The Effect of Computer Assisted Instruction with Simulation in Science and Physics Activities on the Success of Student: Electric Current

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Abstract

The aim of this study is to observe the effect of computer assisted instruction (CAI) with simulation technique used in teaching the subject of "Electric Current" on the successes of students. In the study pretest-posttest control group quasi-experimental method was used. 28 students of 11th grade in the department of chemistry in an industrial vocational school in Izmir-Konak formed the study group; later on one experiment (n=14) and one control group (n=14) were formed of these students. 16 open-ended questions about electric current were prepared as data collection tool. Pretests were applied on groups a week before the application of activities. "Electric Current" was taught to experiment group using CAI technique and to control group with traditional teaching methods. Posttests were applied one week later the application of activities. In the analysis of data Mann Whitney U-test and Wilcoxon signed rank test which are both non-parametrical, were used. At the end of the study it was detected that of the two groups whose successes were the same at the beginning, experiment group students on whom CAI method was applied came out more successful than control group on whom traditional method was applied. We can result that CAI technique increase the academic successes of students in the subject of "Electric Current".

Key words: Computer Assisted Instruction; Physics Education; Electric Current

Introduction

Advances in computer technology have caught the attention of many educators and researchers. Computer-based multimedia applications, because of their flexible and varied presentation capabilities, are considered as an effective alternative to traditional training methods. Today in many educational and training settings interactive computer programs are used to teach young students and adults computer literacy skills (Varank, 2005).

Today many schools in Turkey are trying to integrate Information and Communications Technologies into their teaching and learning processes. Teachers are undergoing to In-service trainings to use computers as part of Information and Communications Technology to improve the quality of their teaching activities. In addition, due to increase in the numbers of computers in schools, both teachers' and students' access to computers and new technologies have been increased so that reason computers have become a common fixture in Turkish

schools. Computers, computer based learning materials, and educational software is widely used in schools and colleges as part of school practice in Turkey (Altun, 2002).

In Altun, Yiğit and Alev's (2007) study, it was stated that the reason for not reaching the aims in the lessons involving abstract concepts like Law of Snell in Physics was because of the application of traditional approaches. In their study based on similar studies in the field of educational research computers and computer supported material (logo) were used in order to find solutions to this problem. In addition to other applications, their study was assumed that LOGO can be used for making abstract concepts concrete in teaching physics. In this software with simulations close to reality life many senses are addressed. With this software it is aimed that the students would learn in effective and permanent way, be active learners, form their own knowledge, learn to think and develop a positive attitude towards physics. So, such kind of studies are considered as necessary in order to explain the points which students cannot understand well and determine the relation between traditional and computer-assisted lessons (Altun, Yiğit and Alev, 2007).

Computer-based learning has the potential to facilitate development of students' decision-making and problem-solving skills, data-processing skills, and communication capabilities. By using computer, students can gain access to expansive knowledge links and broaden their exposure to diverse people and perspectives (Berson, 1996).

Many studies in the published literature indicate that there is a strong relationship between the use of computers and students' academic achievements in teaching and learning processes (Altun, Yiğit and Alev, 2007). For instance Yiğit (2005) found in his study that computer assisted instruction has had positive impact on students' perceptions about computer supported instruction as well as on to their academic achievement.

The aim of this study is to observe the effect of computer assisted instruction with simulation (CAI) technique used in teaching the subject of "Electric Current" on the successes of students.

Problem Sentence

Is there a meaningful difference in the sense of academic success between the experimental group on which computer assisted instruction was applied and control group on which traditional teaching methods were applied in the teaching of "Electric Current" subject of Physics lesson?

Sub Problems

1. Is there a meaningful difference between pretest success mark of experiment group and pretest success mark of control group?
2. Is there a meaningful difference between posttest success mark of experiment group and posttest success mark of control group?
3. Is there a meaningful difference between pretest and posttest success mark of experiment group?
4. Is there a meaningful difference between pretest and posttest success mark of control group?

Method

In the study pretest-posttest control group quasi-experimental method was used. 28 students of 11th grade in the department of chemistry in an industrial vocational school in Izmir-Konak formed the study group; later on one experiment (n=14) and one control group

(n=14) were formed of these students. 16 open-ended questions about electric current were prepared as data collection tool.

Pretests were applied on groups a week before the application of activities. "Electric Current" was taught to experiment group using CAI technique and to control group with traditional teaching methods. Posttests were applied one week later the application of activities. In the analysis of data Mann Whitney U-test and Wilcoxon signed rank test which are both non-parametrical, were used. In the study step below were observed with experiment and control group in 2 weeks of process.

