science education to equipping individuals with the desired characteristics to survive and to be at the forefront of the race in the field of science. For this reason, they try to raise the level of science education they offer (Ayas, 1995). Also, countries revise the science curricula within their education systems at different time periods. Using contemporary approaches, they update their science curricula. After receiving science education based on research, examination, and observations, children can produce effective solutions by using more realistic and rational methods to overcome the problems they may face in everyday life. Given that the science course is aimed at understanding various phenomena encountered in everyday life, the only way to benefit from the acquired knowledge in everyday life and to enable one to come up with solutions to the daily problems faced is through the correct use of the information learned in this course (Küçük, 2014). It is important to teach science more effectively and permanently to allow students to develop these skills (Kaptan, 1998).

Developing students' mental and problem-solving skills makes learning and creating solutions to new problems easier by identifying the root of the problem rather than memorizing it. The Science course is one of the courses that make this possible. In a science course, students are expected to examine

their environment using different scientific methods. Science also plays a pivotal role in encouraging students to make observations, inquire, and constantly build on their knowledge (Kaptan, 1999).

It is notable that the science course considerably affects everyday life. It is further observed that science and technology have become integral to every profession at an ever-increasingly pace (Topsakal, 2005). As science manifests itself in all aspects of life, it is necessary to teach science not only to students who are trained to be scientists but also to students at all school levels (Patton and Bailey, 2014).

According to Alisinanoğlu, Özbey, and Kahveci (2011), science education provides some of the following benefits to individuals: students in the classroom actively use all five senses for the activities in the science lesson, which supports permanent learning; the science lesson offers a pre-learning environment where they can understand how they learn; in other words, this lesson lays the groundwork for students to effectively learn the scientific process skills such as developing hypotheses and changing variables; the science lesson presents an environment where students are active and motivated, and makes learning interesting to students.

An effectively conducted science teaching allows students to obtain a clearer perspective, - and makes it easier for them to understand the phenomena around them and their life. Among the benefits of science teaching to students are that it helps them perceive and recognize their surroundings by providing first-hand life experiences, effectively using basic-level skills, and solving problems above their grade level (MEB, 2017). Although education uses different and effective teaching methods and techniques and makes these methods and techniques popular, learning by doing and experience still retains its importance (Kaptan and Korkmaz, 2000). To teach students science-related concepts as well as the scientific process skills key to science, a number of approaches based on constructivism are used. Among them are research, inquiry-based, project-based, and problem-based learning approaches. Methods such as analogy, metaphors, micro-teaching, educational games, demonstration, and role-playing are used (Demirel, 2011).

The contemporary educational approaches are more student-centered with the teacher as a facilitator or a guide in this process. From this standpoint, science is based on the learning approach that focuses on research and inquiry-based constructivism to meet the requirements of contemporary education in the science curricula (MEB, 2013). Experimental learning is a shining example of learning by doing and experience.

One of the learning approaches used in education is the constructivist approach. A constructivist approach is an educational approach that assumes that an individual receives information from the outside world, then, reconstruct that information in their brain; that is, this approach is based on reconstruction (Fer and Cırık, 2007).

The use of communication technologies in education goes back to the 1920s. After the first radio broadcast in 1927, radio began to be used in education. In Turkey, communication tools were first utilized in the field of education in 1941 thanks to the radio program called "Ziraat Takvimi" (İşman, 2008). Nowadays, different technological tools than radio and television are now being utilized in education. For example, projectors that were once popular in education have been replaced by smartboards. This transformation that has taken place over time also indicates that technology has become increasingly prevalent.

Since the early 2000s, technology in education has been gaining more and more recognition to ensure effective education. The use of technology provides manifold benefits for teachers and students. Technology in education offers various advantages to teachers and students from the construction stage to the implementation stage (Erden ve Uslupehlivan, 2020). Education is inherently influenced by the characteristics of society, culture, region, and era. Education is shaped particularly by the characteristics of the current era. The qualifications of education may vary depending on the needs of the era. When thinking of change and development in the current century, one of the first that comes to mind is the change and development in the field of technology (Tuncer and Dikmen, 2018a).

This study explores the effect of computer simulations on student achievement and the purposes of this study are explained in the following subject.

