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Influence of the Simulation Method on 7th Grade Students' Achievements in Science and Technology Lessons

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Abstract

This study aimed to make a comparative analysis of seventh-grade (the second level of the primary education) students' achievement in "Systems of The Human Body" unit in Science and Technology lesson which was taught using both the simulation method and the traditional method along with the influence of these methods on students' learning. The study was conducted in collaboration with 70 students enrolled in the seventh grade at an elementary school in Konya in the 2009-2010 academic years for five weeks. Thirty-five students were included in the experimental group and 35 in the control group. The study had the pretest and post-test validity; the reliability of the study was also checked (Cronbach's alpha = 0.831) and 30 questions were used in Science and Technology Achievement Test. The findings attained from the tests were analyzed using the SPSS Package Program. The study revealed that there was a statistically significant difference between the learning of the two groups, one of which was taught using the simulation method while the other was provided with the traditional method ($p<0.05$). It was found that the training given using the simulation method created a significant difference to the benefit of the students.

Keywords: Science-and-technology class; Systems of the Human Body; Simulation method

Introduction

We are engaged in the era of information and communication. People today have constantly changing avenues of interest, and in accordance with this phenomenon, society has brand-new expectations every day. In the present day, the main objective of society is to cultivate individuals who are qualified and talented. In order to bring forth productive people who are eager to search and question, it is necessary to use the benefits of technology. Various situations that are experienced during the educational process and the circumstances of life make it difficult to ensure the ultimate educational facilities for individuals from every part of society. When the qualified work force required by the present age is raised by society at every level, this also engenders new technological information and experiences. Individuals, institutions and organizations that are late to follow the technological developments will have difficulty functioning and surviving in a healthy, productive way. Traditional approaches are not fully sufficient for raising individuals who have the qualities that are in demand in the present day. Therefore, one of the most influential solutions is to use the benefits of instructional technologies along with computers (Atam, 2006).

The need to present information in many different ways during educational process highlights the need to use new informational technologies. In this respect, the computer is suitable as a means to prepare educational materials that fit the individual needs of each student. The effective use of computers in the educational process increases the quality level of the educational materials. The sophisticated graphics, animations and audio-visual materials available in this electronic environment are important in terms of interaction. Thus, it is possible to achieve the pedagogical objectives of the educational process using the interactive teaching technologies in consideration of students' individual differences and learning styles (Tuncali, 2006**)**.

Given the pedagogical uses of computers, many software programs have come into use for educational purposes. The traditional lecture mode is commonly employed at schools, but it limits the degree of interaction and hinders personal effort. Consequently, few educational objectives are reached through reliance on this mode. All these facts require that this method is used as rarely as possible in science teaching; instead interactive methods that focus on the learner and learning should be used (Atam, 2006).

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The pedagogical use of simulation is easy and free of expense, and accordingly computer-aided education programs have become the most frequently used tools. These programs allow students to become actively involved in the educational process, since they use GIFs and graphics to draw the attention of students. Simulation provides the opportunity to demonstrate certain phenomena that are difficult or even impossible to observe and discern in other ways. The virtual laboratory implementations created with the use of simulations help students learn through trial and error. This encourages students to search the existing ways of identifying solutions to the problems they encounter. It also allows them to replay the videos again and again, whenever and wherever they wish (Bozkurt, 2007). This study sought to make a comparative analysis of achievement among students in the seventh grade (the second level of primary education) in the "Systems of the Human Body" unit of a science-and-technology class, which was taught using both the simulation method and the traditional method along with the influence of these methods on the students' learning.

Method

Study Design

The study used the pretest/post-test control-group quasi-experimental design was intended to determine the correlation between the access level of the experimental group that was taught the "Systems of the Human Body" unit using the simulation method and that of the control group, which was taught the same unit using the traditional lecture method. The independent variable in this study is the simulation method used for the instruction of the "Systems of the Human Body" unit to the seventh-grade students. The access levels of these students constituted the dependent variable. The study design is shown in Table 1.

Table 1. Quasi-experimental design used in the study

Groups	Pretest	Operation	Post-test
Experimental	T1	The instruction of "Systems of the Human Body" unit using the simulation method	T2
Control	T1	The instruction of "Systems of the Human Body" unit using the traditional lecture method	T2

As the quasi-experimental design shows, the instruction of the subjects in the unit in question (digestive system, urinary system, nervous system and sense organs) with the use of the simulation method was only provided to the experimental group. In this process, the control group was taught the same unit and the same subjects using the traditional lecture method. The author paid special attention so that the Experimental and Control groups were not influenced by the program elements that were applied to each other. A pretest was administered to both groups before the experimental operation. The Science and Technology Achievement Test (STAT) was administered to the groups as the pretest (T1). The same test was administered at the end of the implementation as the post-test (T2).

