EFFECTS OF COMPUTER SIMULATIONS PROGRAMS ON UNIVERSITY STUDENTS' ACHIEVMENTS IN PHYSICS

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ABSTRACT

The present study investigated whether computer assisted instruction was more effective than face-to-face instruction in increasing student success in physics. The study was conducted in the spring semester of 2006 at the Department of Science and Mathematics for Secondary Education at Hacettepe University. Seventy-eight freshman students from the Divisions of Biology Education and Chemistry Education participated in the quantitative study which included a pre-test/post-test control group design. The experimental group consisted of students from the Division of Biology Education while the control group consisted of students from the Division of Chemistry Education. Experiment and control groups were randomly selected.

The subject of geometric optic covered in Physics II Course was provided through a simulation program called Pearls 3.0 to the experiment group, whereas the control group had the same instruction through face-to-face teaching methods.

An achievement test addressing the contents of the geometric optic subject was prepared, which had an internal consistency coefficient of .73. Data obtained through the achievement test were analyzed through conducting t-tests with SPSS 11.0 for Windows. Findings revealed that the experimental group which had the instruction through the computer simulation was more successful than the control group who had face-to-face instruction.

Keywords: Computer assisted instruction, face-to-face instruction, physics education

INTRODUCTION

Rapid scientific and technological developments along with changes in the structure of the society influence the educational systems in general and instructional methods in particular. Such a trend brings about new attempts and needs in terms of the teaching-learning processes. Among these new attempts is the use of computers in instructional endeavors as they are considered as effective communication and individual learning tools. Computers can be used on their own or along with other instructional tools to ameliorate learning practices (Akgun, 2000).

Parallel to the development of these devices, which represents the most important components of the information and communication technologies, science education in general and physics instruction in particular do make use of such tools to improve learning practices.

When the Turkish Educational System is examined, it is observed that face-to-face instruction is the most commonly used instructional practice. Face-to-face instruction assumed in Turkey is mostly based on a teacher-centered learning atmosphere where the focus of the instructional activities is lecture.

Thus, students can have problems in assigning meaning to information, understanding the content as a whole, locating new information in their schema and transforming this information to knowledge. Concepts used in the physics classrooms are mostly abstract making the information hard to grasp, which made the course quite boring and difficult (Çıldır, 2005).

In order to remove the barriers stemming from the abundance of abstract knowledge, several cognitive strategies are assumed. Anyway, they still seem ineffective to sustain higher levels of learning experiences. In this respect, computer assisted instruction can be considered as a fruitful endeavor to integrate science and technology and improve the quality of learning experiences (Yenice, 2003).

As indicated in several resources (Cotton, 1991; Şentürk 2005; Usun,2000), computer assisted instruction allows learners to progress at their own pace, control their learning, participate in the learning endeavors more willingly, learn more effectively, get a richer variety of instructional materials, keep track of the learning experiences, get direct answers for their unique questions, get instant feedback regarding their strengths and weaknesses, conduct experiments which are hard to realize in real-life, and learn at a shorter time in a systematic way. Computers are usually more enjoyable and always more patient than classroom teachers.

They never forget to give feedback, never get tired or angry, never provide face-threatening feedbacks, and never behave according to students' ethnic or cultural backgrounds. They provide the feedback fast, offer a large variety of instructional tools and examples, think faster than human beings, approach students more objectively, address different senses, and realize drudgery work more effectively.

Integration of computer assisted applications in physics instruction might help solving some instructional problems experienced in face-to-face instructional settings, since they require learners to actively participate in the learning process and interpret the content matter of the application to pursue further activities (Yiğit, 2004).

In addition, rather than rote learning endeavors, computer assisted applications might help learners to learn what is provided through the applications permanently, if necessary precautions are taken and arrangements according to learner needs are previously made. Science lessons are particularly appropriate for the application of computer assisted instruction since there are a large bunch of scientific concepts and principles offered in these lessons, which can be illustrated through effective visuals through computers.

