



World Journal on Educational Technology



Vol 7, Issue 1, (2015) 87-98

www.awer-center/wjet

The effect of simulation methods in teaching physics on students' academic success

Cigdem Hursen*, Near East University, Department of Educational Curriculum and Instruction, Nicosia, North Cyprus, Mersin 10 Turkey.

Gulsum Asiksoy, Near East University, Department of Computer Education and Educational Technology, Nicosia, North Cyprus, Mersin 10 Turkey.

Suggested Citation:

Hursen, C., & Asiksoy, G. (2015). The effect of simulation methods in teaching physics on students' academic success. *World Journal on Educational Technology*, 7(1), 87-98.

Received December 14, 2014; revised March 03, 2015; accepted March 27, 2015

Selection and peer review under responsibility of Assoc. Prof. Dr. A. Askim Kurt, Near East University, Cyprus.

©2015 Academic World Education & Research Center. All rights reserved.

Abstract

The aim of this study is to determine the effect of simulation methods in teaching physics on students' academic success. 70 students (35 control, 35 experimental) who studied at the Near East University Faculty of Education, in the Department of Computer Education and Educational Technology, in 2013-2014 academic year participated in this research. Mixed methods approaches, which included both qualitative and quantitative methods, were used in the research. Instructional transaction included the subject of "Shooting" in the "Movements on Earth" unit. Statistical results of the data obtained after the application showed that students of the experimental group who were taught using simulations were more successful than the students of the control group who were taught by the traditional approach. Also, it was determined that students of the experimental group were satisfied by simulation-based Physics education.

Keywords: physics education, simulation-based education, education technology.

*ADDRESS FOR CORRESPONDENCE: **Gulsum Asiksoy**, Near East University, Department of Computer Education and Educational Technology, Nicosia, Cyprus. E-mail address: gulsum73@yahoo.com

1. Introduction

Physics is a science that uses quantitative measurement and experimental observations in order to understand natural events. It can explain natural events mathematically and can relate these events to daily life events (Tekbiyik & Akdeniz, 2010; Eren & Gurdal, 2010).

Of all the sciences, Physics is the one that students experience the most difficulties with because most of the physical notions are abstract. Also, when compared to other lessons, although there are many relationships between main subjects and number of the subjects to be learned, simply knowing definitions is not enough to learn the subject (Karaca, 2013). Theories and numerical expressions also make it difficult to understand Physics and to make a connection between the subjects (Ergul & Cigrik, 2013; Jian-Hua & Hong, 2012; Arvind & Heard, 2010; Bakac, Tasoglu & Akbay, 2011). McDermott (1993) mentioned that the problems occurring in Physics education are a result of traditional education methods. Students who were taught using traditional education methods could not participate in the lesson actively and were just acting as listeners. Studies that focus on solving the difficulties students experience in Physics concentrate on what the students learn and how they learn it (Hoellwarth, Moetter & Knight, 2005).

In order to manage effective learning in Physics, there should be a learning environment where the level of the students' prior knowledge is known, real life events are discussed, students are both mentally and physically ready and cognitive change is provided. At the same time, these learning environments should provide opportunities to students to consolidate the recently-learned notions (Guvercin, 2010). To develop the students' cognitive learning and their performance in solving problems, there is a need to teach Physics by using different student-centered education methods instead of the traditional methods (Ergun, 2010). Relating the subjects to real life events, getting rid of the boring mathematical processes, in other words the use of special methods, would protect students from memorising and make them participate in the lesson willingly and with pleasure (Demir & Demir, 2014; Baran & Maskan, 2010; Lateh & Vasugiammai, 2011; Abdusselam, 2014; Buyukkara, 2011). The memorization approach leads to difficulty for the students in interpreting abstract notions and comparing the results, which creates an obstacle in understanding Physics' nature (Cildir, 2012). One of the methods that needs to be applied to students in order for them to comprehend Physics as a subject which is hard to understand and memorize and is also abstract, is using visuality to make a relationship between recently learned notions and previously learned ones (Yigit, Alev, Altun, Ozmen, & Akyildiz, 2005). Giving visual education in Physics lessons can eliminate many problems. Visuals like films, shapes, schemas, graphics, pictures, animations, and simulations related to the subject can be used to motivate students and attract their attention at the beginning of the lesson, providing more effective learning by addressing both their eyes and ears (Kuvvetli, 2008). This can be done most effectively by using computers and educational technologies. After computers began to be used in education and schooling, the notion of "Computer-based education" arose (Guyen & Sulun, 2012). There are many advantages to the use of computers in Physics education. It helps to concretize abstract notions, and eases learning at the students' own speed. Additionally, using multimedia techniques makes education effective and interesting, addressing students' personal differences in learning. It is really important to prepare new programmes and materials following technological progress in order to have a good quality education system (Adiguzel, Gurbulak & Saricayir, 2011; Celen, Celik & Seferoglu, 2011; Akkagit & Tekin, 2012). For this reason, it is necessary to update programmes that are prepared for Physics education periodically, taking into consideration the changes happening in science, technology and education (Dogan & Marulcu, 2010). It is very important to use student-centred teaching in Physics education. However, not every school has laboratories, and due to financial problems there is lack of equipment, therefore laboratories cannot be used effectively. At the same time, experiments are not enough to explain Physics subjects, which are mostly about microscopic sized events. Simulation, which is considered as a comparison, simulates missions, relationships, phenomena, equipment, behaviours or some cognitive activities that happen in reality (Patrick, 2002). It is possible to make simulations using different programmes on computers in order to explain events and experiments complying with physical rules. Simulations have an