First Week

At the end of pretests; subjects of current direction, direction of electron, current-resistance relations which are basis for the activities were taught to both groups by using traditional teaching methods in order to complete lacking learning of students. Later on activities with computer assisted instruction were carried out with experiment group.

Simulations were projected and students were asked "What is the direction of current and electron in a circuit?". Students answered as "The direction of current is from '+' pole of the generator to '-' pole; the direction of electron is from '-' pole of the generator to '+' pole."

Current-resistance relation and current-potential relation were explained with animations; activities below were carried out on series circuit simulation as follows.

In the explanation of current-resistance relation, students were asked the question and reason of "why does the intensity of light decrease when we connect a resistance to the circuit serially?". Ohm law was given as a cue (Figure 1 and Figure 2). In here it was expected from the students to understand that since equivalent resistance of the circuit will increase when one more resistance is connected to the circuit, smaller current would be enabled to the circuit according to Ohm Law.
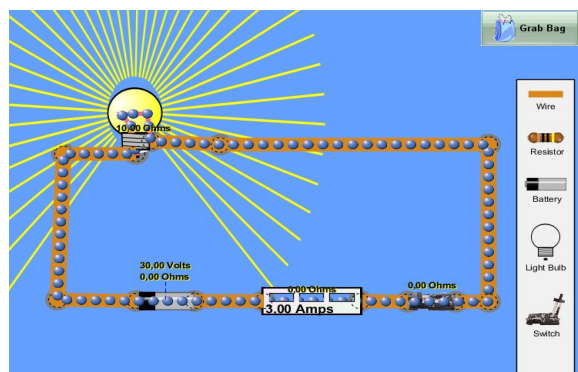

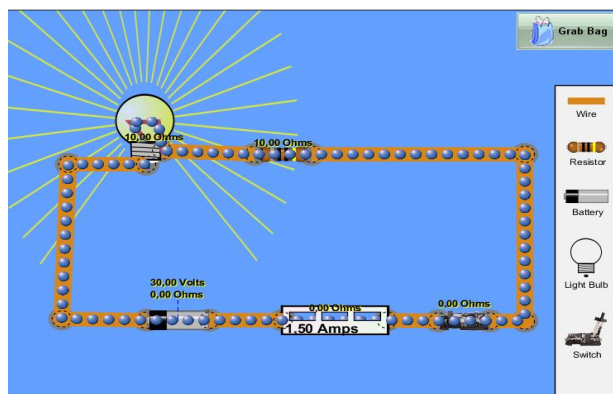**Figure 1.** Current-resistance relation   **Figure 2.** Current-resistance relation

In the explanation of current-potential relation, students were asked the question and reason of "how far does the brightness of lamp would increase when the potential of generators connected to the circuit are increased?" (Figure 3 and Figure 4). In here it was expected from the students to understand that when the potential of generator is increased the current of circuit would increase too according to Ohm Law.
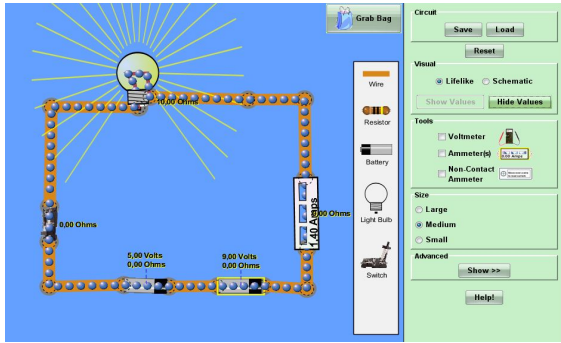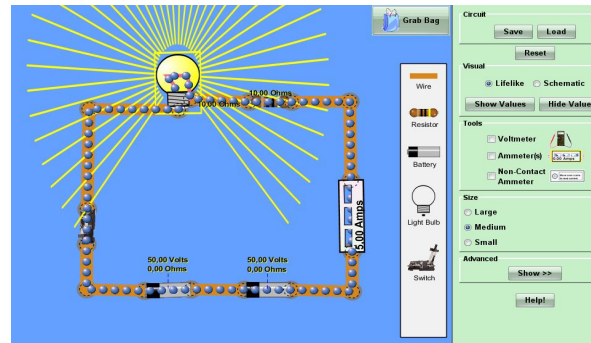
Figure 3. Current-potential relation

Figure 4. Current-potential relation

Second Week

Connection in parallel of resistance was explained to control and experiment groups using traditional teaching methods. Later on, activities with CAI were applied on experiment group. Making use of the learning of connection of series of students, connection in parallel was explained in comparison with connection in series. The students were asked the question and reason of "how bigger the current of three resistances connected in parallel would be compared with their connection in series?" (Figure 5). It was expected from the students to observe that when the resistances are connected in parallel, equivalent resistance of the circuit would be smaller and therefore the current would be bigger compared with its connection in series.

