The Effect of Interactive Computer Animations Accompanied with Experiments on Grade 6th Students' Achievements and Attitudes toward Science

E. Akpınar[1] and O. Ergin[2]
[1] Dokuz Eylül University, Buca Faculty of Education
Department of Computer Education and Instructional Technology, Izmir, Turkey
[2] Dokuz Eylül University, Buca Faculty of Education
Department of Science Education, Izmir, Turkey

***Abstract*—The aim of the present study was to investigate the effect of instruction including interactive computer animations accompanied with experiments over traditionally designed Instruction in 6th grade students' physics achievement and attitudes toward science. In this study, a quasi-experimental pretest-posttest design was used. As a data collection instruments, physics achievement test and attitude scale toward science were administered to experimental and control group. In the experimental group, the materials were used while doing the experiments and then they did the same experiments interactively on the computer. In the control group, the experiments were done only by materials and the students did not use the computer during the experiments. The findings indicated that there was no significant difference between groups with respect to achievement before the treatment and there was a significant difference between the groups in favor of experimental groups after the treatment. The means of attitude towards science showed no significant difference between the groups before and after treatment.**

***Index Terms*—attitude toward science, interactive animation, science achievement, science experiments**

I. INTRODUCTION

The traditional view of knowledge is based on common-sense belief that real world exists regardless of whether we take interest in it or even notice it. This realist perspective assumes that we come into the world as discoverers who build copies or replicas of reality in our minds [6]. In opposite this view, constructivism is a theory that assumes knowledge can not exist outside the minds of thinking persons. Constructivism emphasizes that the importance of each pupil's active construction of knowledge through the interplay of prior learning and newer learning [2]. Researchers and theorists maintain that the key element of constructivist theory is that people learn by actively constructing their own knowledge, comparing new information with their previous understanding and using all of this to work through discrepancies to come to a new understanding [5], [8], [10], [18]. When the primary science programs (curriculum) of highly developed countries are viewed, it can be seen that these countries have developed students centered science programs and put them into practice since the middle 1970s [11]. These programs were impressed by constructivist theory. In contrast, in Turkey the primary science programs had been under the effects of behaviorist view from 1924 to 1989. Although the program applied in 1992 had some constructivist views, it was heavily based on behaviorist views and continued to be employed until 2000 [20]. In 2000, The Ministry of National Education has changed the primary science program radically and that program has been continued since 2001. When viewed, it is seen that this program has been under the constructivist theory [14] and given up former programs' perspectives. The latest one has been a student centered program [1]. As a result, constructivist theory has been the dominant paradigm of learning science in Turkey since the beginning of 2000 years [20]. This program offers students opportunities to engage in hands on and minds on activities and has students construct meaningful knowledge based on their own prior knowledge and experiences. In this program, student has some responsibility such as learning to learn, discovering, making research. Moreover, it offers students work cooperatively and share their knowledge and experiences with each other [19]. This program offers that student should build their own knowledge from their own experiences, from both doing and thinking [2]. Having interesting things for the children to do is not enough; thinking and talking about what they have done must be part of the science program, as well [12]. By this way, children build their own knowledge from their own experiences. In additional to hands-on and minds-on activities, computer-based technologies provide powerful means for meaningful learning. Computer has the capacity to support to design interactive learning climate and help students learn especially abstract concepts by making them visible. Computer simulations may be used as a means of enhancing, motivating and stimulating students' understanding of certain events. When phenomenon are simulated using a model the relation between concepts are revealed and the students see them clearly. Students' interaction, their observing the variables under different conditions and revelation of cause and effect through computer animations play a key role in comprehending the concepts [3]. Simulations foster learning and help students to see different aspects of a subject and generalize it. While simulations help students grasp new information, it helps them to make connection between the former and the newer information and be stored in a long-term memory. Moreover, simulations, in the shape of a cognitive tool, allow the learner to externalize their thinking, to enrich it, manipulate it and change it, all by interacting with one or more conceptual models on the computer [24], and is expected to contribute to the acquisition of varied knowledge as well as to promote student independence and growth of responsibility for schoolwork [25]. Especially, using animation may increase conceptual understanding by promoting the formation of dynamic mental models of the phenomena. The dynamic quality of animation may promote deeper encoding of information than that of static pictures [21]. Because of the many benefits of animation in science teaching, there are many studies which widely apply computer animation, simulation and other computer assisted or mediated tools in science education [4], [13], [22], [23], [26], [27]. For instance, "Ref. 4"reported in their study that the experimental group instructed by multimedia (including animation) got higher scores both in an achievement test and molecular presentation than the control group. "Ref. 30" in their study using enriched voice, graphics, and animation, stated that this instruction affected the students' affective behaviors and helped their cognitive levels positively. Additionally, some researchers have offered that future studies are needed to determine the effect of computer animations on students' learning science concepts [26]. However, there are few studies on the influence of the science activities supported with computer to the learning of students [31]. One of the distinctive features of present study from others studies given in above is that students first use material during making science experiment and then they use computer-based interactive activity (animation) in learning static electricity concepts. The present study also investigated students' attitudes towards science as a school subject.