Study Sample

The sample of this study consists of 70 students in two classes enrolled in the seventh grade at an elementary school in Konya in the 2009-2010 academic years. One of these classes was randomly selected and designated as the experimental group to be taught with the simulation method, while the other group was the control group and was taught with the traditional lecture method. The distribution of the students in the experimental and control groups according to their genders is shown in Table 2.

Table 2. Distribution of students in the experimental and control groups according to gender

Gender	Experimental Group	Control Group
Female	17	16
Male	18	19
TOTAL	35	35

Creation of the Experimental and Control Groups, Pretest and Post-Test Administrations

Thirty-five students in the randomly selected class 7C class at an elementary school formed the experimental group, and 35 students in class 7B formed the control group. The Science and Technology Achievement Test (STAT) were administrated to the students in the experimental and control groups as the pretest. Table 3 shows the distribution of the students according to their classes.

Table 3. Distribution of students that attended the pretest according to their classes

Groups	Class	Number of Students	Total
Experimental Group	7 C	35	70
Control Group	7 B	35	

The students in the control group were taught the subjects in the "Systems of the Human Body" unit (digestive system, urinary system, nervous system and sense organs) for duration of five weeks with the use of the traditional lecture method. The students in the experimental group were taught the same unit using the simulation method. The Science and Technology Achievement Test (STAT) were administered as the post-test. Table 4 shows the distribution of students who attended the post-test according to their classes.

Table 4. Distribution of students attending the post-test according to their classes

Groups	Class	Number of Students	Total
Experimental Group	7 C	35	70
Control Group	7 B	35	

Science and Technology Achievement Test (STAT)

The author consulted the expert opinion before preparing the Science and Technology Achievement Test (STAT) and, armed with such expert opinion, prepared 50 multiple-choice questions about the subjects in "Systems of the Human Body" unit in the seventh-grade curriculum. These questions were posed to the eighth-grade students who had been taught the relevant subjects before. The author administered the 50-question multiple-choice test to 95 eighth-grade students for the purpose of determining the difficulty and distinctiveness of the items along with the reliability of the test. Subsequently, the implementation results were analyzed. Based on the analysis results, the questions were arranged. The final order is shown in Table 5.

Table 5. Analysis of the science and technology achievement test (STAT)

Question No.	Difficulty (Pj)	Distinctiveness G (rjx)	Reliability
1	0.564	0.597	0.838
2	0.488	0.596	0.834
3	0.323	0.615	0.829
4	0.351	0.620	0.829
5	0.389	0.457	0.824
9	0.345	0.687	0.834
11	0.452	0.616	0.841
12	0.366	0.550	0.831
13	0.409	0.688	0.832
17	0.349	0.695	0.835
18	0.407	0.727	0.832
20	0.437	0.609	0.839
22	0.364	0.578	0.827
23	0.448	0.699	0.825
24	0.432	0.649	0.837
26	0.506	0.603	0.834
27	0.506	0.675	0.828
31	0.556	0.608	0.828
33	0.586	0.621	0.832
34	0.583	0.706	0.829
35	0.492	0.664	0.83
38	0.436	0.662	0.833
40	0.447	0.596	0.828
42	0.454	0.701	0.828
43	0.458	0.750	0.841
45	0.643	0.630	0.83
47	0.361	0.636	0.837
48	0.385	0.623	0.836
49	0.386	0.480	0.831
50	0.332	0.549	0.811

Subsequent to the analysis, the validity and reliability of the items were ensured (Cronbach's $\alpha = 0.831$) and the Science and Technology Achievement Test consisting of 30 questions was created. The above-mentioned test was administered to 35 students in the experimental group and 35 students from the control group as the pretest and post-test. The results of the pretest and post-test were analyzed using the SPSS 15.0 package program.

Experimental Implementation

The "Systems of the Human Body" unit is included in the seventh-grade science-and-technology course curriculum designed by the Ministry of National Education (MNE). This course is taught four hours per week for duration of five weeks. In the first week the main subject was the digestive system; it was the urinary system in the second week, nervous system in the third week, and the sense organs in the fourth and fifth weeks. In the experimental group, the author posed questions to students during the first five minutes of the lesson in order to review the previous subjects. The author also checked how prepared the students were for the subject to be taught. Later, the subject was taught with the support of relevant presentations and simulations. During the last five minutes of the lesson, the author posed questions to the students and answered the questions they asked in order to ensure that all the students comprehended the subject. The unclear points were determined and further explanations were provided about them. The simulations used in the study were taken from mebvitamin.com (supported by MNE) and from youtube.com. The presentations and simulations were reflected using the computer-aided projector, and they were provided in audio-visual quality. The control group was taught the same subject with the traditional lecture method using models related to the materials and systems in the unit along with questions and answers.