important role in Physics education and schooling (Guvercin, 2010). Simulation speeds up teachers' educational potential and students' learning actively. It also provides options for modelling notions and processes, and acts as a bridge in learning new Physics notions by using prior knowledge. Problems occurring due to teaching subjects that are hard to explain and that are difficult to carry out even in laboratories can be overcome by using simulations (Tatli & Ayas, 2011; Trundle & Bell, 2010). Additionally, there are other advantages of using simulations in Physics education. They minimize the high cost of laboratories, shorten the duration for experiments that take a long time, provide a safe environment for dangerous experiments and motivate students, which leads to an active participation (Smetana & Bell, 2012; Rotimi, Ajogbeje & Akeju, 2012; Tanel & Onder, 2010; Binder & Heerman, 2010). Therefore, when we look at the studies conducted in Physics education, using simulations by means of computer-based education is the most common subject which is studied (Rutten, Joolingen & Van der Veen, 2012; Azar & Sengulec, 2011; Jaakkola, Nurmi & Veermans, 2011; Han & Black, 2011; Katirci & Satici, 2010). Studies have revealed that simulations reflect situations that are impossible to be seen by real experiments and help students imagine events easily in their minds (Zabunov, 2013; Fiscarelli, Bizelli & Fiscarelli, 2013; Kocakaya & Gonen, 2010; Bozkurt & Sarikoc, 2008; Bozkurt, 2007). In some studies in the literature, researchers made their own simulations and compared the schooling carried out by traditional methods and the schooling carried out by the simulations they prepared (Coskun & Ozdemir, 2013; Yildiz, Solak, Altinisik & Inal, 2012; Chen, 2010; Bozkurt & Ilik, 2010; Tatli & Ayas, 2011; Renken & Nunez, 2013; Yukselen, 2012; Gunhaart & Srisawasdi, 2012; Tippmann, Kim & Rhymer, 2013; Karal, Cebi & Peksen, 2010; Dasdemir & Doymus, 2012; Sokolowski & Rackley, 2011). Emrahoglu and Bulbul used simulations while teaching optics in their 2010 research and found that schooling with simulation had a positive effect on academic success and permanence. Jaakkola, Nurmi and Vermass (2011) stated that in teaching electric circuits, students who used electric circuit simulation together with real electric circuits were more successful than students who only used simulation. Sarabandoa, Cravino and Soares (2014) investigated the contribution of simulation on students' academic success in teaching mass and weight. Akkagit and Tekin (2011) developed an educational tool for logical doors and analysed whether there is a difference in students' academic success when simulation-based education is used instead of traditional methods which are often used in education and schooling environments, in order to provide accurate and permanent learning in a logical circuits module. The result of the research showed that students who were taught using the developed simulation-based educational tool were more successful. Rather than using a classic method Korkmaz and Yildiz (2012) applied a different method for students in Physics lessons at secondary education schools, which was based on interactive education in order to increase academic success. They illustrated experiments with simulation methods while teaching the subjects. The result of the research indicated that students who received education with simulation and computer-supported educational methods were more successful than the students who received education with the classical method.

There are many studies in the literature in which simulations were used for Physics laboratory lessons (Wang, Li, Yang & Hao, 2013; Dincer & Guclu, 2013; Civelek, Ucar, Gokcol, Ustunel & Umut, 2013; Guvercin, 2010; Tanel & Tanel, 2010; Ulukok, Celik & Sari, 2013; Yener, Aydin & Koklu, 2012). However, no study exists that has examined the effect of simulations on academic success where they are used as a tool for supporting theoretical lectures. Therefore, the purpose of this study is to determine the effect of simulation methods on students' academic success. In order to fulfil this purpose, the authors have sought answers to the following questions:

Is there a meaningful difference between pre-test success scores of the students in the control group and those in the experimental group?

Is there a meaningful difference between post-test success scores of the students in the control group and those in the experimental group?

What do the students in the experimental group think about simulation supported Physics education?

2. Method

2.1. Research Model

An experimental pattern which contains pre-test post-test of the control group and a mixed pattern which contains qualitative data were used in this research. It is necessary to make a deep analysis in order to show all aspects of the studies done in scientific research. For this reason, it is important for the result of the research studies based on the paradigm of combined research where qualitative and quantitative research patterns are used together to be reliable (Secer, Ay, Ozan & Yilmaz, 2014). Research pattern is shown in Table 1. Students who were supported by simulations constituted the experimental group and those not supported by simulations constituted the experimental group.

In the control group lessons were given by the researcher using traditional teaching methods, while simulation based teaching methods were used in the experimental group.