Purpose of the Study

The purpose of this study was to find the answer to the following question: How does teaching by the simulation method in the subject of "light" in science lessons for 7th graders in secondary school affect students' academic success in science? This study also aimed to find answers to the following sub-questions as well:

1. Was there a significant difference between the pre-test scores of the students in the experimental and control groups on the science academic achievement test (SAAT)?
2. Was there a significant difference between the pre-test and post-test scores of the students in the control group on the science academic achievement test (SAAT)?
3. Was there a significant difference between the pre-test and post-test scores of the students in the experimental group on the science academic achievement test (SAAT)?
4. Was there a significant difference between the post-test scores of the students in the experimental and control groups on the science academic achievement test (SAAT)?

METHOD

This study draws on the pre-test and post-test control group design. This design allows unbiased assignment of participants to two different groups. One of these groups was the experimental group while the other was the control group. Measurements were made on both groups in the pre-and post-experiment phases. The assignment of the experimental group and the control group was randomly performed (Karasar, 2005). The experimental group was the one where the simulation method was employed.

Research Group

The study was carried out in the 2013-2014 academic year with the participation of students in classes 7-A(27), 7-B(26), 7-C(25), and 7-D(20) at a secondary school located in the central district of Çanakkale, Turkey. The pre-test results in these classes showed that the scores obtained by 7/A and 7/C on the SAAT were similar to those of 7/B and 7/D. 7/A and 7/B were randomly assigned to the control group whereas the remaining two classes, 7/A and 7/C, formed the experimental group. - A total of 52 students in classes 7-A and 7-C participated in the experimental group.

Data Collection Tool

This study drew on the Science Academic Achievement Test (SAAT) to collect data. This test was developed by Benli, Sarıkaya and Kayabaşı (2012). The validity and reliability of SAAT were tested in two different secondary schools in Çanakkale; consequently, its validity and reliability were confirmed by statistical methods.

The Science Academic Achievement Test: The SAAT was used to evaluate the achievement of the 7th graders at the secondary school level in the subject of "light." The achievement scale used in this study aimed to determine the effect of the learning methods on academic achievement. The course was taught by different methods in the experimental and control groups to explore the effect, the SAAT was applied as a pre-test and post-test in both the experimental and control groups.

The SAAT starts off with information on the purpose of the test, the number of items it presents, and how to respond to the items.

Data Analysis

The data obtained from the Science Academic Achievement Test (SAAT) were analyzed using the SPSS program, the necessary statistical methods, and techniques. T-test for dependent samples was applied to examine the relationship between the pre-test and post-test in the experimental group; likewise, a t-test for dependent samples was conducted to analyze the relationship between the pre-test and post-test in the control group. Also, a t-test for independent samples was carried out to compare the

experimental group and the control group. The study concluded with some remarks based on these findings.

FINDINGS

This section presents analyses of the sub-problems and offers the findings using different statistical methods and tables. Some remarks were made taking into consideration these findings.

Findings on the 1st sub-problem

Was there a significant difference between the pre-test scores of the students in the experimental and control groups on the science academic achievement test (SAAT)?

Table 1 shows the t-test results for independent groups on whether the SAAT scores of the students in the experimental and control groups prior to this study were different or not.

Table 1. The results of the SAAT pre-test-t of the Experimental Group and the Control Group

Group	N	x̄	S	sd	t	p
Experimental	52	18.34	5.24	96	1.48	.14
Control	46	16.54	6.71			

p>.05

It is evident from Table 1 that there was no statistically significant difference between the academic achievements of the students the experimental and control groups on science ($t(96)=1.48$, $p>.05$), which implies that the academic achievements of the students in both groups on science were similar.

Findings on the 2nd sub-problem

Was there a significant difference between the pre-test and post-test scores of the students in the control group on the science academic achievement test (SAAT)?

T-test for dependent samples was performed to determine whether the scores of the students in the control group on the science academic achievement test differed in the pre-test and the post-test.

Table 2. The results of the t-test of the students in the control group for dependent samples for SAAT pre-test and post-test

Test	N	x̄	S	sd	t	p
Pre-test	46	16.54	6.71	45	8.50	.000
Post-test	46	27.91	10.13			

p<.05

Table 2 indicates that there was a statistically significant difference between the science academic achievements of the 7th grade students at secondary school level in the control group, considering their pre-test and post-test results ($t(45)=8.50$, $p<.05$), meaning that there was a significant difference in the science academic achievement levels of the secondary school students in the control group. In other words, it can be argued that the course taught using the constructivist approach considerably enhanced the achievement of the students.

