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THE EFFECT OF COMPUTER-ASSISTED INSTRUCTION ON THE LEARNING OF BLACK BODY, COMPTON AND X-RAYS*

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Abstract

The main purpose of this study is to compare the effect of computer assisted instruction on the learning of black body, Compton, x-rays topics by pre-service science teachers with the method of traditional teaching. This research was conducted by the participation of 70 students from two different classes of 2nd grade at the İnönü University Education Faculty during the spring semester of 2008-2009 academic years. The study has been done as an experimental study according to pretest and posttest model. Independent sample t test was used for data analysis. While the instruction of black body, Compton, x-rays subjects in experimental group was performed for two weeks by means of animations which were prepared with Macromedia Flash 8.0 Program, the instruction of same subjects in control group was performed by using a traditional instruction method. The result of the study shows that students taught by computer supported animations were performed better scores than those in traditional teaching group ($p<0,05$).

Keywords: Computer-assisted instruction, animation, black body, Compton, x-rays.

INTRODUCTION

The rapid development of technology shows itself in the field of education as well. Technology, which is an indispensable part of education system today, has brought about innovations. In the education institutions which hold the duty of growing up individuals society needs, the rate of benefitting from technological opportunities has been increasing and the innovations that technology has brought have enabled the preparation and usage of class materials in compliance with technology. According to Kacar (2006) education has to be equipped with and regulated in accordance with the developing technology's opportunities in order to meet the necessities of today. In the new learning program regulated by the Ministry of National Education in compliance with the constructivist understanding, the students should be grown up as active, deeply motivated, searching and self controlled individuals. For this reason, technology should be used in education institutions sufficiently.

The most important technological device used in learning-teaching activities is computers. Computers have been an indispensable part of learning activities in terms of having superior qualifications such as effectuality, integrity, consistency, usefulness, multipurpose usage, high speed, reliability, mutual interaction, and are used in every field of learning teaching process. The method of making use of computers in the process of education is called computer assisted learning, shortly CAL (Baki, 2002; Çetin, 2007; Kıyıcı and Yumuşak, 2005). As the traditionally taught lessons are insufficient in terms of helping individuals understand the concepts, the opportunities technology provides, particularly computers, should be used (Yiğit and Akdeniz, 2003). In cases that the direct teaching method is used alone in traditional method, the student gets bored and loses his interest for the lesson, but when the same lesson is taught with various animations, graphics and sounds, it has been observed that the students listen to the lesson more eagerly (Bodur, 2006).

The design and usage of visual materials such as graphics, animations, diagrams, charts, maps and pictures have a great effect on learning. Visual materials are used to define, clarify or support verbal concepts. Thereby, a more permanent learning is provided (Kılıç, 1997; Yalın, 2004). Animations, which have a significant place among visual materials, make students develop positive attitudes towards the lesson as well as enabling them to make meaningful connections between lessons. As the animations make the lessons more comprehensible, it prevents students from being loaded with unnecessary information. By preparing animations for students from all ages, the comprehension of the students increases and a positive effect is created on students by animating abstract cases thanks to their dynamic appearances (Costa et. al.,2000; Najjar, 1996; Pekdağ, 2005). For this reason, it has been pointed out that by using animation, picture, and sound together, learning environment has been spared from traditionality, and the level of learning has been increased (Clark and Craik, 1992).

In Science lessons, teaching becomes more difficult because of the majority of scientific concepts and principles (Gerçek et. al. 2006). The fact that there are more abstract cases than concrete ones increases the importance of the use of computers in Science lessons. By computers, students may be enabled to perceive an event as real. The use of computers in Science lessons makes the subject more realistic and comprehensible. Concepts which are difficult to comprehend due to their abstractness may be objectified via computers and thus it makes the meaningful learning easy. Besides, the experiments which are not possible to show or repeat may be taught to students easily thanks to the technology (Aykanat, 2005; Kurt, 2006; Soylu, 2004). Because there are a lot of abstract subjects especially in Physics, the subjects should be taught practically, or else the incomprehension of the abstract subjects will lead to misconceptions and makes the students develop negative attitude towards Physics (Mdledshe et. al. 1995).

Animations, which are more proper to be used in Physics lessons, make the presented content to be learned better and increase the level of recollecting information. It has been previously obtained in the result of the studies made by Çelik (2007), Dalton (2003), Daşdemir (2006), İskender (2007), Kulik et. al. (1980), Milheim (1993), Saka et. al. (2006) that animations create positive effects on students learning in different subjects.