A "Success Test" based on Physics was given to both groups before and after the experimental processes. Also, 10 students from the experimental group were interviewed based on a semi-structured question form when the experimental process ended.

2.2. Study Group

70 students (35 control, 35 experimental) who studied in the Department of Computer Education and Educational Technology in the first semester of the academic year 2013-2014 constituted the study group of the research. The ages of the students, who took place in the research ranged from 18 to 26 and the average age was 21.14.

28 students in the third year participated in this research, the highest percentage with 40%. In addition there were 15 second-year students (21.4%), 14 fourth-year students (20%) and 13 first-year students (18.6%), who constituted the smallest number of students participating in this research.

3. Data Collection Tools

3.1. Physics Success Test (Pre-Test/Post-Test)

Researchers prepared a multiple choice success test about the shooting subject, which contained 35 items based on the aim-behaviour of the Movement on Earth unit (Hursen & Asiksoy, 2014). After preparing the test items, the test was administered to 30 different students rather than the students in the study, who were taught the shooting subject based on the traditional methods. This was carried out in order to do the analysis of reliability and validity. After this pilot application, the percentage of correctly answered items in the test (p : item difficulty index) and the percentage of identifying whether the item is known (r : item discrimination index) were calculated.

The aim of choosing an item is to bring the item difficulty to somewhere between 0.20 and 0.80 without changing the examined behaviour. However, the main purpose is to reach the value of 0.50. Under the condition of being in the right direction, discrimination should be as high as possible (Kert & Tekdal, 2008; Akdag & Tok, 2008). After applying the item analysis, Kuder Richardson – 20 (KR-20, 21) coefficients are used to examine the inner consistency of the test (Buyukozturk, 2007). In research studies, reliability coefficient is expected to be at least 0.70 (Sencan, 2005; Ozen, Gulacti & Kandemir, 2006). 26 items in which the item discrimination index value is greater than 0.30 and item difficulty index is between 0.40 and 0.76 were taken for the test form of the research. 9 items did not provide the significant conditions so they were taken out of the test. 26 suitable test items were chosen for the application. In order to find the inner reliability of these 26 items which formed the Physics success test, the KR-20 reliability coefficient was calculated as 0.73 and KR-21 as 0.70. These values are

important because they show whether the questions are consistent within themselves (Ozen, Gulacti & Kandemir, 2006).

3.2. Semi Structured Interview Form

Researchers (Hursen & Asiksoy, 2014) prepared a semi-structured interview form which contains 10 open-ended questions for the students in the experimental group in order to determine their ideas about simulation-supported Physics education. This form was presented to a group of experts (7 academicians from the field of Physics and 8 academicians from the field of education) in order to get their ideas. Necessary corrections were made considering their ideas. 10 voluntary students were interviewed from the experimental group, and their voices were recorded using a recorder. Each interview took about 8 minutes per participant.

For qualitative data, "coding based on the notions that are received from data" technique was used. In this technique, a researcher reads the data and determines the important aspects considering the aim of the research. Depending on these aspects, the researcher manifests particular codes or produces codes based on the data (Yildirim & Simsek, 2005). Data acquired from the answers of the students from the experimental group were encoded separately and were put together considering certain concepts. In the next steps, frequencies of these codes and what some students said were shown on tables to help readers understand better and to visualize the research. The identities of the students interviewed were concealed and numbers were given to each of them (O1, O2, etc.)

4. Data Collection

A pre-test about the shooting subject was applied to the students both in the experimental and control groups before the study began. The subject was taught to the experimental group students using simulation-supported activities for six lesson hours over three weeks. Shooting simulations that were progressed as part of the University of Colorado's Physics Education Technology (PhET) project were used in this study (<https://phet.colorado.edu/tr/simulations/category/physics>). Researchers informed the experimental group students how to use the software before the study.

Simulations were located in computers in front of the students and this gave them an opportunity to change the parameters, such as first angle or first speed, and then they tried shooting many times. During the lessons, student-student and student-teacher communication were provided and importance was given to student participation. Lessons were done in the same way for the second and third weeks and all shooting sessions were completed.

"Shooting" as a subject was also taught to the control group students for six lesson periods over three weeks using traditional methods, and at the end of three weeks a post-test was given to both groups. Also, 10 students from the experimental group were interviewed with a semi-structured interview form to get their ideas on simulation-supported physics education, and qualitative data was obtained.

5. Data Analysis

Qualitative and quantitative research methods were used together in this study. SPSS 20.0 was used to analyse the quantitative data. Independent t-test was used to analyse the quantitative data obtained from the success test. The researcher recorded the results of the semi-structured interview and formed the frequency tables of the obtained qualitative data.

6. Findings

The obtained data was analysed by statistical techniques relating to each sub-problem of the research. Findings with comments obtained from the results of this analysis form this section of the research.

6.1. Pre-test Success Scores of the Students from the Experimental and Control Group

Firstly, a pre-test, administered by the researchers, was given to the students from both groups in order to determine the level of information they had about "Shooting" as a subject. It is necessary to have a homogenous distribution among the students of both groups in terms of academic knowledge. As can be seen in Table 2, an independent t-test was applied to the data obtained from the pre-test.