The main purpose of computer assisted instruction is to deliver the contents of the course through computers and realize instructional endeavors through the help of computer applications. In this respect, several software programs with different specifications might be used to deliver the subject matters. Simulations, which allow representing real-life events in a controlled environment, are effective software programs ameliorating learning endeavors. Learners can make their own decisions for each problem they are exposed to and see the results of their decisions in a safe environment.

The current study uses a simulation program named Pearls 3.0 in order to teach students the geometric optic which is currently covered in the Physics II Course. The study is designed as a quantitative research which uses the pre-test post-test control group design.

It aims to investigate whether computer assisted instruction realized through simulation is more effective than face-to-face instruction in increasing student success in physics.

METHODOLOGY

Type of Research and Sampling

The study was conducted with students at the Department of Science and Mathematics for Secondary Education at Hacettepe University in the spring semester of 2006.

Seventy-eight freshman students from the Divisions of Biology Education and Chemistry Education participated in the study. The experimental group consisted of 39 students from the Division of Biology Education, while the control group consisted of 39 students from the Division of Chemistry Education. Experiment and control groups were randomly selected and given instruction by the same instructor.

Data Collection

An achievement test including 17 questions and addressing the contents of the geometric optic subject was developed by the researcher. The followings were realized in order to sustain reliability and validity:

- **A Table of specifications covering the course objectives was prepared. The course objectives were determined according to the Physics II program suggested by the Turkish Higher Education Council.**
- **After the objectives were determined, two questions addressing each objective were prepared. Using Physics II coursebooks and the objectives covered in the Table of specification, a total of 30 multiple-choice questions were prepared.**
- **In order to sustain the content validity of the achievement test, expert opinions were resorted to. Experts involved three scholars experienced in physics and four scholars experienced in physics education.**
- **The achievement test was piloted with 56 students to further examine the reliability and validity issues.**
- **The internal consistency of the achievement test was determined through calculating Kuder-Richardson-20 coefficient which was found as .73.**
- **After expert panels, pilot applications and other reliability and validity measures; the number of questions to be included in the test was determined as 17. Students who answered all 17 questions correctly got a score of 100 from the achievement test.**

Procedure

The subject of geometric optic covered in Physics II Course was provided through a simulation program called Pearls 3.0 to the experiment group, whereas the control group had the same instruction through face-to-face teaching methods. The simulation programs used with the experiment group is illustrated in Figure: 1.