The quantum mechanics, which is a popular theme today, examines the invisible granule size of substances that is, molecule, atom, nucleus, nucleon, basic particles and quark. The word quantum may be defined as the minor energy unit. Max Planck came up with the Theory of Quantum in 1900 and made great contributions to the history of Science (Taşkan, 2005).
The black body, Compton and X ray which constitutes a big part of Quantum Mechanics has great importance in understanding the natural part of light or the granulated structure of substance. So, the aim of this study is to examine the relationship between the students' academic success in teaching the subjects of Black body, Compton as well as X ray and the use of animations and CAL compared to the traditional method.

METHOD

The pattern of the research which has been planned as an experimental study is in the form of pretest- posttest control group model. The population of the research consists of the sophomores of 2008-2009 education year in Inonu University Faculty of Education Department of Science Teaching. The sample consists of 70 people chosen systemically. These people are divided into two: 35 of them are chosen as the control group, while the other 35 are chosen as the experimental group. In the control group, Black body, Compton and X-ray subjects were taught via the traditional method, while in the experimental group the same subjects were taught via animations.
As for the data collection tool, the multiple choice scale which has been developed to measure the achievement of the pre-service teachers about Black body, Compton and X-ray was used. The reliability- validity study of the scale has been done and it was applied as pretest and posttest. In order to increase the content validity, the balance of the subjects was taken into consideration in the distribution of the questions, and the validity of the achievement test was provided by consulting to the opinions of the experts. The reliability of the achievement test has been provided by applying the test to the pre-service Science teachers who had taken this lesson the previous year and the reliability of the achievement test was calculated as 0,70. The statistical analysis of the collected data has been made by the SPSS17 packaged software.
In the control group, in order to determine the pre-knowledge that the students have, they were asked questions about the subjects of Black body, Compton and X-ray. Later, the subjects were taught via the direct teaching method, the necessary figures have been drawn on the board by the researcher, and the details regarding the subjects were taught to the students via these figures. In the experimental group, while teaching the subjects of Black body, Compton and X-ray, some examples from daily life were given by the researcher and the students were enabled to think. In teaching of any new concept, the students' pre-knowledge should be revealed primarily and then, the information should be reconstructed. (Günel et. al., 2010). Later, questions about the subject were asked, and the views of the students regarding the subject were tried to understand. After this step, the misconceptions of the students were determined, and in order to overcome these misconceptions, animations prepared by using the Macromedia Flash 8.0 program were shown to give the details of the subject by the researcher.

The screenshots of the animations of Black body, Compton and X-ray are shown below:

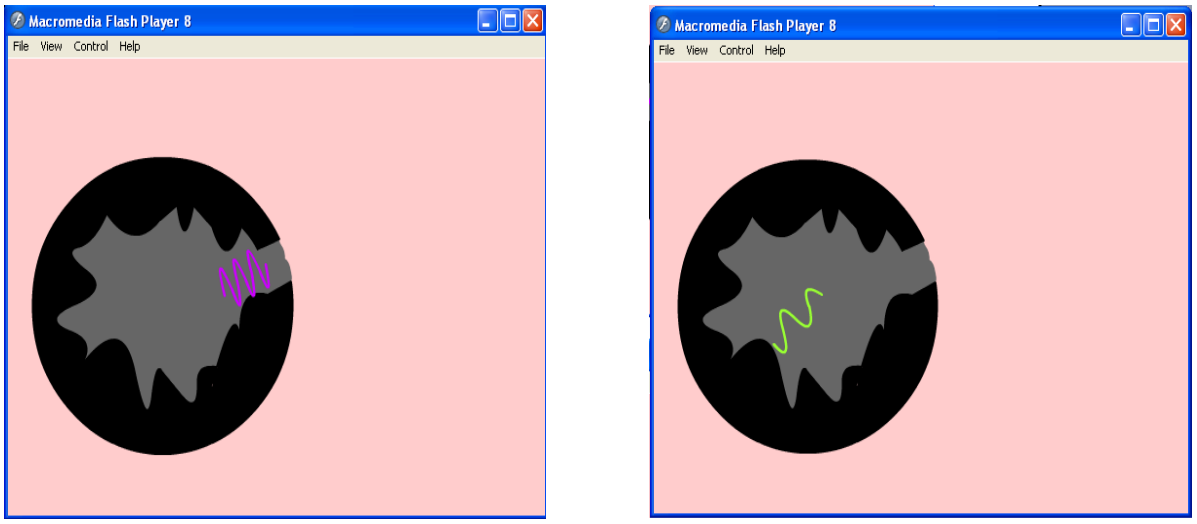


Figure 1. The animated screenshots show the change in frequency and wavelength of the photon going inside the black body.