Findings on the 3rd sub-problem

Was there a significant difference between the pre-test and post-test scores of the students in the experimental group on the science academic achievement test (SAAT)?

T-test for dependent samples was performed to determine whether the scores of the students in the experimental group on the science academic achievement test differed in the pre-test and the post-test.

Table 3. The results of the t-test of the students in the experimental group for dependent samples for SAAT pre-test and post-test

Group	N	$\bar{X}$	S	sd	t	p
Pre-test	52	18.34	5.24	51	8.46	.000
Post-test	52	28.61	1.59			

$p<.05$

Table 3 demonstrates that there was a statistically significant difference between the science academic achievements of the students in the experimental group, considering their pre-test and post-test results ($t(51)=8.46$, $p<.05$). This finding implies that the science academic achievement of the students in the experimental group increased. In other words, the course taught using the simulation method boosted the academic achievements of the students in the experimental group.

Findings on the 4th sub-problem (Second type Heading)

Was there a significant difference between the post-test scores of the students in the experimental and control groups on the science academic achievement test (SAAT)?

T-test for independent samples was performed to determine whether the scores of the secondary school students on the science academic achievement test differed between the experimental and control groups.

Table 4. The results of the t-test of the students in the experimental and control groups for independent samples for SAAT post-test

Group	N	x̄	S	sd	t	p
Experimental	52	28.61	10.59	96	.34	.73
Control	46	27.89	10.15			

p>.05

Table 4 revealed that there was no statistically significant difference between the post-test scores of the students in the experimental and control groups on the science academic achievement test (t(96)=.34, p>.05). This finding demonstrated that the secondary school students in both groups had similar science academic achievement levels.

CONCLUSION and DISCUSSION

This study ascertained that the scores of the students in both groups in the pre-test on the science academic achievement did not show a significant difference. However, it found that the post-test scores obtained by both groups after the lecture performed by the methods applied differed significantly from the pre-test scores. That is to say, both methods considerably boosted academic achievement.

The study ascertained that the scores of the students in both groups in the pre-test on the science academic achievement did not show a significant difference. However, it showed that the post-test scores obtained by both groups after the course differed significantly from the pre-test scores. That is to say, both methods considerably boosted academic achievement.

Notably, the science academic achievement score of the experimental group increased from 18,34 to 28,61; the pre-test score of the control group was 16.54 and this increased to 27.91 in the post-test. Given the post-test scores, there was no statistically significant difference between the groups.

Other studies presenting results congruent with this study are as follows: Yeşiltaş and Turan (2015) benefited from the pre-test post-test group experimental design. The researchers performed a social studies lecture for the experimental group using the instructional software programs. The same lecture was carried out using teaching methods in the Social Studies curriculum and textbooks for the control group. They observed that the academic achievement of the experimental group increased more.

Elçiçek and Bahçeci (2017) examined the effect of the designed mobile learning page on student academic achievement and attitudes. Their study was based on the pre-test and post-test control group design. As their sample, the researchers used the students at the Faculty of Education, Siirt University, Turkey. They determined that academic achievement increased more in the experimental group for whom mobile learning systems were utilized.

Another study in the city center of Adana, Turkey, aimed to observe the effect of teaching with computer simulations and animations on the subject of optics within the physics course for 9th graders. It revealed that the animation&simulation-supported teaching enhanced academic achievement in the experimental group (Emrahoğlu, Bülbül, 2010).

The study by Tuncer and Dikmen (2018) investigated the effectiveness of computer-aided teaching by reviewing the research conducted in the last decade using the meta-analysis method. The researchers concluded that computer-aided teaching effectively improved academic achievement.

Based on the meta-analysis method, another study analyzed a total of 52 studies that compared computer-aided teaching with classical methods in teaching in Taiwan. The meta-analysis study yielded that computer-aided teaching is more effective than classical teaching methods. This study also shed light on the findings of studies that offered different results (Liao, Kuang, 2007).

In another study comparing the classical teaching methods and computer-based teaching, the researcher determined that the academic achievement in the group where computer-assisted teaching was performed, that is in the experimental group, was higher (Tareef, 2014).

The effect of computer-based assignments and traditional paper assignments on student achievement was investigated; the results showed that computer-based assignments had a deeper effect on student achievement than traditional paper assignments. The primary reason for this was reported as the ability to provide instant feedback (Wong, 2001).