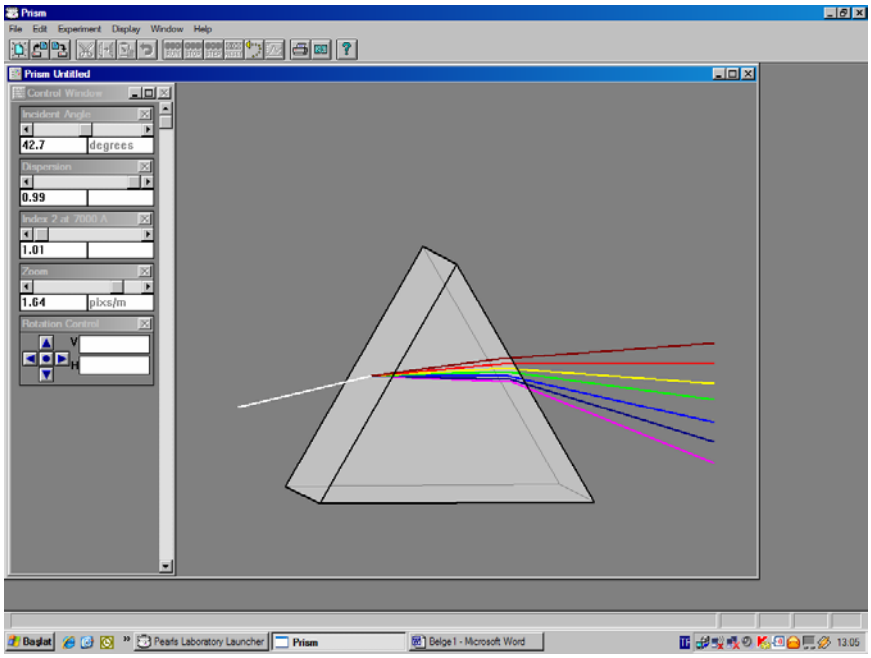

Figure: 1
Simulation program: Refraction of the light in prism

Figure: 1 illustrates the simulation program which was used to teach the refraction of the light in prisms and minimum deviation. In order to teach the refraction of the light in different environments, reflection of the light, and its transition in environments with different refraction indices (Snell's Law); the simulation program illustrated in Figure: 2 were used (See Figure: 2). The achievement test mentioned above was administered as the pre-test and post-test in order to investigate the influence of the program on student success.

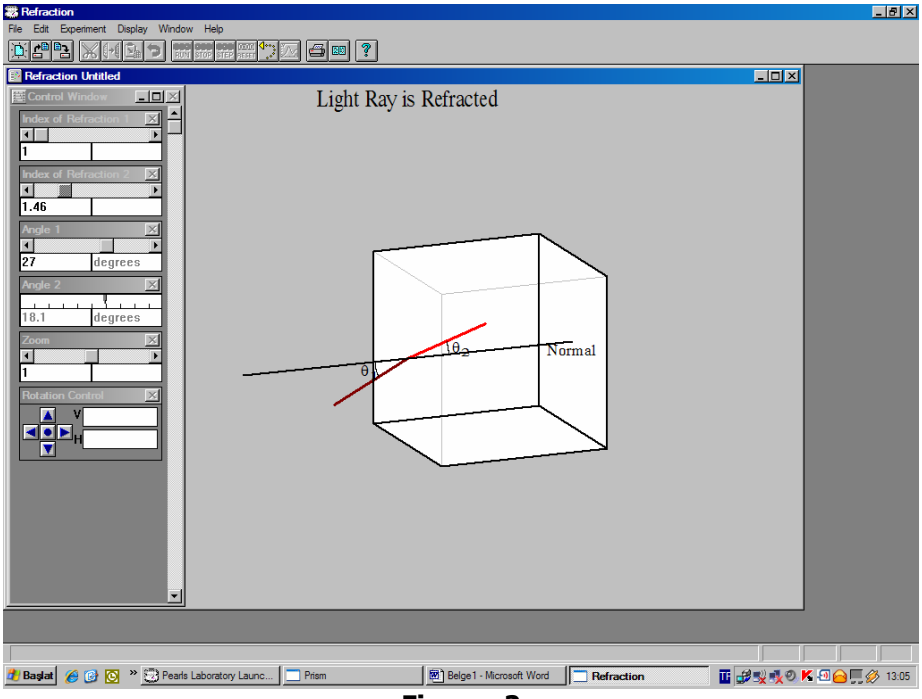

Figure: 2
Simulation program: Refraction of the light in different environments

Data Analysis

The data consisted of the pre-test and post-test results obtained from the achievement test. All parametric tests were conducted at a probability level of .05. Data were analyzed through t-tests. Findings were obtained through conducting the parametric tests with SPSS 11.0 for Windows.

FINDINGS OF THE STUDY

Statistical results of the achievement tests administered before the study and after the study are provided in Table: 1, Table: 2, Table: 3 and Table: 4. In order to investigate the prior knowledge of students, both the experiment and control groups were administered pre-tests.

As indicated in Table: 1, students' prior knowledge measured through the achievement tests did not differ significantly ($t_{(76)}$= 0.042, p>0.05). In this respect, it can be suggested that the prior knowledge levels of the experiment group and the control group was equal at the inception.

Table: 1
Independent-samples t-test conducted with the pre-test results of the experiment and control groups.