In the present study, interactive computer animations accompanied with experiments based on constructivist approach were used as a supplement to the regular classroom instruction. The aim of the present study was to investigate the effect of instruction including interactive computer animations accompanied with experiments over traditionally designed Instruction in 6th grade students' physics achievement and attitudes toward science. The unit of "electric that guide our lives" in primary science education includes abstract concepts such as electron, proton, electrical current, electrification, positively charged, negatively charged, and atom. Since these are abstract concepts they are difficult to comprehend. In their studies, "Ref. [15]" asserts that in the unit called "Electric" students have difficulties in learning these concepts. In addition, students from primary school to university, in all levels, have misconceptions while learning them [16], [17].

Although experiments are important parts of the science teaching they may be totally far from providing students with full understanding of some science concepts. Therefore, to concretize phenomena such as lightning in teaching science can help student learn them meaningfully and easily. The another aim of this study is to prepare instructional software which is suitable teaching strategies based on constructivist theory in order to make primary school students grasp and concretize the static electricity subject in the unit "electric in our life"

II. METHODOLOGY

To determine the efficiencies of using interactive computer animations accompanied with experiments, a quasi-experimental pretest-posttest design was used [7]. The sample of this study consisted of 65 6th grade students in a state primary school in Izmir in Turkey. The students in one class were referred to as experimental group (n=33) and the students in other class were referred as control group (n=32). Both groups were taught by two different teachers until 6th grade. In 6th grade, they were allotted to their classes according to their achievement levels in various subjects such as science, mathematics, Turkish language etc. Since the Turkish Ministry of National Education does not allow changes in the classes after the school term has begun, two of the 6th classes were assigned randomly as experimental and control groups at the beginning of the study. Before starting the treatment, the teacher was trained about the instruction. The teacher was also trained to standardize the administration procedures and implementation of the instruction. Up to 6th grade, students have no instruction about electricity topic in school. Therefore, the students in both groups had similar backgrounds.

As a data collection instruments, physics achievement test and attitude scale toward science were used. To measure the students' achievement about static electricity concepts and attitudes toward science, these instruments were given to the students in both groups at the beginning and end of the treatment.

In the experimental group, the materials were used while doing the real science experiments and then they did the same experiments interactively on the computer. In the control group the same science experiments was done only by using materials and the students did not use the computer during the science experiments. The experimental group was given opportunity to discuss the results of the experiments in the classroom and asked to explain what they see. Both groups took notes when they did the real science experiments and gave answers to questions in he worksheets shows how they do the experiments. The same teacher lectured in both groups to get rid of unexpected variables and changes during the lecture. There are three science courses in per week and each treatment took place during ten, 40- minute class sessions, and the treatment lasted a period of approximately four weeks including data collection.

III. INSTRUMENTS

A. *Physics Achievement Test (Static Electricity Concept Test):*

This test was developed by the researchers to identify students' static electricity concepts. During the developmental stage of the original test, the following procedures was followed; first, the instructional objectives of the unit "electricity in our life" were stated and a test consisted of 37 items was prepared by the researchers. Secondly, the test was examined by a group of experts in science education, physics and primary science teachers for the appropriateness of the test items. Thirdly, two items in the test were extracted and remaining 35 items in the test were administered to 302 primary school students for pilot study. Finally, the data gathering from this application were analyzed and, a test consisted of 22 multiple choice items was prepared. Each question had one correct answer and three distracters. The KR-20 reliability of the test was 0.71. The test was administered to both experimental and control groups as a pretest before the treatment and as a posttest after the treatment. The posttest achievement test was identical to that used as a pretest.