Another research was conducted on a total of 100 students studying at the faculty of education of Sriwana University on the subject of everyday life in the biology course. In this research, one group was lectured using the simulation method and the other was lectured through classical methods. The results indicated that teaching by the simulation method further boosted academic achievement (Sasikala, 2016).

In another study, the activities prepared by Omani students through the 3DL in the experimental group were presented in the three-dimensional science laboratory; on the other hand, the traditional teaching methods were followed in the control group. This study ascertained that student academic achievement increased in the experimental group (Musawi, Ambusaidi, Sinani, Balushi, 2017).

Kulik, Rangert, and Willams (1983) examined the effectiveness of computer-aided education in secondary school. They concluded that computer-aided teaching promoted success.

Performing Computer-Assisted Education (CAE), Güven and Sülün (2012) investigated the academic achievements and attitudes of 8th graders. This study was conducted with 8th graders in a secondary school in the province of Ankara, Turkey. One class from the 8th grade in this secondary school was selected as the experimental group, whilst the other class was selected as the control group.

While the lecture was performed using CAE in the experimental group, the traditional methods were utilized in the control group. The findings of this study showed that the academic achievement of the experimental group was higher than that of the control group.

Karaduman (2011) examined the effect of computer-aided and computer-based applications on student academic achievement and permanence among 6th graders at the primary school level. The researcher drew on the two-group experimental design. Computer-based teaching was applied to one experimental group whereas computer-assisted teaching was conducted for the other experimental group. It was found that the success of the students in both experimental groups increased. Comparing the two experimental groups, the researcher reported that computer-based teaching improved academic achievement more.

Şahin and Akbaba (2016) probed into the effect of computer-assisted teaching on 7th graders in the subject of "Solar system and beyond, the riddle of space." Their study aimed to reveal the effect of computer-assisted teaching in teaching abstract concepts in this subject. One group was lectured based on the principles of computer-assisted teaching, and the other group was lectured using traditional methods. Their study yielded that computer-assisted teaching enhanced the academic achievement of students more.

Salgut (2012) applied Web-based computer-assisted teaching to reveal the effect of computer-assisted teaching in the subject of "Light and Sound" for 5th graders in Science course. The data of this study were collected through the pre-test and post-test designed by the researcher. The results demonstrated that academic achievement increased in the experimental group.

Gömleksiz and Fidan (2012) aimed to observe the effect of the computer-aided mind maps method in a science course. Their study utilized mixed methods (qualitative and quantitative). Computer-aided mind map method was utilized in the experimental group, whilst traditional methods were used in the control group. Their findings revealed that the computer-aided mind map method had a positive effect on academic success.

In the study conducted by Şimşek (2017), the lecture was performed using the simulations on the website phet.colorado.com to teach the subject of light and sound in science courses for 5th graders. The researcher ascertained that using simulation and animation in science courses boosted student achievement.

Bülbül ve Emrahoğlu (2009) examined the impact of teaching based on simulations and animations on the subject of optics in a physics course for 9th graders. The data were collected through the physics achievement test. The physics achievement test was performed as a pre-test and post-test. The results showed that academic achievement could be increased by benefiting from simulations and animation in the subject of optics in a physics course.

Akkağıt and Tekin (2012) developed a simulation in their study to use for the logic circuits unit. They further designed an academic achievement test and utilized this test before and after the study. Their study indicated that academic achievement increased in the group for whom the lecture was conducted using simulations.

Suggestions

The findings of this study showed that the use of the simulation method in teaching the subject of "light" in science courses for 7th graders boosted the academic achievement of the students, so the following suggestions can be made: a) teachers should be encouraged to benefit from computer simulations to attract student attention and to increase their motivation in a science course, b) simulation-based software should be increasingly used as course material in implementing the curricula of the Turkish Ministry of National Education c) simulations should be designed and applied by teachers for different grade levels, different subjects and specific to each subject. Researchers are recommended to conduct more large-scale and comprehensive research on the use of simulation methods in education. The relevant departments in the Turkish Ministry of National Education are also advised to carry out in-service training for teachers to equip them with the necessary skills to use simulation-based education modules. Computer animations do not often provide students with opportunities to question the reason for their correct or incorrect answers. The practitioners in this field should consider using simulations that allow them to question their correct and incorrect answers, rather than animations.

REFERENCES

Akkağıt, Ş. F. & Tekin, A. (2012). Simülasyon Tabanlı Öğrenmenin Ortaöğretim Öğrencilerinin Temel Elektronik ve Ölçme Dersindeki Başarılarına Etkisi. *Ege Eğitim Dergisi, 13* (2), 1-12.