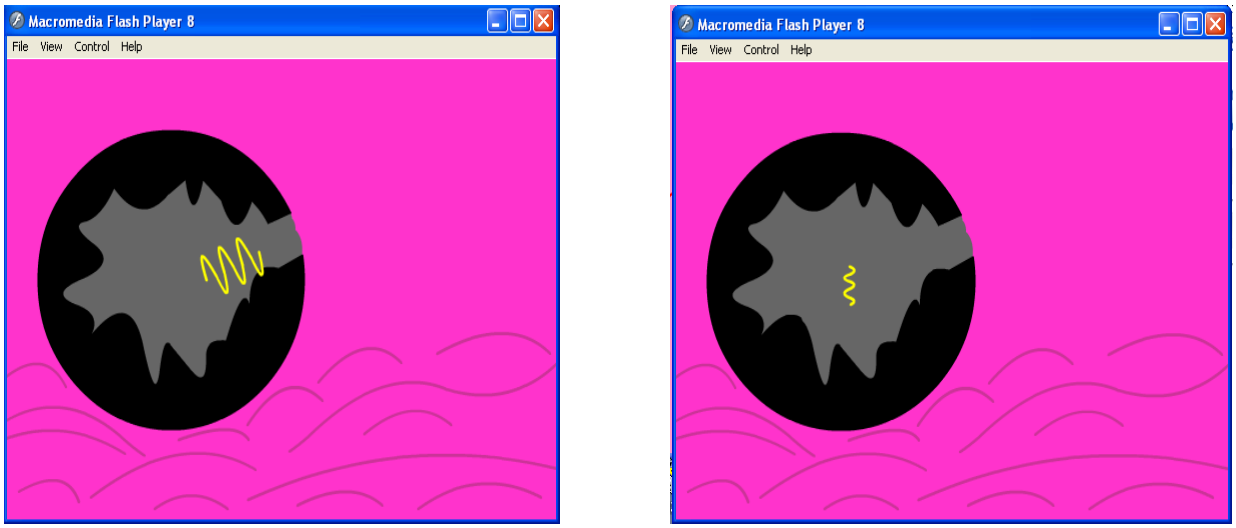


Figure 2. The animated screenshots show that magnitude and energy of the photon going inside the black body change

Figure 3. The animated screenshots show the numbers and frequencies of photons that the black body radiates in different temperatures