B. *Attitude Scale toward Science as a School Subject*

This scale was developed by "Ref. [9]" to measure primary students' attitude toward science as a school subject. The Attitude scale contains 15 items in a five-point Likert-type scale. The alpha reliability coefficient was found to be 0.83. It was administered to all students as a pretest and posttest in the experimental and control group.

C. *Designing and developing interactive computer animations*

Macromedia Flash MX was used for authoring interactive computer animation regarding static electricity and the animations were prepared by the researcher by taking help from computer experts and scientists and primary science teachers. Once the animations were tested and modified, we tested again it on 25 sixth graders students in a computer lab in a different primary school. After this application, some changes were made again. In this study, 8 interactive animations were prepared. One example of the interactive animations was given in below in Turkish.

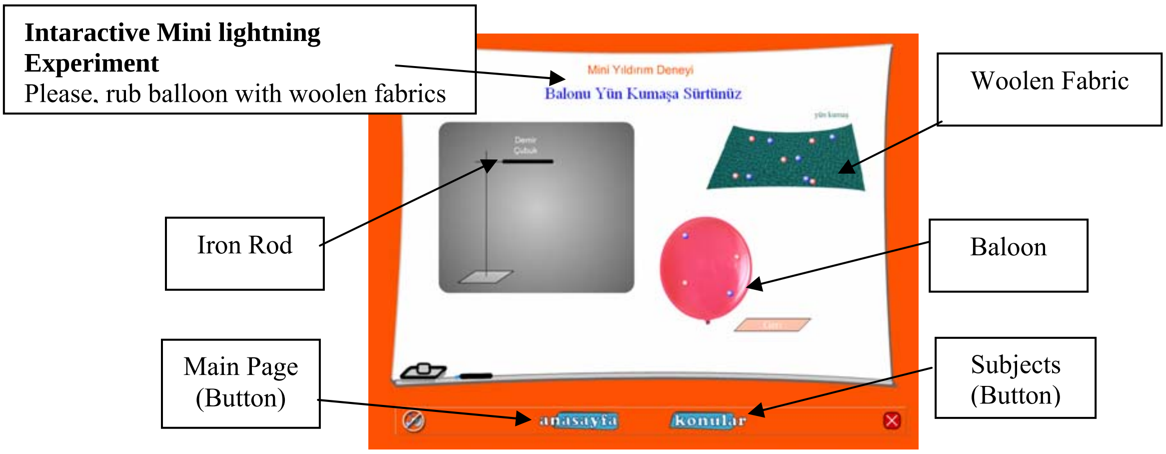

Figure 1. First stage of interactive computer animation regarding mini lightning (after doing the real lightning experiments, students in experimental group use this animation and count negative and positive charges on the plastic balloon and woolen fabric and record these data. In this stage, the balloon and woolen fabric are neutral. Because, the balloon has two negative and two positive charges and the woolen fabric has five negative and positive charges (on the balloon and woolen fabric, red figures represents positive charges and blues ones represents negative charges)

Figure 2. Second stage of interactive computer animation regarding mini lightning (after first stage, students can hold the balloon by means of mouse and rub the balloon with the woolen fabric and then count negative and positive charges and record these data. In this stage, some negative charges would remove to the balloon and finally the balloon has negative charges and the woolen fabric has positive charges.

(a) (b)

Figure 3. The last formation stages of mini lightning interactively (when the balloon which has negative charges is came closer to the iron rod by removing it with the help of mouse (a), the mini lightning would become immediately(b) and at the same time, the students can see a shining light and hear a sound)

After the experiment in above was carried out by the students interactively on the screen, they were asked when the balloon is assumed as a cloud and the iron rod is the earth how lightning is formed. And then the students were asked to explain and draw the picture of how lightning is formed.