Alisinanoğlu, F., Özbey, S., & Kahveci, G. (2011). *Okul öncesinde fen eğitimi*. Maya Akademi.

Ayas, A. (1995). Lise 1 kimya öğrencilerinin maddenin tanecikli yapısı kavramını anlama seviyelerine ilişkin bir çalışma. II. Ulusal Fen Bilimleri Eğitimi Sempozyumu'nda sunulan bildiri. ODTÜ Eğitim Fakültesi, Ankara.

Benli, E., Kayabaşı, Y., & Sarıkaya, M. (2012). İlköğretim 7. sınıf öğrencilerinin fen ve teknoloji dersi "ışık" ünitesinde teknoloji destekli öğretimin öğrencilerin fen başarısına, kalıcılığa ve fene karşı tutumlarına etkisi. *Gazi University Journal of Gazi Educational Faculty .32*(3), 733-760.

Çevik, E. (2006). *Bilgisayar Destekli Kimya Eğitimi İle İlgili Öğretmen ve Öğrenci Görüşleri*

[Yayınlanmamış Yüksek Lisans Tezi]. Hacattepe Üniversitesi.

Dikmen, M., & Tuncer, M. (2018) Bilgisayar destekli eğitimin öğrencilerin akademik başarıları üzerindeki etkisinin meta-analizi: son 10 yılda yapılan çalışmaların incelenmesi. *Turkish Journal of Computer and Mathematics Education. 9* (1), 97-121.

Elçiçek, M. & Bahçeci, F. (2017) Mobil öğrenme yönetim sisteminin öğrenenlerin akademik başarısı ve tutumları üzerindeki etkilerinin incelenmesi. *Kastamonu Eğitim Dergisi, 25* (5), 1695-1714.

Ergün, M. (1994). *Eğitim sosyolojisi.* Ocak Yayınları.

Erden, M,. K,. & Uslupehlivan,. Eda,. (2020). Eğitimde teknoloji kullaniminin bugünü ve geleceğine ilişkin öğretmen adaylarinin düşüncelerinin incelenmesi. *Uşak Üniversitesi Sosyal Bilimler Dergisi, 1*(2020), 109-126.

Emrahoğlu, N., & Bülbül, O. (2010) 9. sınıf fizik dersi optik ünitesinin bilgisayar destekli öğretiminde kullanılan animasyonların ve simülasyonların akademik başarıya ve akılda kalıcılığa etkisinin incelenmesi. *Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 19*(3), 409-422.

Fer, S. & Cırık İ., (2007). *Yapılandırmacı öğrenme kuramdan uygulamaya*. Morpa Yayınları.

İşman, A., (2008). *Uzaktan eğitim*. Pegem Akademi.

Gül, G. (2004). Birey toplum eğitim ve öğretmen. *Hasan Ali Yücel Eğitim Fakültesi Dergisi. 1* (1), 223-236.

Güven, G., & Sülün, Y. (2012). Bilgisayar destekli öğretimin 8. sınıf fen ve teknoloji dersindeki akademik başarıya ve öğrencilerin derse karşı tutumlarına etkisi. *Journal of Turkish Science Education, 9*(1), 68-79.

Gömleksiz, M. N. & Fidan, E. K. (2012). Fen ve teknoloji dersinde bilgisayar destekli zihin haritası tekniğinin öğrencilerin akademik başarısına, tutumlarına ve kalıcılığa etkisi. *Gaziantep Üniversitesi Sosyal Bilimler Dergisi, 12*(3), 403-426.

Kaptan, F. (1998). Fen Bilgisi Öğretiminin Niteliği ve Amaçları (Ed. Ş. Yaşar), *Fen Bilgisi Öğretimi, (ss.13-30)*. T.C. Anadolu Üniversitesi Yayınları.

Kaptan, F. (1999). *Fen Bilgisi Öğretimi.* Milli Eğitim Basımevi.

Kaptan, F., & Korkmaz, H., (2000). *İlköğretimde Etkili Öğretme ve Öğrenme Öğretmen El Kitabı İlköğretimde Fen Bilgisi Öğretimi*. MEB Yayınevi.

Karasar, N. (2005). *Bilimsel araştırma yöntemleri.* Nobel Yayıncılık.