		N	$\overline{X}$	SD	SEM	Df	t	p
Pre-test	Experiment	39	37,44	12,81	2,05	76	0,042	0,966
	Control	39	37,56	13,99	2,05			

(N: Number of participants, $\overline{X}$: mean, SD: Standard deviation, SEM: Standard error of mean, Df: degree of freedom, p: significance value)

The mean of the students in the experiment group was 37.44, while the mean of those in the control group was 37.56. The scores of the experiment and control groups on the pre-test are illustrated in Figure: 3 below:

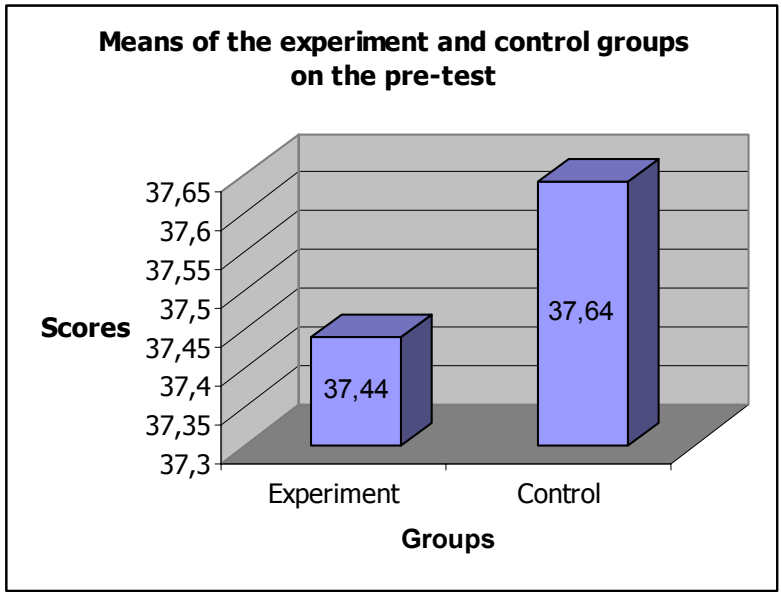

Figure: 3
Means of the experiment and control groups on the pre-test

The results of the independent-samples t-test comparing the experiment and control groups in terms of the post-test results are provided in Table: 2 below:

Table: 2
Independent-samples t-test conducted with the post-test results of the experiment and control groups.

		N	$\overline{X}$	SD	SEM	Df	t	p
Post-test	Experiment	39	67,18	3,95	2,23	76	0,562	0,040
	Control	39	60,77	13,21	2,11			

As can be seen in Table 2, a statistically significant difference between the post-test scores of the experiment group and the control group was found ($t_{(76)}$=0.562, p<0.05).

The mean of the students who were exposed to computer assisted instruction (67.18) was significantly higher than that of the control group (60.77) at a probability value of .04 (See Figure: 4).

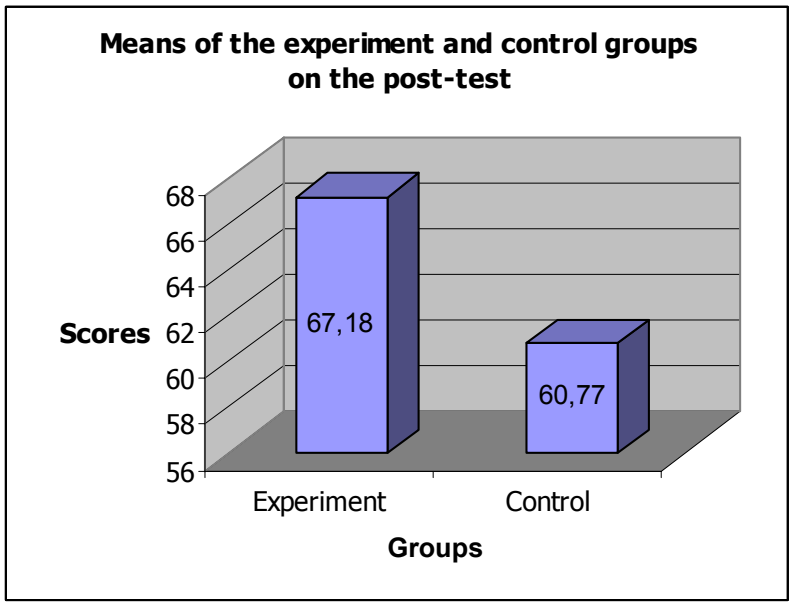

Figure: 4
Means of the experiment and control groups on the post-test

In order to see whether the experiment groups scores on the pre-test which was administered before the computer assisted instruction and on the post-test which was administered after the instruction, a dependent-samples t-test was administered (See Table: 3).