IV. Results

Before and after treatment, the achievement test and attitude scale toward science were administered to experimental and control groups. Each correct response in the achievement test was scored as one point. Comparisons were made in terms of the experimental and control groups' pre-post test achievement score means with t-test analyze. The attitude scale with 5 gradations was scored between 5-1 points, for fully agree 5 point and fully disagree 1 point were scored. These findings were analyzed through *t* test.

TABLE I.
COMPARISON OF MEAN SCORES OF CONTROL GROUP AND EXPERIMENTAL GROUP IN PHYSICS ACHIEVEMENT TEST (PRE-TEST)

Groups	N	$\overline{X}$	Ss	T	p
Experimental	33	4,93	2,58	,406	.686
Control	32	4,68	2,41		

Table 1 showed that there was no statistically significant difference between the mean scores of students in the control and experimental group with respect to physics Achievement Test before the treatment ($p>.05$). Consequently, the two groups were equivalent on this dependent measure. Thus, it can be said that students in the both groups had similar knowledge about static electricity concepts.

TABLE II.
COMPARISON OF MEAN SCORES OF CONTROL GROUP AND EXPERIMENTAL GROUP IN PHYSICS ACHIEVEMENT TEST (POST-TEST)

Groups	N	$\overline{X}$	Ss	T	p
Experimental	33	13,00	2,64	5.806	.000[a]
Control	32	8,12	4,00		

[a] $p<.001$

Table 2 showed that there was a statistically significant difference between the mean of score of the students taught by instruction including interactive computer animations accompanied with experiments and that of the students taught by traditional method in favor of experimental group ($p<.001$).

TABLE III.
COMPARISON OF MEAN SCORES OF CONTROL GROUP AND EXPERIMENTAL GROUP IN ATTITUDE SCALE (PRE-TEST)

Groups	N	$\overline{X}$	Ss	T	p
Experimental	33	60,45	6,40	-,977	.333
Control	32	62,28	8,54		

Table 3 showed that there was no statistically significant difference between the mean scores of students in the control and experimental group with respect to attitude toward science before the treatment.

TABLE IV.
COMPARISON OF MEAN SCORES OF CONTROL GROUP AND EXPERIMENTAL GROUP IN ATTITUDE SCALE (POST-TEST)

Groups	N	$\overline{X}$	Ss	T	p
Experimental	33	64.21	6.23	1.053	.296
Control	32	62.32	8.20		

Table 4 showed that there was no significant difference between post-test mean scores of the experimental and control group. When mean scores of pre and post test compared, it can be seen that attitudes of the experimental group toward science as a school subject was more positive than those of the control group.

V. Discussion and Conclusion

The purpose of this study was to investigate the effectiveness of instruction including interactive computer animations accompanied with experiments over traditionally designed Instruction in 6th grade students achievement related to static electricity concepts and attitudes toward science. The physics achievement test (static electricity concepts test) was administered to all students prior to treatment. It was found that there was no significant difference between the pretest means scores of two groups. This result showed that experimental and control group were equal in terms of achievement related to static electricity concept before the treatment. The same test was administered to all students as a posttest after the treatment to compare the effects of two instructions. The result showed that experimental group had a significantly higher scores with achievement related to static electricity concepts. In other words, the students in the experimental group understood the static electricity concepts better than the students in the control group who were taught by traditional method. Regarding attitude toward science as a school subject, although there was no significant difference between experimental and control group, students in experimental groups have more positive attitudes toward science then those in the control group.

There are a number of studies in the literature that compare the effects of simulation-based learning to some kind of expository teaching [13]. In the study by "Ref. [28]" a program was designed to incorporate the use of computer technology innovation called the computer-mediated simulations (CMS) program to enhance pupils' learning outcomes in school biology. The study was carried out in a real biology classroom setting. It involved comparisons between the treatment and control groups. The findings of the study has demonstrated that the use of well-designed computer simulations learning environments can be effective in improving pupils' knowledge and performance in the biology course on cell theory as well as their perceptions of the classroom environment and attitudes towards the subject. "Ref. [22]" found that Computer animations have an effect to enhance conceptual change. "Ref. [22]" in their study on the effects of computer animations on the particulate nature of matter level concluded that animations increased students' conceptual understanding by helping them create dynamic mental models of particulate phenomena. Besides, some studies indicate that computer simulation and animation have a great contribution on students' science achievements [4], [21]. The findings of the study by "Ref. [29]" reveal that significant differences were found between the achievements of students who solved the tasks with and without the simulation. In their study, the use of the simulation contributed to students' confidence and enhanced their motivation to stay on-task. The detailed analysis of students' work revealed its role as a source of constructive feedback, helping students realize their misconceptions and correct them.