Kulik, JA, Bangert, RL & Williams, GW (1983). Bilgisayar destekli öğretimin ortaokul öğrencileri üzerindeki etkileri. *Eğitim Psikolojisi Dergisi, 75* (1), 19–26. https://doi.org/10.1037/0022-0663.75.1.19.

Karaduman, B. & Emrahoğlu, N. (2011). "Maddenin tanecikli yapisi" ünitesinin öğretiminde, bilgisayar destekli ve bilgisayar temelli öğretim yöntemlerinin, akademik başari ve kaliciliğa etkisi. *Kastamonu Eğitim Dergisi, 19* (3), 925-93.

Küçük, T. (2014) *Işık ünitesinde simülasyon kullanımının öğrencilerin akademik başarısına ve fen tutuma etkisi* [Yayınlanmamış Yüksek lisans Tezi], Çanakkale Onsekiz Mart Üniversitesi.

Liao, Y. K. C. (2007). Effects of computer-assisted instruction on students' achievement in Taiwan: A meta-analysis. *Computers & Education, 48*(2), 216-233.

Milli Eğitim Bakanlığı (2013). İlköğretim kurumları (ilkokullar ve ortaokullar) fen bilimleri dersi (3, 4, 5, 6, 7 ve 8. sınıflar) öğretim programı. Ankara: Talim Terbiye Kurulu Başkanlığı.

Milli Eğitim Bakanlığı (2017). İlköğretim kurumları (ilkokullar ve ortaokullar) fen bilimleri dersi (3, 4, 5, 6, 7 ve 8. sınıflar) öğretim programı. Ankara: Talim Terbiye Kurulu Başkanlığı.

Musawi, A. A., Ambusaidi, A., Al-Balushi, S., Al-Sinani, M., & Al-Balushi, K. (2017). Effectiveness of Learning with 3D-Lab on Omani Basic Education Students' Achievement, Attitudes and Scientific Thinking. *Journal of Education and Training Studies, 5*(11), 177-188.

Onur, J. (2021). *Sınır tanımayan eğitim modeli:* IB.

Salgut, B. (2012). *İlköğretim 5. Sınıf fen ve teknoloji dersi ışık ve ses ünitesinde internetin de kullanıldığı bilgisayar destekli öğretimin öğrenci başarısına etkisi* [Yüksek Lisans tezi], Çukurova Üniversitesi.

Sasikala, P., & Tanyong, S. (2016). A Study on Simulation Methods in Academic Success with Reference to Teaching Biology for Education Students. *Journal of Education and Practice*, *7*(11), 164-168.

Şahin, R. & Akbaba, U. (2018). Bilgisayar Destekli Öğretimin Güneş Sistemi ve Ötesi, Uzay Bilmecesi Ünitesindeki Öğrenci Başarısına ve Derse Karşı Öğrenci Tutumuna Etkisi. *Kafkas Eğitim Araştırmaları Dergisi, 5*(1), 10-24.

Şimşek, F. (2017). Fen Bilimleri Dersinde Animasyon ve Simülasyon Kullanımının Öğrencilerin Akademik Başarısı ve Bilgilerin Kalıcılığı Üzerine Etkisi. *Uluslararası Eğitim Bilim ve Teknoloji Dergisi, 3*(3), 112-124.

Polloway, E. A., Serna, L., Patton, J. R., & Bailey, J. W. (2014). *Özel gereksinimli öğrenciler için öğretim stratejileri*. (Çev. ed. Ş. Yücesoy Özkan). Nobel yayınları.

Tareef, A. B. (2014). The effects of computer-assisted learning on the achievement and problem solving skills of the educational statistics students. *European Scientific Journal*, *10*(28), 271-279.

Tezcan, M. (1985) *Eğitim bilimlerine giriş.* Ankara Üniversitesi Eğitim Bilimleri Fakültesi Yayınları.

Topsakal, S. (2005) *Eğitim fakülteleri ve öğrencileri fen bilgisi ve sınıf öğretmenleri için fen teknolojileri öğretimi.* Nobel.

Wong, C. K. (2001). Attitudes and Achievements. *Journal of Research on Computing in Education*, *33*(5), 284-298.

Yeşiltaş, E., & Turan, R. (2010). Sosyal Bilgiler Öğretimine Yönelik Geliştirilen Bilgisayar Yazılımının Akademik Başarı ve Tutuma Etkisi. *Uluslararası Türk Eğitim Bilimleri Dergisi, 2015*(5), 1-23.