Table 2. Findings Regarding the Pre-test Scores of the Experimental and Control Groups

Groups	N	Average	Standard Deviation	Degree of Freedom	<i>t</i>	<i>p</i>
Experimental	35	39.71	10.843	1.833	0.163	0.871
Control	35	39.29	11.124	1.880		

A 0.05 level of significance was used while interpreting the results. The average of the pre-test points of the students from the experimental group is 39.71, while it is 39.29 for the control group. Results of the Independent T-Test which were used to determine whether there was a meaningful difference between the average values showed that there was not a meaningful difference ($p > 0.05$). This finding indicates that students from both groups had the same level of knowledge before the application; this means that they were suitable for the experimental study.

6.2. Post-test Success Marks of the Students from the Experimental and Control Group

Independent T-Test was applied to determine if there is a meaningful difference between the post-test success points of the students from the experimental and control group.

Table 3. Findings Regarding the Post-test Scores of the Experimental and Control Groups

Groups	N	Average	Standard Deviation	Degree of Freedom	<i>t</i>	<i>p</i>
Experimental	35	71.14	2.787	13.973	5.213	0.000
Control	35	53.0	3.031	15.156		

As it can be seen from Table 3, the experimental group students' post-test average score is 71.14, while the control group students' post-test average score is 53. To determine if there is a significant difference between these average values, the independent t-test was performed and results showed that there is a significant difference in favor of the experimental group ($t = 5.213$, $p < 0.05$). These results showed that simulation-supported teaching is much more effective than the traditional teaching method.

6.3. Ideas of the Experimental Group Students on Simulation-supported Physics Education

Data obtained from the interviews with 10 students from the experimental group about simulation-supported education is shown in Table 4. This was done by using semi-structured interviews.

Table 4. Ideas of the Students on Simulation-supported Physics Education

Students' Opinions	<i>f</i>	Sentences of Some Students
General opinion about simulation-supported Physics education	8	"I learnt the concepts easily, without getting bored, by doing and experiencing when we used simulation software in Physics lessons." (S4)
Ease of using simulation software	9	"I didn't experience any difficulties in using the software and I did the shooting movements easily." (S6)
Making a connection between real life examples and physics event in simulation-supported education	8	"I could think of examples about where shooting was used in real life, after seeing types of it in simulation." (S5)
Increasing attention given to Physics lessons	7	"I was afraid of Physics lessons but when I started to understand the subject, my interest has increased towards the lesson and I realised that Physics is not that difficult." (S9)
Making abstract subjects concrete	7	"It was easier for me to understand the subject because I could see the abstract concepts like shooting angle or first speed in a concrete way in simulation." (S7)
Giving an opportunity to repeat	9	"It gives an opportunity to repeat the subject and makes learning easier." (S6)

According to Table 4, it can be seen that eight of the ten voluntary students from the experimental group mentioned that they learnt the subject more easily and without getting bored when simulation was used in Physics lessons. When students were asked if they experienced any difficulties while using simulation, nine out of ten students said that they did not. Also eight out of ten students mentioned that they could make a connection between real life examples and Physics events and seven of them said that they started to perceive the lesson as easier and this helped them to increase their attention towards the lesson. Again, seven students explained that simulations made abstract concepts concrete and helped them understand the subject and nine of them said that it provided an opportunity to repeat the subject and made the learning process easier.

7. Results and Discussion

In this research before the experimental study, Physics success test (pre-test) was applied to students in the control and experimental groups. It was found out that the averages of the pre-test success marks for both groups were very close to each other. The significance of the difference between the averages were analysed by T-test and it was seen that there was not a statistical difference between the average of the physics pre-tests success rate of the two groups. Based on this result, it was determined that both the experimental group's and the control group's students had the same level of knowledge about the shooting on earth concept.

After the experimental process was completed, a post-test was applied to the experimental and control group students. The significance of the difference between the experimental group and the control group students' post-test success scores average were analyzed by t-test and a significant difference was found in favor of the experimental group. Considering the results of the analysis, it was determined that simulation-supported physics education has a positive effect on students' academic success. This result of the research is similar with the findings in literature (Emrahoglu & Bulbul, 2010; Coskun & Ozdemir, 2013; Hancer & Tuzemen, 2008; Inac, 2010; Bulbul, 2010; Ergorun, 2010; Polat & Tekin, 2013; Odom, Marszalek, Stoddard & Wrobel, 2013). Also, Rutten, Joolingen and Van der Veen (2012) examined 510 articles published between 2001 and 2010 which were scanned in ERIC, Scopus and ISI Web of Knowledge and examined the effects of simulations in science education. They found that using simulations gave positive results in all research done with different purposes.