Figure 5. Connection in parallel of resistance

In the simulation it was asked: "when we connect a resistance serially to resistances connected in parallel, what can we say about the magnitude of the current on each resistance?" and students were expected to do a synthesis of what they had learned.

That the currents always would choose resistless or lower resistive way in connection both in series and in parallel is the acquisition that is expected by the students to perceive. The subject is expected to be perceived permanently in short time with ampere meters and lamps connected to circuit.

Results

The first sub problem of the study was expressed as "Is there a meaningful difference between pretest success mark of experiment group and pretest success mark of control group?". Findings obtained from this sub problem are presented in Table 1.

Table 1. Comparison of experiment and control groups according to pretest results

Group	n	Mean Rank	Sum of Ranks	U	P
Experiment	14	11,86	166,00	61,00	0,087
Control	14	17,14	240,00		

In Table 1, it is seen that there is no meaningful difference between pretest results of experiment group and pretest results of control group (U= 61,00; p>0,05).

The second sub problem of the study was expressed as "Is there a meaningful difference between posttest success mark of experiment group and posttest success mark of control group?". Findings obtained from this sub problem are presented in Table 2.

Table 2. Comparison of experiment and control groups according to posttest results

Group	n	Mean Rank	Sum of Ranks	U	p
Experiment	14	19,46	272,50	28,50	0,001
Control	14	9,54	133,50		

In Table 2, it is seen that there is no meaningful difference between posttest results of experiment group and posttest results of control group (U= 28,50; p<0,05).

The third sub problem of the study was expressed as "Is there a meaningful difference between pretest and posttest success mark of experiment group?". Findings obtained from this sub problem are presented in Table 3.

Table 3. Comparison of pretest and posttest results of experiment group

Posttest- pretest	n	Mean Rank	Sum of Ranks	z	p
Negative Ranks	0	0,00	0,00		
Positive Ranks	14	7,50	105,00	-3,301	0,001
Ties	0				

In Table 3, it is seen that there is no meaningful difference between pretest and posttest success points of experiment group. When the average rank and rank sum of difference marks are considered, it is seen that the difference observed is on behalf of positive ranks, in other words of posttest (z = -3,301; p<0,05). According to this result, it can be said that CAI technique in Physics influences the success of students positively.

The fourth sub problem of the study was expressed as "Is there a meaningful difference between pretest and posttest success mark of control group?". Findings obtained from this sub problem are presented in Table 4.

Table 4. Comparison of pretest and posttest results of control group

Posttest- pretest	n	Mean Rank	Sum of Ranks	z	p
Negative Ranks	1	6,00	6,00		
Positive Ranks	12	7,08	85,00	-2,766	0,006
Ties	1				

In Table 4 it is seen that there is a meaningful difference between pretest and posttest success points of control group. When the average rank and rank sum of difference marks are considered, it is seen that the difference observed is on behalf of positive ranks, in other words of posttest (z = -2,766; p<0,05). According to this result, it can be said that traditional teaching methods can increase the success of students.

Discussion

At the end of the study it was detected that of the two groups whose successes were the same at the beginning, experiment group students on whom CAI method was applied came out more successful than control group on whom traditional method was applied. We can result that CAI technique increase the academic successes of students in the subject of "Electric Current". Similar results were obtained in other studies applied in different topics carried out (Altun, Yiğit and Alev, 2007; Hedges, Konstantopoulos and Thoreson, 2000; Karamustafaoğlu, Aydın and Özmen, 2005; Kara, 2008; Kıyıcı and Yumuşak, 2005; Olgun, 2006; Tavukcu, 2008; Yiğit and Akdeniz, 2003; Yiğit, 2005). For instance Yiğit and Akdeniz (2003) found in their studies that CAI technique increase the academic achievements and attitudes of students in the subject of "Electric Circuits".