Results

Figure 1 shows the STAT pretest scores of the students in the experimental and control groups.

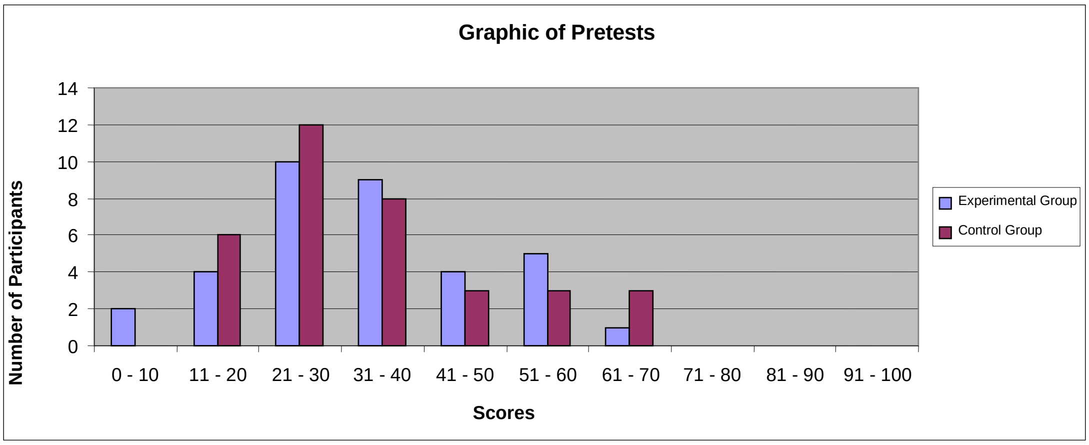

Figure 1. STAT pretest scores of the students in the experimental and control groups

The author analyzed the scores of the experimental and control groups on the STAT pretest using the independent t-test in order to identify any significant differences between the scores of the two groups. The statistical data given by this analysis is shown in Table 6.

Table 6. Arithmetic mean and standard deviation values of STAT pretest scores of students in the experimental and control groups

Groups	N	$\overline{X}$	SD	t	p
Experimental Group	35	35.31	14.83	0.282	0.063
Control Group	35	34.34	14.01		

The independent samples t-test was administered to both groups in order to compare the arithmetic means they obtained from the access-level test. There was no statistically significant difference between the mean scores of the experimental and control groups ($t=0.282$, $p>0.05$). These valued were attained from the analysis, and it was found that the access-level test pretest scores of the two groups were close to each other.

Figure 2 shows the STAT pretest and post-test scores of the students in the control group.

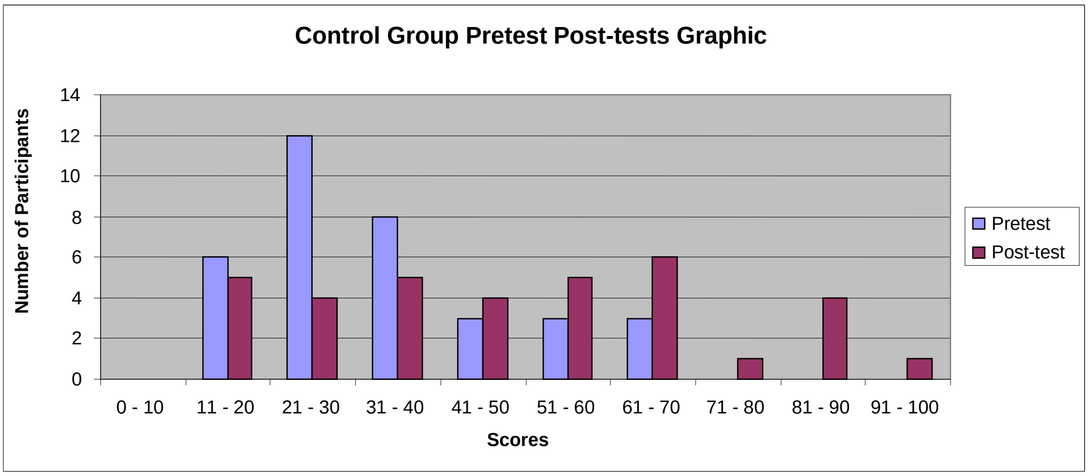

Figure 2. The STAT pretest and post-test scores of the students in the control group

Figure 3 shows the STAT pretest and post-test scores of the students in the experimental group.