In another study, entitled "A Hypermedia Environment to Explore and Negotiate Student's Conceptions: Animation of Solution Process of Table Salt" carried out with 11th grade students, "Ref. [23]" reported that animation can be used to explore, negotiate, and assess students' conceptions of the submicroscopic aspects of solution chemistry.

In the present study, it was revealed that using interactive computer animation accompanied with real science experiments was more effective compared to using only real science experiments in primary science course. And also, the results of the present study are consistent with most of studies' findings stated in above.

VI. Recommendations

Similar research studies can be conducted for different science topics in primary school. Students' misconception can be examined regarding static electricity topic before and after treatment. In order to have more positive attitude, these cognitive tools may need to be used for a considerable length of time. Future studies should be conducted using different research design, methodologies, and quality interactive animation. Besides, further studies may be done by adding new instructional materials such as web-based cognitive tools, concepts maps, conceptual change text, analogies etc.

References

[1] D. Akpınar, "The views of science teachers related to science curriculums in 1992 and 2001 in Turkey," Unpublished Master Thesis**.** Dokuz Eylul University (Turkey), 2002.

[2] E. Akpınar and Ö. Ergin, "Constructivist theory and science teaching," *Journal of Faculty of Buca Education,* Vol.15, pp.108-113, 2004. (In Turkish)

[3] Y.Akpınar, *Computer Based Instruction*. Ankara:Anı Yayıncılık, 1999. (In Turkish)

[4] D. Ardac and S. Akaygün, "Effectiveness of multimedia-based instruction that emphasizes molecular representation on students' understanding of chemical change," *Journal of Research in Science Teaching*, Vol.41, No.4, pp.317-337, 2004.

[5] A. Bettencourt, "The construction of knowledge: a radical constructivist view," *The Practise of Constructivism in Science Education*, K. Tobin, (Ed.). New Jersey: Lawrence Erlbaum Associates, 1993, pp.38-50.

[6] G.M. Bodner, "Constructivism: A Theory of Knowledge," *Journal of Chemical Education*, Vol 63, No 10, pp. 873-878

[7] D.T. Campbell, and J.C. Stanley, *Experimental and quasi-experimental designs for research*. chicago: Rand McNally College Publishing Company, 1966.

[8] C.T. Fosnot, *Constructivism: Theory, Perspectives, and Practice.* New York and London: Teachers College Press, 1996.

[9] O. Geban, H. Ertanpınar, G. Yılmaz, A. Atlan, and Sahpaz, F, *Effects of Computer Assisted Instruction on Students' Sceince Achievement and Attitudes toward Science as A School Subject.* The Proceedings of First National Science Education Symposium. Buca Faculty of Education, İzmir, 1994. (In Turkish)

[10] *D.* Hawkins, "Constructivism: Some Histor," in *The Content of Science A Constructivist Approach to its Learning and Teaching,* P. J. Fenshman, R. F.Gunstone, and R. T. White (Eds.). London, The Falmer Press, 1995, pp.9-13

[11] D. Hodson and J. Hodson, "from constructivism to social constructivism: a vygotskian perspective on teaching and learning science," *School Science Review*, Vol.79, No,289, pp.33-41. 1998.

[12] A.C. Howe, *Engaging Children in Science* (3th ed.). Upper Saddle River,NJ:Werrill Prentice Hall, 2002.

[13] T.D. Jong, E. Martin, J.M. Zammarro, F. Esquembre, J. Swaak, and W.R.V. Joolingen, "The integration of computer simulation and learning support: an example from the physics domain of collisions. *Journal of Research in Science Teaching.* Vol.36, No.5, pp.597-615, 1999

[14] G.B. Kılıç, "Constructivist science teaching," *Educational Sciences: Theory & Practice,* Vol.1, pp.7-22, 2001.