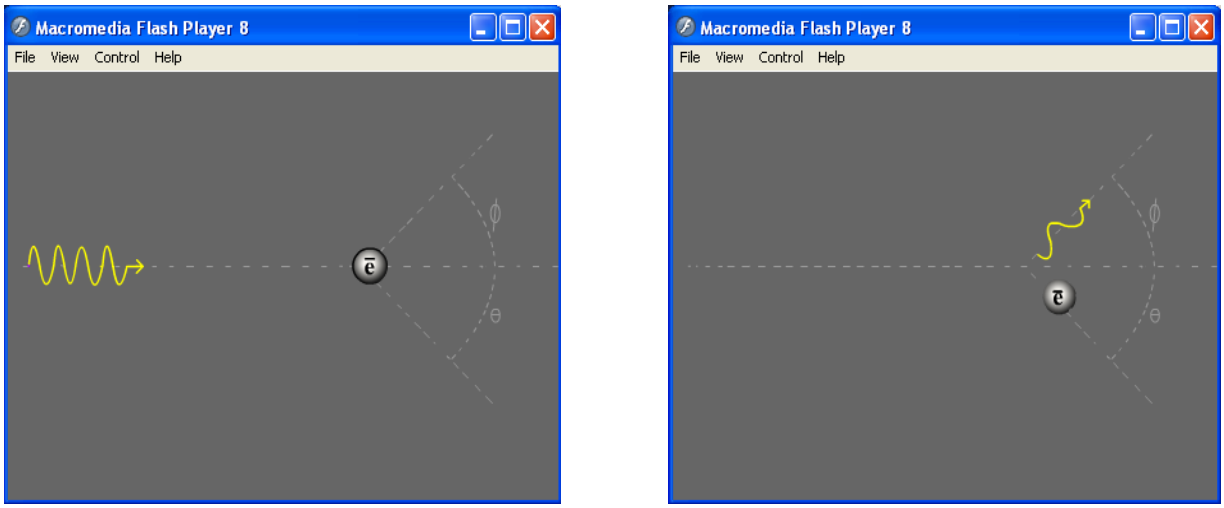
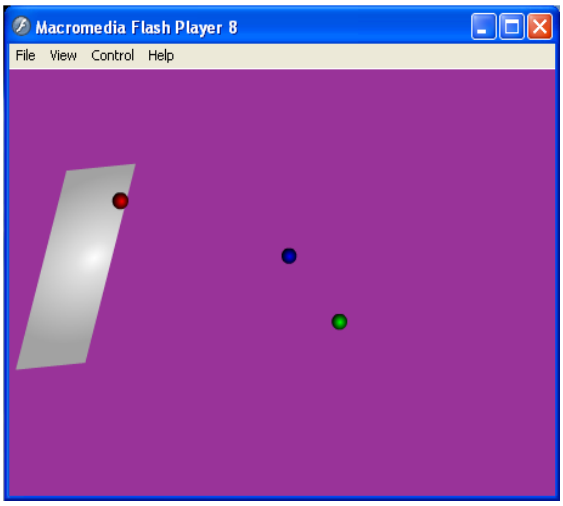


Figure 4. The screenshots of the animations prepared about the Compton case.



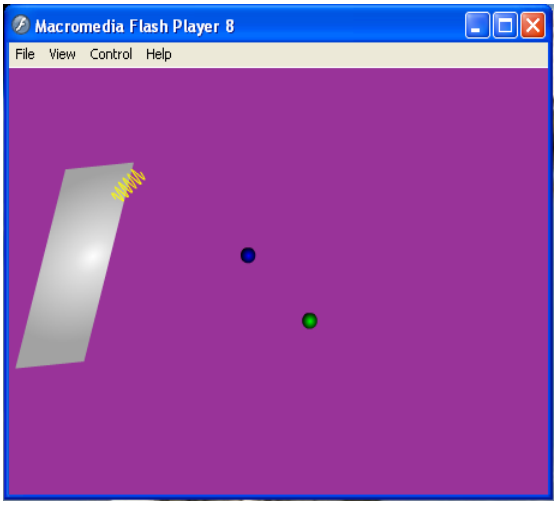


Figure 5. The screenshots of the animations prepared about about x-rays.

FINDINGS

The findings regarding the achievements of the pre-service teachers on subjects ofBblack body, Compton, X-ray with the traditional teaching method and computer assisted teaching method have been shown in Table 1. When Table 1 is examined, it has been found out that the arithmetic average of the pre-test achievement score of the experiment group is 32,2857 and the standard deviation score is 14,76994. The arithmetic average of the pre-test achievement score in the control group is 33,1429 and the standard deviation is 13,67080. When the results of "independent t test" which is made by taking pretest results of control and experimental groups are considered, a significant difference has not been found before starting teaching between the control group on which traditional teaching method will be used and the experiment group on which computer assisted teaching method will be used. (p>0,05). These analysis results show that the achievement levels of the control group and the experiment group were close to each other in the beginning.

Table 1. The independent t test analysis results of pretests and posttests.

Tests	Groups	N	X	SD	T	P
Pretest	Control	35	33,14	13,67	-0,252	0,802
	Experiment	35	32,28	14,76		
Posttest	Control	35	50,57	13,49	5,542	0,00
	Experiment	35	69,42	14,93		

Note: Maximum Score=100

After these planned teaching methods have been applied to both groups, the achievement test has been reapplied as posttest and as a result it has been found out that the arithmetic average of the posttest achievement score in the experiment group is 69,4286 and the standard deviation is 14,93965, whereas the arithmetic average of the posttest achievement score in the control group is 50,5714 and the standard deviation is 13,49136. After the analysis, a statistically significant difference has been found out between the averages of posttest achievement scores of the control group and the experimental group ($p<0,05$).