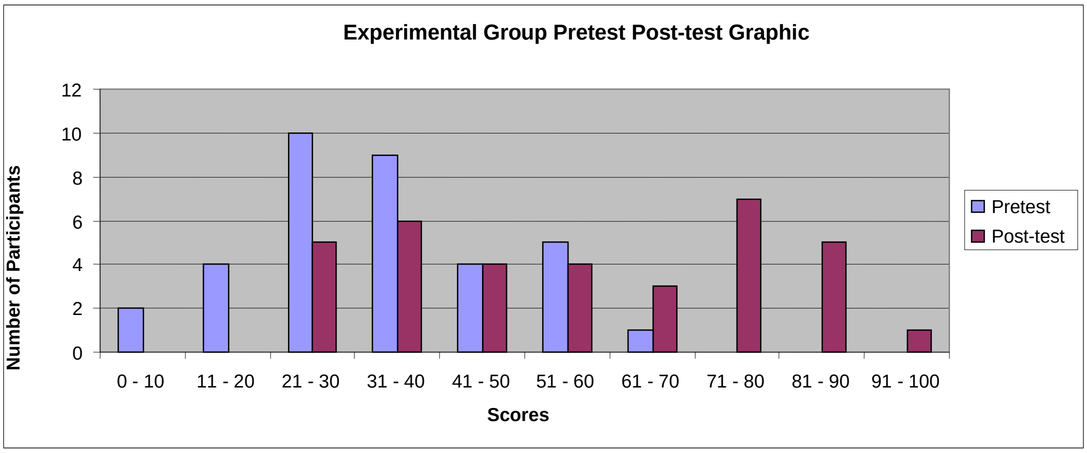

Figure 3. The STAT pretest and post-test scores of the students in the experimental group

Figure 4 shows the STAT post-test scores of the students in the experimental and control groups.

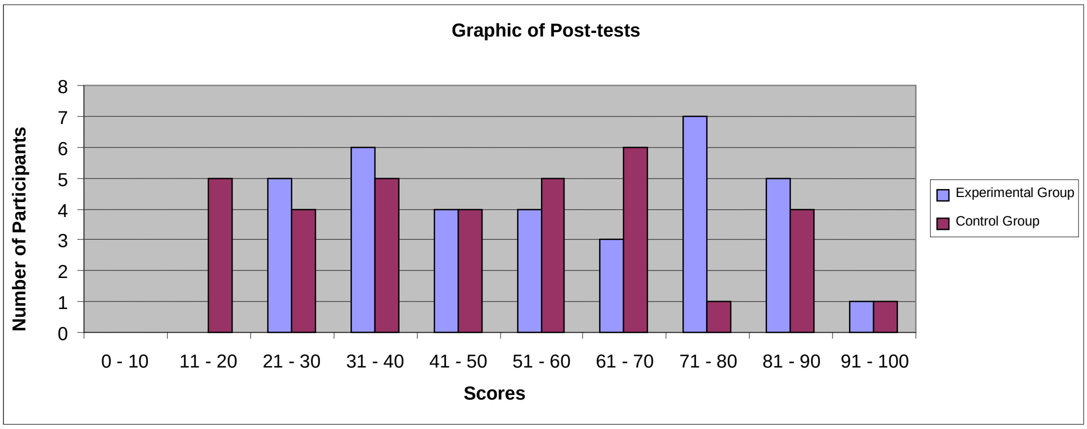

Figure 4. The STAT post-test scores of the students in the experimental and control groups

Table 7 shows the STAT post-test scores of the students in the experimental group, who were taught the "Systems of the Human Body" unit using the simulation method, and those of the students in the control group, who were taught the same unit using the traditional lecture method.

Table 7. Arithmetic means and standard deviation values of the STAT post-test scores of the students in the experimental and control groups

Groups	**N**	$\overline{X}$	**SD**	**p**
Experimental Group	35	57.08	20.96	0.002
Control Group	35	49.88	23.20	

Table 8. Arithmetic means and standard deviation values of the STAT pretest and post-test scores of the students in the experimental and control groups

Groups		**N**	$\overline{X}$	**SD**
Experimental Group	Pretest	35	35.31	14.83
	Post-test	35	57.08	20.96
Control Group	Pretest	35	34.34	14.01
	Post-test	35	49.88	23.20

An analysis of Table 8 revealed that the achievement-test pretest mean score of the students in the experimental group was $\overline{X}$ = 35.31, while the access-level test post-test score of the students in the same group was $\overline{X}$ =57.08. The author conducted a one-way ANOVA in order to determine whether the difference between these scores was statistically significant. Table 9 shows the results of this analysis.