In the last stage of the research, the experimental group students were asked for their ideas about the application. When the experimental group students were asked about "Their ideas about simulation supported physics education", they mentioned that they learned the concepts more easily and without getting bored, also by doing and experimenting with this method, and that they were satisfied with it. Results obtained from the research in literature show that students were glad to use simulations while learning Physics and this supports the results obtained from this research (Bell, Urhahne, Schanze & Ploetzner, 2010; Ayvaci & Abdusselam, 2012; Venkataraman, 2009). During the interviews, experimental group students mentioned that they could establish a relationship between shooting movements using simulations and real life examples of these moves. They also said that it was easier to understand some abstract concepts such as first speed and shooting angle. As a result of using simulations, students also pointed out that as a science, Physics is used in daily life and has a connection with real life. This result is also supported with studies done in other areas (Karaca, 2010; Doymus, Simsek & Karacop, 2009; Bradley, 2006; Sendir, 2013; Midik & Kartal, 2010; Soderstrom, Hall, Ahlqvist & Nilsson, 2012). Based on the findings obtained from students' ideas, simulation-supported physics education also helps in overcoming fear and anxiety towards Physics lessons and it is effective in increasing interest and motivation. There are studies in the literature supporting this result (Karacop, 2010; Kebtittchi, Hirumi & Bai, 2010; Koh, Tan, Tan, Fang, Fong, Kan, Lye & Wee, 2010). In line with the results of the research, Finkelstein, Perkins, Adams, Kohl and Podolefsky (2005) found in their studies that visualizing Physics concepts using technology increases students' interest and courage towards Physics.

Considering the findings obtained from the results of the current research, the following may be recommended:

This study was limited to 70 students and a time period of three weeks. The findings of this study could be supported by extending the duration to a longer period and with a larger number of participants.

At the end of this research, it can be stated that by using simulation-supported physics education in a difficult subject like the shooting in the "Movements on Earth" unit increased student success. This means it can be used in teaching difficult concepts of Physics in other units as well.

It is important that the simulation software that is chosen for teaching Physics does not include distractive elements for students. It should also not contain elements that will make it difficult to use.

Physics is one of the lessons that students are generally afraid of and have difficulty in understanding. Considering the result of this research, it can be said that by using the simulation supported method, students' feelings, thoughts and interest towards Physics have changed in a positive way. The result suggests that this method should be included in the education process.

References

- Abdusselam, M., S. (2014). Teacher and Student Views on the Use of Augmented Reality Environments in Physics Education, *Pegem Journal of Education and Instruction*, 4(1), 59-74
- Adiguzel, T., Gurbulak, N. & Saricayir, H. (2011). Smart Boards and Instructional Applications, *Mustafa Kemal University Journal of Social Sciences Institute*, 8, 457-471.
- Akdag, M., & Tok, H. (2008). Effect of Traditional Instruction and Power Point Presentation Supported Instruction on Students' Accessibility, *Education and Science*, 33(147).
- Akkagit, S., F., & Tekin, A. (2011). An educational tool for logic doors. *5th International Computer and Instructional Technologies Symposium*, Fırat University, Elazığ, Turkey, 564-568.
- Akkagit, S., F., & Tekin, A. (2012). Effect of Simulation-based Learning on Success in Basic Electronic and Assessment Courses of Secondary School Students', *Ege Journal of Education*, 2(13), 1-121.
- Arvind, V., R., & Heard, J., W. (2010). Physics by simulation: Teaching circular motion using applets, *Latin American Journal of Physics Education*, 4(1), 35-39.
- Ayvaci, H., S., & Abdusselam, Z. (2012). The Effect of Animation-Assisted Cartoons in Science Teaching: 6th Grade Force Topic Example, *Journal of Research in Education and Teaching*, 4(1).
- Azar, A., & Sengulec, O., A. (2011). Computer-assisted and laboratory-assisted teaching methods in physics teaching: the effect on student physics achievement and attitude towards physics, *Eurasian Journal of Physics and Chemistry Education*, 43-50.
- Bakac, M., Tasoglu, A., K., & Akbay, T. (2011). The effect of computer assisted instruction with simulation in science and physics activities on the success of student: Electric current. *Eurasian Journal of Physics and Chemistry Education*, 32-42.
- Baran, M., & Maskan, A., K. (2010). The Effect of Project-Based Learning on Pre-Service Physics Teachers Electrostatic Achievements, *Cypriot Journal of Educational Sciences*, 5(4).
- Bell, T., Urhahne D., Schanze S., & Ploetzner R. (2010). Collaborative inquiry learning: Models, tools, and challenges, *International Journal of Science Education*, 32(3), 349-377.
- Binder, K., & Heermann, D., W. (2010). *Monte Carlo Simulation in Statistical Physics: An Introduction*. Springer.
- Bozkurt, E. (2007). The effect of a virtual laboratory application that is prepared for Physics education on student success compared to traditional laboratory: RC circuit example in direct current. Received from: <http://pietc2008.home.anadolu.edu.tr/ietc200860.doc>
- Bozkurt, E., & Ilik, A. (2010). The effect of computer simulations over students' beliefs on physics and physics success. *Presidia - Social and Behavioural Sciences*, 2(2010), 4587-4591
- Bozkurt, E., & Sarikoc, A. (2008). Can virtual laboratories substitute traditional laboratories in Physics education? *Selcuk University Journal of Ahmet Kelesoglu Faculty of Education*, 25, 89-100.
- Bradley, P. (2006). The history of simulation in medical education and possible future aspects. *Med Educ*, 40, 254-262.
- Bulbul Y. (2010). *Effects of learning Cycle Model Accompanied with Computer Animations on Understanding of Diffusion and Osmosis Concepts*, Post Graduate Thesis, ODTU, Ankara
- Buyukkara, S. (2011). *The effect of teaching voice unit of science and technology lessons to grade 8 Elementary School students with computer simulations and animations on student success and attitude* (Unpublished Master's thesis). Selcuk University Institute of Educational Sciences.
- Buyukozturk, S. (2007). *Data Analysis Manual for Social Sciences (7th Edition)*. Ankara: Pegem Academy Publishing Company.
- Chen, S. (2010). The view of scientific inquiry conveyed by simulation-based virtual laboratories, *Computers & Education*, 55(3), 1123-1130.
- Civelek, T., Ucar, E. Gokcol, O., Ustunel, H., & Umut, I. (2013). The effects of computer assisted physics experiment simulations on students' learning. *Cypriot Journal of Educational Sciences*, 8(4), 457-471.
- Celen, F. K., Celik, A., & Seferoglu, S. S. (2011). Turkish Education System and PSA Results. Academic IT, 2011, 2-4 February 2011, Inonu University, Malatya.
- Cildir, S. (2012). Visualization of Limit in Computer Environment and The Views of Prospective Teachers on This Issue, *Hacettepe University Journal of Education*, 42, 143-153.