Kara (2008) investigated the retention effect of computer assisted instruction on students' academic achievement for teaching the Force and Pressure units in the physics topics. At the end of the study, significant differences between the science subject test scores of experiment and control group were found in favor of experiment group. Altun, Yiğit and Alev (2007) found that computer assisted instruction is more feasible than the traditional approach in terms of cognitive and affective behaviors. Students' perceptions before and after the applications have significantly changed about physics, and computer assisted instruction.

Karamustafaoğlu, Aydın and Özmen (2005) aimed in their study to compare the effect of computer aided teaching realised from the simulations of the software developed by the researchers for the Interactive-Physics Programme and Traditional Teaching methods on the success of the science prospective teachers and, to determine the effect of their concept learning on Simple Harmonical Motion. At the end of study, it was observed that the teaching realized through simulation program with dynamic system applied on the experimental group is more successful than the teaching carried out with a traditional method applied on the control group. However, it was found out that the control group gave wrong answers with a great percentage and these wrong answers were the examples accepted as misconceptions such as "The pendulum makes an accelerated movement at the lowest level of the oscillation" and "Harmonic oscillations continue up to infinity". Also it was reported that computer based learning approach in the science training affected the students' achievement positively, and improved students' scientific process skills (Tavukcu, 2008). Olgun (2006) found that the computer assisted science teaching affected the attitudes of the students towards science and metacognition. Furthermore, the student's who were in computer assisted learning environment, were more successful than the student's who were in traditional learning environment was determined. In addition, Liu (2010) found that students substantially

reduced their correlation misconceptions after learning with Simulation Assisted Learning Statistics.

Spradlin (2009) compared academic performance of students enrolled in a developmental mathematics course using traditional instruction, traditional instruction supplemented with computer-assisted instruction, and online distance learning. Generally, the conclusion of this study was that CAI had a positive effect on student learning.

Nurse (2009) compared knowledge acquisition and retention, modification in clinical practice and learner satisfaction when using computer-assisted and traditional classroom instruction to teach positioning and pushing guidelines during the second stage of labor. Results indicated that nurses completing the module using the computer exhibited higher knowledge scores, retained more knowledge and reported greater satisfaction with CAI. However, the method of instruction made no difference in changing clinical practices during the second stage of labor.

Erkfritz-Gay (2009) found that students perceived CAI procedures acceptable as a way to improve their math skills. Thavikulwat (2009) suggested that the technology is ready for computer-assisted simulations to be much more widely used than they are today, but that progress may nevertheless be slow because a great deal of personal investment of time and energy is needed to do good work. According to Ufondu (2008), a CAI lesson can be a very effective tool for teaching and learning the concepts of force, work and machines. Chang et al. (2008) investigated the effects of learning support on simulation-based physics learning in three learning models: experiment prompting, a hypothesis menu, and step guidance. They found that the different learning models didn't have different effects on individuals with different abstract reasoning abilities.

Pol, Harskamp and Suhre (2005) developed a computer program about the subject of forces containing hints for the various different episodes of problem solving in their study. The research conducted with a group taking part in the experiment who used both their textbook and the computer program, and a control group who used their textbook only. They found that pupils involved in the experiment made better use of their declarative knowledge in solving problems than pupils from the control group. Kulik and Kulik (1991) found that computer-based instruction produced small but positive changes in students attitudes toward teaching and computers, and it reduced substantially the amount of time needed for instruction. In the study of Riggi (1981), two programs, describing the simulation of a successive radioactive decay and the random motion of a gas molecule, were presented. And in the study of Shinohara (1981), different methods of teaching using the computer in a Computer-Assisted Instruction system were discussed and illustrated with sample courseware in mathematics, physics, and elementary science.

Gerrell (1972) researched the extent to which computer-assisted instruction and knowledge of group dynamics could overcome the serious instructional problems of large introductory lecture courses. According to the result of the study; the combination of CAI and group process could indeed produce superior academic achievement. And, students preferred both the CAI alone or in combination with the group activity to traditional techniques, with the combination being most preferred.

The findings of these researches supports the views of Runyon and Semich (2002) who strongly argue that positive intervention makes the real difference in student learning when teachers use technology appropriately in the classroom.

Suggestions

Simulations, animation and software programs should be developed for physics courses in order to apply CAI applications at schools. In-service courses should be organized for teachers to use CAI activities efficiently in new secondary education programs. Courses that would bring knowledge and skill that are necessary to carry out computer assisted instruction should be organized at faculties that train teachers. CAI techniques should be used much more at schools.

In future studies, it can be investigated whether CAI has similar effects on students' other outcome variables or not. And by discovering the learning styles of the new generation of students more efficient methods of teaching physics through computers can be explored.

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