In the achievement test prepared on the relevant subjects, all the concepts that the students are supposed to have about the subjects have been included. By taking these concepts into account, animations have been designed using the Macromedia Flash 8.0 program by the researcher. For example;

In figures 1 and 2, the students have seen that the frequency of the photon which has been absorbed by a black body has increased in the black body after many reflections and as a result, the wavelength has grown and the energy has decreased because of the decrease of magnitude, and in the end the energy of the photon has disappeared. They have learnt that the disappeared photon is absorbed by the black body completely, and thus the body looks completely black. Furthermore, they have comprehended that the black body is not just black but may be in other colors which absorb the light.

In figure 3, there are animated screenshots which show the photon number and photon frequencies of the black body which has been exposed to different temperatures. In this animation, students have seen that the frequency of the electromagnetic radiation has increased as the heat of the metal has increased during the heating of metals and that the energy increases as a result. They also learnt that as the heat increases, the number of the photons increases and the intensity of the light increases and that a body of any temperature does not have to be black in order to radiate.

In figure 4, the screenshots of the animation related to the Compton case have been given. In this animation, the students have learnt that high energy photon is not absorbed but energy and the momentum is radiated after the crash in a lessened way; because the energy and the momentum of the crashing photon is shared between the electron and the radiating photon and because the energy of photon decreases, the frequency decreases and the wavelength increases; and that the photon goes with the same velocity before and after the crash.

In figure 5, the screenshots prepared about the X-ray has been given. With this animation, the students have compared the velocities of electrons which are results of the change in the wavelengths after they crash the plaque. They have seen the connection between frequency and velocity by comparing the wavelengths as the one with big frequency will have the biggest velocity. They have also learnt that x-rays may be absorbed by substances, and that they are neutral and thus they are not affected by electricity and magnetic field, and that they realize interference and diffraction.

At the end of the study, the fact that the control group is less successful than the experimental group shows that the students have understood and learnt the concepts of black body, Compton and x-ray better as animations have been used in the experimental group.

DISCUSSION AND CONCLUSION

The aim of this study is to reveal the differences between CAL and traditional learning among university students in understanding the subjects of Black body, Compton and X-ray. According to the academic achievement test which has been used in the research, of which validity and reliability studies have been made and of which reliability coefficient is 0,70, the academic achievement of the students in the experimental group is higher than the students in the control group which shows the positive effect of computer assisted learning on students. In many researches it has been revealed that learning with animations has been more effective than the traditional learning method in specifically biology, chemistry, physics, and foreign language learning and electrical-electronics training (Bosco, 1986; Fletcher, 1989; Khalili et. al., 1994). Learning with animations has proved to be more effective in providing the visual presentations of the concepts of Quantum Mechanics, making students understand the subject by alienating them from rote learning, making students acquire problem solving skill, drawing the attention of students, making students think creatively, and objectifying the abstract subjects in students' minds.

Animations have been prepared by considering the facts that students may miscomprehend the concepts, may have difficulty in understanding and may forget the memorized information and; thus have served to their purposes. The animations make students learn easily by animating the abstract concepts as well as increasing the probability of students' recollecting this information. The researches show that %83 of learning is realized by seeing, %11 is realized by hearing, %3,5 is realized by smelling, and%1,5 is realized by touching (Halis, 2002) ; that is, majority of learnt information is possible via seeing. The computer animations which are particularly used in objectifying some abstract concepts are an effective teaching technology in education. The researches in this field show that the practices of CAL increase the interest to the Science lessons and effect the cognitive achievement positively (Çepni, 2005). For this reason, visual materials should be used in order to create more effective learning environments.

In this research most of the students in the control group were not be able to explain the concepts about the subjects of Black body, Compton and X-ray; and they were not able to comprehend the relationship between magnitude and energy of photon. And also they were unable to understand that black body is just black, the differences between the frequencies of and the change in the number of photons in heated black bodies, and that there would be a change in the high energy photon in Compton case after the crash, the relationship between the energy of the radiating photon and its frequency, and the relationship between frequency and velocity in x-rays.

During the research it has been observed that the students have interest for the computer, and this interest should be evaluated in the learning environment in the process of learning-teaching, and computers should be used as means of teaching devices. They should especially be used in physics lesson as they provide learning of some scientific concepts in an easier way.

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