- Hursen, C., & Asiksoy, G. (2015). The effect of simulation methods in teaching physics on students' academic success. *World Journal on Educational Technology*, 7(1), 87-98.
- Coskun, A., & Ozdemir, M., (2013). The Effect of Computer Aided Instruction on Academic Achievement (Among High School Students) on the Subject 'Motion on the Earth Surface'. Cukurova University, *Journal of Science and Engineering*, 29(3).
- Dasdemir, I., & Doymus, K. (2012). The Effect of Using Animation on Students' Academic Achievement, Retention of These Achievements and Development of Scientific Process Skills in Force and Motion Curriculum of Science and Technology in Eighth Grade Primary School, *Journal of Research in Education and Teaching*, 1 (1).
- Demir, C., & Demir, S. (2014). The Investigation of Physics Teachers' Use of Special Teaching Methods in Their Lessons, *International Journal of New Trends in Arts, Sports & Science Education*.
- Dincer, S., & Guclu, M. (2013). Effectiveness of using simulation in computer aided learning and new trends in science education: A meta-analysis study article, *International Journal of Human Sciences*, 10.
- Dogan, M. & Marulcu, İ. (2010). Physics teachers' and their students' opinions about the current physics curricula and textbooks in Afyon karahisar, Erciyes University, *Journal of the Institute of Social Sciences*, 29(2), 193-209.
- Doymus, K., Simsek, U., & Karacop, A. (2009). The effects of computer animations and cooperative learning methods in micro, macro and symbolic level learning of states of matter. *Eurasian Journal of Educational Research*, 36, 109-128.
- Emrahoglu, N., & Bulbul, O. (2010). Simulations and animations effects in computer assisted instruction on academic success and retention when teaching the optic unit in Physics in the ninth grade, *C.U. Journal of the Institute of Social Sciences*, 19(3), 409-422.
- Eren, C., D., & Gurdal, A. (2010). The effect of teaching physics with fragmented teaching method on students' academic success, recalling the attitudes towards group work, *Pamukkale University Journal of Education*, 28, 67-79.
- Ergul, N., R., & Cigrik, E. (2013). The Process of Knowledge Construction about the Concept of Electrical Power. *Hacettepe University Journal of Education*, 28(1), 153-164.
- Ergorun, O. (2010). *The effect of Computer supported Physics instruction on students' achievement and attitudes*, Unpublished Master's Thesis, Yeditepe University, Institute of Social Sciences, İstanbul.
- Ergun, H. (2010). *The Effect of Problem Design in Physics Education on Cognitive Learning and Problem Solving*, PhD Thesis, Marmara University, Institute of Education, İstanbul.
- Finkelstein, N., D., Perkins, K.K., Adams, W., Kohl, P., & Podolefsky, N. (2005). Can computer simulations replace real equipment in undergraduate laboratories? *In AIP Conference Proceedings*, 790, 101.
- Fiscarelli, H., S., Bizelli, M., & Fiscarelli, P., E. (2013). Interactive Simulations to Physics Teaching: A Case Study in Brazilian High School International, *Journal of Learning and Teaching*, 5(1) 18-23.
- Gunhaart, A., & Srisawasdi, N. (2012). Effect of Integrated Compute-based Laboratory Environment On Students' Physics Conceptual Learning of Sound Wave Properties. *Procedia-Social and Behavioral Sciences*, 46, 5750-5755.
- Guven, G., & Sulun, Y. (2012). The Effect of Computer Supported Instruction on Academic Achievement and Students' Attitudes Towards the Lesson in Eighth Grade Science and Technology Lessons, *Journal of Turkish Science Education*, 9(1).
- Guvercin, Z. (2010). *The effect of simulation-based software on students' academic achievement, attitudes and retention in Physics lesson*, Unpublished Master's Thesis, Cukurova University, Institute of Social Sciences, Adana.
- Han, I., & Black, J., B. (2011). Incorporating haptic feedback in simulation for learning physics, *Computers & Education*, 57, 2281-2290.
- Hancer, A., H., & Tuzemen, A.T. (2008). A Research on the Effects of Computer Assisted Science Teaching, *World Applied Sciences Journal*, 4(2), 199-205.
- Hoellwarth, C., Moetter, J., M. & Knight, R., D. (2005). A Direct Comparison of Conceptual Learning and Problem Solving Ability in Traditional and Studio Style Classrooms, *American Journal of Physics*, 73(5), 459-462.
- Inac A. (2010). The Effect of Using Animations on Elementary School Students' Academic Achievement in Science and Technology Lessons and on the Level of Retention: Example of Sixth, Seventh and Eighth Grades, *Master's Thesis*, 18 Mart University, Canakkale