Table 9. Bonferroni correction on the experimental and control groups

	Total of Squares	**SD**	**Mean of Squares**	**F**	**p**	**Bonferroni Correction**
Intergroup	8294.91	1	8294.91			
In-group	22418.28	68	329.68	25.16	0.002	Experimental Group > Control Group
Total	30713.20	69				

As is seen in Table 9, there is a statistically significant difference between the access-level test post-test results of the experimental and control groups (F= 25.160, $p<0.05$). The author administered a Bonferroni correction in order to determine the group that caused this difference. The Bonferroni correction administered on the access-level test post-test scores of the experimental and control groups indicated that the mean score of the experimental group regarding their access level ($\overline{X}$ = 57.08) is higher than that of the control group ($\overline{X}$ = 49.88). It was observed that this difference was to the benefit of the students in the experimental group. This result reveals that the simulation method used in the delivery of "Systems of the Human Body" unit stood as an important factor in increasing students' access levels. Finally, these findings showed that there was a significant difference between the access level of students who were taught this unit through the simulation method and that of the students who were taught the same unit through the traditional lecture method.

Discussion and Conclusion

This study was conducted in collaboration with 70 students in two classrooms enrolled in the seventh grade at an elementary school in Konya in the 2009-2010 academic years. As Table 6 shows, there is no statistically significant difference between the STAT pretest scores of the students in the experimental group and the control group. In other words, the access-level test pretest scores of the students in the two groups are close to each other. Table 9 reveals that there is a statistically significant difference between the access-level test post-test scores of the experimental and control groups. This result indicated that the increase in the post-operational access level of the group that was taught the "Systems of the Human Body" unit using the simulation method was higher than that of the students in the control group. The findings show that the simulation method is more efficient than the traditional method in terms of its ability to increase a student's access level.

It was also found that computer-aided teaching methods are more effective than the traditional lecture method for the delivery of meiosis and mitotic division subjects (Cagiran, 2008). Three types of simulation uses are believed to have a positive influence on the learning process. The other results indicate that the joint use of cardboard models and the simulation method is more influential on student achievement than the simulation used on its own. Thus, it was reported that they completed each other. Additionally, it was found that the change in their order of use was an important factor; the students who started studying with simulation and continued with the cardboard model were more successful than the group that did the opposite (Bodur, 2006). Dilek (2006) found that an instruction supported by experiments and simulation was more efficient than an instruction supported by experiments alone. Kocakulah and Kocakulah (2006a) identified significant differences between the attitudes of students before and after the instruction regarding the use of simulation and experimental apparatus. Kocakulah and Kocakulah (2006b) examined a specific instructional process that included the use of computer simulations and experimental apparatus. They found that there was a statistically significant difference between the pretest and post-test scores of the students and that their attitudes were positively influenced.

Pektas et al. (2006) determined that the students who were taught the digestion and excretion topics in a computer-aided instructional process were more successful than those who were taught the same topics through the traditional lecture method. Akcay et al. (2005) stated that the computer-aided method in science education was more efficient than the traditional teaching method in regard to the increase of student achievement. Karamustafaoglu et al. (2005) made a study on pre-service science-and-technology teachers regarding the "Simple Harmonic Motion" module. It was found that the dynamic-system simulation-based instruction provided to the experimental group was more successful than the traditional instruction provided to the control group. Ozdener (2005) suggested that the use of virtual laboratories could support the traditional laboratories. It was also asserted that students were more successful at problems related to force and motion when they learned the "Force" topic in lessons supported with simulations prepared in interactive physics programs (Uzun, 2004).

Ozdener also found that students making use of computer-simulated experiments were statistically better at comprehending the concepts of speed and velocity. This proves that computer-simulated experiments are as effective as laboratory experiments in some subjects (Sengel et al., 1997). In the study titled "Use of Computer Simulations in the Instruction of Science and Biology," it was asserted that the use of simulations in biology and science pedagogy enabled some experiments in the electronic environment, made some complicated scientific concepts easier to understand and positively changed students' attitudes toward science (Turkmen, 1998). The relevant studies demonstrate that computer-aided instruction is more efficient than the traditional teaching method in regard to increasing students' achievement and ensuring the permanent retention of the information acquired.

In conclusion, models can make some subjects in a science-and-technology class concrete to an extent, particularly when they are impossible to show and apply through the use of living creatures. Moreover, the simulations help make the instruction of scientific terms more influential. Thus, it was determined that it is possible to increase students' access levels and that simulations are superior to the traditional lecture method in terms of students' learning.

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