A t value of 22.467 with a probability value below .000 was found indicating that the achievement levels of the students in the experiment group increased at a statistically significant level (p<.05).

Table: 3
Dependent-samples t-test comparing the pre-test and post-test results of the experiment group.

		N	$\overline{X}$	SD	SEM	Df	t	p
Experiment Group	Pre-test	39	37,44	8,27	1,32	38	-22,467	0,000
	Post-test	39	67,18					

More specifically, the experiment group had a mean of 37.44 on the pre-test, while their mean increased to 67.18 on the post-test. This increase is illustrated in Figure: 5.

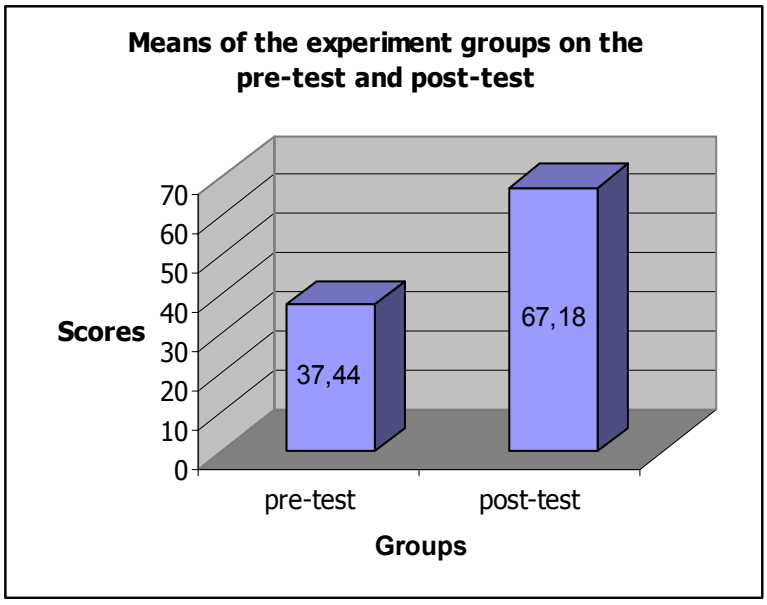

Figure: 5
Means of the experiment group on the pre-test and post-test

Table: 4 provide the pre-test and post-test results of the control group which was exposed to the face-to-face instruction.

Table: 4
Dependent-samples t-test comparing the pre-test and post-test results of the control group

		N	$\overline{X}$	SD	SEM	Df	t	p
Control Group	Pre-test	39	37,56	8,38	1,34	38	-17,27	0,000
	Post-test	39	60,77					

As careful analysis of Table 4 indicates that the students in the control group who were exposed to the face-to-face instruction had significantly higher scores in the post-test in comparison to their scores in the pre-test ($t_{(38)}$=-17.27 p<0.05).

This finding suggested that the control group who were exposed to face-to-face instruction was also more successful in the post-test.