- Jaakkola, T., Nurmi, S., & Veermans, K. (2011). A comparison of students' conceptual understanding of electric circuits in simulation only and simulation-laboratory contexts, *Journal of Research in Science Teaching*, 48(1), 71-93.
- Jian-Hua, S., & Hong, L. (2012). Explore the Effective Use of Multimedia Technology in College Physics Teaching. Energy Presidia 17 (2012) 1897 – 1900. 2012 International Conference on Future Electrical Power and Energy Systems.
- Karaca, K. (2013). *Views of Pre-service Teachers' on Contribution of Visual Materials in Physics Instruction*, Gazi University, Institute of Education, Ankara.
- Karaca, N. (2010). *The effects of computer-based animations on developing graphical and interpretation skills*, Unpublished Master's Thesis, Karadeniz Technical University, Institute of Science, Trabzon.
- Karacop, A. (2010). *The effects of animation and jigsaw techniques on students' understanding in the subjects of electrochemistry and chemical bonds units*, Unpublished PhD Thesis, Ataturk University Institute of Science, Erzurum.
- Karal, H., Çebi, A., & Pekşen, M. (2010). The web based simulation proposal to 8 th grade primary school students' difficulties in problem solving. *Procedia-Social and Behavioral Sciences*, 2(2), 4540-4545.
- Katirci, E. & Satici, A. F. (2010). Effects of creating simulations in interactive physics application and developing portfolio on students' academic self-concept and creativity, *Journal of Turkish Science Education*, 7(4), 46-59.
- Kehtittchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation, *Computers & Education*, 55(2), 427-443.
- Kert, S., B., & Tekdal, M. (2008). The Effects of Multimedia based Courseware Prepared on the Basis of Design Principles from Literature on the Academic Achievement and Retention in High School Physics Instruction, *Pamukkale University Journal of Education*, 23(1).
- Kocakaya, S., & Gonen, S. (2010). The effects of computer-assisted instruction designed according to 7E model of constructivist learning on physics student teachers' achievement, concept learning, self-efficacy perceptions and attitudes, *The Turkish Online Journal of Distance Education*, 11(3), 206-224.
- Korkmaz, A. & Yildiz, A. (2012). Comparisons of Gender Differences, The Interactive of Physics Lessons and the Success of Classical Education in Secondary Schools, *International Journal of New Trends in Arts, Sports & Science Education*, 1(3).
- Koh, C., Tan, H.S., Tan, K.C., Fang, L., Fong, F.M., Kan, D., Lye, S. L., & Wee, M.L (2010). Investigating the Effect of 3D Simulation Based Learning on the Motivation and Performance of Engineering Students. *Journal of Engineering Education*, 99(3), 237-251.
- Kuvvetli, E. (2008). *Researching the effect of visual readout on secondary school students' achievement in physics lesson*, Unpublished Master's Thesis, Gazi University, Ankara.
- Lateh, H. & Vasugiammai, M. (2011). Technology integrated teaching in Malaysian schools: GIS, a SWOT analysis, *World Journal on Educational Technology*, 3 (2).
- McDermott, L., C. (1993). How we teach and how students learn: a mismatch? *Am J Phys* 61, 295- 298.
- Midik, O., & Kartal, M. (2010). Simulation-based Medical Education, *Marmara Medical Journal*, 23(3), 389-399
- Odom, A., L., Marszalek, J., M., Stoddard, E., R., & Wrobel, J.M. (2011). Computers and Traditional Teaching Practices: Factors influencing middle level students' science achievement and attitudes about science, *International Journal of Science Education*, 33(17), 2351-2374.
- Ozen, Y., Gulacti, F., & Kandemir, M. (2006). The Problem of Validity and Reliability in Educational Research. *Erzincan University Journal of Education Faculty*, 8 (1).
- Patrick J. (2002). *Simulation*. In: Patric J, ed., Training: Research and Practice. London: Academic Press, 487-508.
- Polat, E., & Tekin, A. (2013). The effect of web based education assisted by animation on academic success in the course of science and technology, *International Journal of Human Sciences*, 10 (Special Issue), 17-26.
- Renken, M., D., & Nunez, N. (2013). Computer simulations and clear observations do not guarantee conceptual Understanding. *Learning and Instruction*, 23, 10-23.
- Rotimi, C., O., Ajogbeje, O., O., & Akeju, S. (2012). A New Kind of Visual-Model Instructional Strategy in Physics, *Eurasian Journal of Physics and Chemistry Education*, 28-32.