[15] K. Pine, D. Messer, and K. S. John, "Children's misconceptions in primary science: a survey of teachers' views," *Research in Science & Technological Education*, Vol.19,No.1, pp.79-95, 2001.

[16] K.C. Sharon and A. Thomas, "Genderi, prior knowledge, interest and experince in electricity and conceptual change text manipulantions in learning about direct current," *Journal of Research in Science Teaching,* Vol. 34, No. 2, pp.107-123, 1997.

[17] W. Tianyu and A.Thomas, "Conceptual change versus traditional text nad application questions versus no questions in learning about electricity," *Contemporary Educational Psychology,* Vol.16, pp.130-116, 1991.

[18] K. Tobin and D. Tippins, "Constructivism as a Deferent for Teaching and Learning," in *The Practise of Constructivism in Science Education*, K. Tobin, (Ed.). New Jersey: Lawrence Erlbaum Associates, 1993.

[19] Turkish Ministry of Education, "Turkish National Primary Science Program", Turkish Ministry of Educational Bulletin Board Journal," 63, 2518, 2000.

[20] G. Unal and E. Akpınar, "To What extent science teachers are constructivist in their classrooms?," *Journal of Baltic Science Education*, Vol.2, No.10, pp. 40-50, 2006.

[21] V. Williamson and M. Abraham, "The effects of computer animation on the particulate mental models of college chemistry students," *Journal of Research In Science Teaching,* Vol..35, No.2, pp.145-160, 1995.

[22] M. Windsehitl and T. Andre, "Using computer simulations to enhance conceptual change: the role of constructivist instruction and student epistemological belifs," *Journal of Research In Science Teachin,,* Vol..35, No.2, pp. 145-160, 1998.

[23] J.V. Ebenezer, "A hypermedia environment to explore and negotiate students's conceptions: animation of solution process of table salt", *Journal of Science Education and Technology,* Vol.10, No.1, pp.73-92, 2001

[24] M. Wild and C.N. Quinn, Implications of educational theory for the design of instructional multimedia. British Journal of Educational Technology, Vol.29, pp. 73–82, 1998.

[25] G. Jedeskog and J. Nissen, "ICT in the classroom:is doing more important than knowing?," *Education and Information Technologies,* Vol.9, No.1, pp. 37–45, 2004

[26] M. J. Sancar and T.J. Greenbowe, "Addressing student misconceptions concerning electron flow in aqueous solutions with instruction including computer animations and conceptual change strategies", International *Journal of Science Education*, Vol.22, No.5, pp.521-537, 2000

[27] K. A. Burke, T. J. Greenbowe, and M. A. Windschitl, "Developing and using conceptual computer animations for chemistry instruction. *Journal of Chemical Education* 75: 1658, 1998

[28] J.K., Kiboss, M., Ndirangu and E.W. Wekesa, "Effectiveness of a computer-mediated simulations program in school biology on pupils' learning outcomes in cell theory". *Journal of Science Education and Technology*, Vol.13, No.2, pp. 207-213, 2004

[29] M. Ronen and M. Eliahu, "Simulation — A bridge between theory and reality: the case of electric circuits. *Journal of Computer Assisted Learning* Vol.16, pp.14-26, 2000

[30] I. Ustuner and M. Sancar, "The effect of computer software on physics students' learning and using computer. *Journal of Buca Faculty*, Vol.10, pp.165-171, 1999 (In Turkish)

[31] O., Karamustafaoğlu M., Aydın, and H. Özmen, "The influence of the Physics activities supported with computer to the learning of students : An example of Simple Harmonic Activity". *The Turkish Online Journal of Educational Technology*, V.4, No.4, Article 10, 2005

AUTHORS

E. Akpınar is PhD in education and a lecturer in Computer Education and Instructional Technology Department at Dokuz Eylul University, Izmir, Turkey, (e-mail: ercan.akpinar@deu.edu.tr).

O. Ergin is a Professor in Science Education Department at Dokuz Eylul University, Izmir, Turkey (e-mail: omer.ergin@deu.edu.tr).

Manuscript received 23 February 2007. This work was supported by Dokuz Eylul University under Grant 2005.KB.EGT.004

Published as submitted by the author(s).