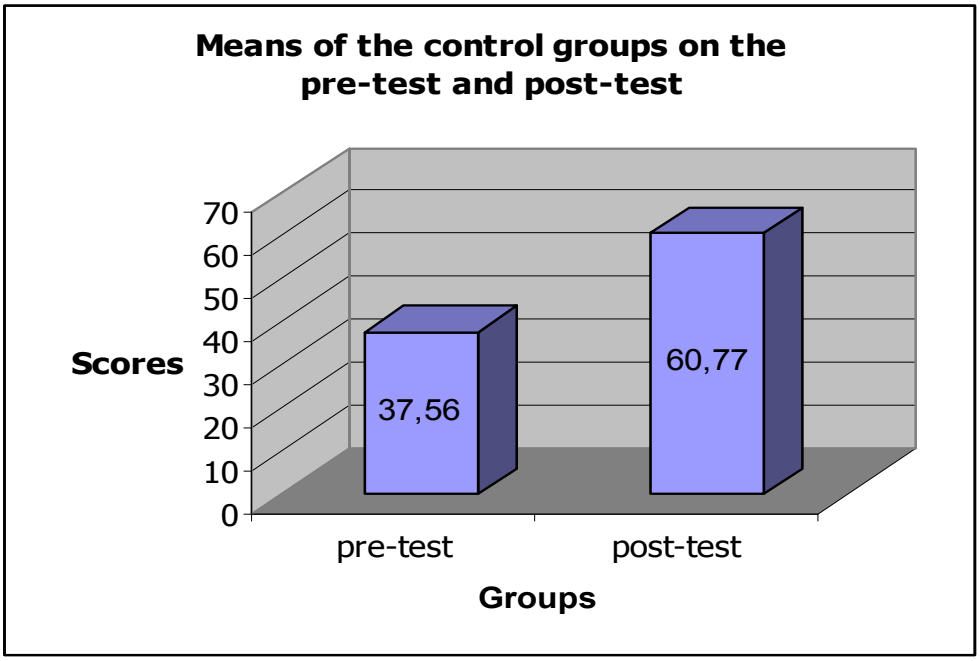

Figure: 6
Means of the control group on the pre-test and post-test

The Figure 6 illustrates their improvement of the control group from the pre-test through the post-test.

CONCLUSIONS AND DISCUSSION

Findings of the study suggested that students in the experiment group who were exposed to computer assisted instruction were more successful than the control group students who were exposed to face-to-face instruction. This finding supports the studies conducted by Chang (2002); Çekbas, Yakar, Yildirim and Savran (2003); Gönen and Kocakaya (2005), and Hacker and Sova (1998).

Through computer simulations, students had the chance to conduct real-like experiments and see physical facts, which can only be investigated in laboratory settings.

Several abstract concepts and conceptual relations covered in the physics courses were provided in a concrete way through the help of computer simulations, which improved the student success significantly.

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REFERENCES

Akgun, S. (2000). ***Science Instruction to Pre-Service Teachers*****. Ankara: Pegem A Yayincilik.**

Chang, C. Y. (2002). Does- computer-assisted instruction+problem solving= improved science outcomes? A pioneer study. ***The Journal of Educational Research,*** **95(3), 143-150.**

Cotton, K. (1991). Computer-Assisted Iınstruction. ***School Improvement Research Series.*** **Retrieved January, 1 2008, http://www.nwrel.org/scpd/sirs/5/cu10.html.**

Cekbas, Y., Yakar, H., Yildirim, B. & Savran, A. (2003). Effect of Computer Assisted Instruction on Students). ***The Turkish Online Journal of Educational Technolagy (TOJET),*** **ISSN:1303-6521:2:4, Article 11.**

Cildir, I. (2005). Idenfication of High School Students' Misconception About Electric Current by Concept Maps. Hacettepe University, Master's dissertation.

Hacker, R. G, & Sova, B. (1998). Initial Teacher Education: A Study of the Efficacy of Computer Mediated Courseware Delivery in a Partnership Concept. ***British Journal of Education Technology,*** **29 (4), 333–341.**

Gonen, S. & Kocakaya, S. (2005). Comparison of Attitudes Towards Physics and Computer attitudes in High School First Graders According to two Different Instructional Methods). ***Pamukkale Üniversitesi Eğitim Fakültesi Dergisi,*** **17.**

Senturk, A. (2005). Computer Applications in Instruction and CBI. (Instructional Technologies and Materials Development)(p. 115–126). Ankara: Öğreti, PagemA Yayincilik

Usun, S. (2004). ***Fundamentals of Computer Assisted Instruction).*** **Ankara: Nobel Yayin Dağıtım.**

Yenice, N. (2003). Effect of Computer Assisted Science Instruction on Attitudes Towards Computers and Science). ***The Turkish Online Journal of Educational Technolagy (TOJET)*** **ISSN: 1303–6521: 2;4, Article 12.**

Yigit, N. (2004). Effect of Computer Based Applications on Achievement in Physics Instruction). ***Milli Eğitim.*** **Sayı 161.**