- Rutten, N., Joolingen, W.R., & Van der Veen, J. T. (2012). The learning effects of computer simulations in science education, *Computers Education*, 58, 136-153.
- Sarabandoa, C., Cravino, J., P., & Soares, A.A. (2014). Contribution of a computer simulation to students' learning of the physics concepts of weight and mass. *Procedia Technology* 13, 112 – 12.
- Secer, I., Ay, I., Ozan, C., & Yilmaz, B.S. (2014). Research Trends in the Field of Guidance and Psychological Counselling: A Content Analysis, *Turkish Psychological Counselling and Guidance Journal*, 5(41), 49-60.
- Smetana, L., K. & Bell, R., K. (2012). Computer Simulations to Support Science Instruction and Learning: A critical review of literature. *International Journal of Science Education*, 34(9), 1337-1370.
- Sokolowski, A. & Rackley, R. (2011). Teaching harmonic motion in trigonometry: Inductive inquiry supported by physics simulations. *Australian Senior Mathematics Journal*, 25(1) 2011.
- Soderstrom, T., Hall L.O., Ahlqvist, J., & Nilsson, T. (2012). How Group Size and Composition Influences the Effectiveness of Collaborative Screen-Based Simulation Training: A Study of Dental and Nursing University Students Learning Radiographic Techniques, *World Journal on Educational Technology*, 4(3), 180-193
- Sencan, H. (2005). *Reliability and Validity in Social and Behavioural Evaluations*, Ankara: Seckin Publishing Company.
- Sendir, M. (2013). Using Simulation in Nursing Women's Health. *Florence Nightingale Journal of Nursing*, 21(3), 205-212.
- Tanel, Z., & Onder, F. (2010). Effect of Computer Simulations on Students' Achievement at Electronics Laboratory: Example of Diode Experiments, 9 September, *University Journal of Buca Faculty of Education*.
- Tanel, Z., & Tanel, R. (2010). Conditions of Physics Laboratories, Information Environments and Teachers' Views on Their Use. 9 September, *University Journal of Buca Faculty of Education*, 27.
- Tatli, Z., & Ayas, A. (2011). Development Process of Virtual Chemistry Laboratory. International Computer & Instructional Technologies Symposium. Firat University, Elazig- Turkey.
- Tekbiyik, A., & Akdeniz, A.R. (2010). Up To Date Physics Attitude Scale for Secondary School Students: Development, Validity and Reliability, *Journal of Turkish Science Education*, 7(4).
- Tippmann, J.D., Kim, H., & Rhymer, J.R. (2013). Experimentally validated strain rate dependent material model for spherical ice impact simulation, *International Journal of Impact Engineering*, 57(2013) 43-54.
- Trundle, K.C. & Bell, R.L. (2010). The use of a computer simulation to promote conceptual change: a quasi-experimental study, *Computers & Education*, 54, 1078-1088.
- Ulukok, S., Celik, H., & Sari, U. (2013). The Effect of Computer Supported Applications about Simple Electric Circuits on the Development of Experimental Procedure Skills. AKU, *Journal of Theoretical Educational Science*, 6(1), 77-101.
- Venkataraman, B. (2009). Visualization and interactivity in the teaching of chemistry to science and non-science students, *Chemistry Education Research and Practice*, 10, 62–69
- Wang, Z., Li, S., Yang, L., & Hao, A. (2013). Real-Time CUDA Based Collision Detection and Physics Based Collision Response Simulation, *Global Journal on Technology*, 3
- Yener, D., Aydin, F., & Koklu, N. (2012). *Examination of Students' Self-efficacy who were Applied Animation-Simulation in Physics Laboratory*, 10. International Congress on Science and Mathematics Education, Nigde University, Nigde.
- Yildirim, A., & Simsek, H. (2005). *Qualitative Research Methods in Social Sciences*, Ankara: Seckin Publishing Company.
- Yildiz, U., Solak, S., Altinisik, U. & Inal, M. (2012). Applications of Branched Software Simulation: Laboratory Applications of Information Technology Course, *Journal of Research in Education and Teaching*, 1(4).
- Yigit, N., Alev, N., Altun, T., Ozmen, H., & Akyildiz, S. (2005). *Educational Technologies and Material Development*, Trabzon: Derya Bookstores.
- Yukselen, M., A. (2012). Computer Assisted Aerodynamics Education. *Procedia - Social and Behavioural Sciences*, 47, 362 – 368.
- Zabunov, S., S. (2013). The Effect of Points Construction in Online Stereo 3D Rigid Body Simulation on the Performance of Students in Mathematics and Physics, *Eurasian Journal Physics & Chemistry Education*, 5 (2), 111-119.