African Journal of Physics Vol. 1 (3), 12 pages, November, 2013. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Utilizing computer-assisted teaching in physics to boost student education

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Accepted 9 September, 2013

Simple harmonic motion (SHM) is an important topic for physics or science students and has wide applications all over the world. Computer simulations are applications of special interest in physics teaching because they support powerful modeling environments involving physics concepts. This article is aimed to compare the effect of computer-assisted teaching (CAT) realized from the simulations of software developed by the researchers for the interactive-physics program and traditional teaching methods on the success of the science prospective teachers and to determine the effect of their concept learning on SHM. The study was conducted in 2008 to 2009 academic year and was carried out in two different classes taught by the same teacher, in which there were seventy freshman science student teachers, attending to Amasya University Science Education Department. An experimental research design including SHM test was applied at the beginning and at the end of the research as pre-test and post-test. After the practice, general achievement in SHM test increased by 15% in favor of experiment group at ($p<0.05$) significant level. Research findings strongly supported that computer simulations might be used as an alternative instructional tool to help students develop their understanding of physics and CAT is more successful than traditional teaching methods.

Key words: Computer-assisted teaching, physics education, simple harmonic motion, interactive physics program.

INTRODUCTION

Not only in Turkey but also all around the world most people have come to believe that we should embrace the approaches which place a greater emphasis on student-centered learning processes in which students are responsible for learning, rather than the approaches based on teacher-centered instruction. Only by using such methods it is possible to bring forth the creative thinking, intelligence, and individual skills of students (Banerjee and Yager, 1995; Winey and Squibb, 1991). As technology keeps marching on, people find it necessary to make use of it in class. The use of technology provides students with enriched possibilities to learn and feel closer to subjects in their areas. In this respect, technology plays an important role in a process in which learning and teaching occur (Đ man et al., 2002). In the course of time computers came into being and were used to design such audio-visual aids as animation through the advances in technology. As a result of this, computer-assisted teaching was made possible. What we call CAT is to present the subjects of a course, to go over what has been previously taught, to solve problems and to carry out researches in class by computers.

CAT is an interactive teaching method in which computers are used to help the teacher as a teaching aid, to boost student motivation, to help them keep up with their own pace of learning (Fraij, 2010; ßahin and Yildirim, 1999). Harwood and McMahon (1997) point out that success will be attained if we can enhance the learning environment through technology-assisted methods which will, in turn, help us teach concepts and terminology hard to grasp. Moreover, an emphasis has been placed over CAT when compared with the traditional way of teaching in many articles published in Turkey as well as around the world (Bayrak and Bayram, 2010; Binta and Çamli, 2009; Karamustafaoğlu, 2009; Rong and Zhao, 2008; Yiğit and Akdeniz, 2003; Chang, 2002; Jimoyiannis and Komis, 2001; Hacker and Sova, 1998; Yalçinalp et al., 1995). Through, the use of computer-assisted software, animated features that encourage students to participate more in learning process interactively and simulations done on concrete concepts will enable students to visualize the concepts in their minds they have difficulty in understanding.

However, it is known that simulations produce quicker results than animated features in terms of changing certain parameters and observing the results (Demirci, 2003). Therefore, effectively-prepared simulations and practices based on these simulations will result in real reactions from the students, and enhance the speed of learning. Đ man et al. (2002) approve of CAT with simulations by saying "Technology makes it easier for students to comprehend complicated practices and to learn by doing them. For example, experiments carried out by students may cause deaths or injuries in the labs. Instead of doing them in real life, they just use simulated experiments and get the opportunities of grasping the results without actually doing them". In addition to these, simulations mean less cost, using the time wisely, more safety, and higher motivation (Tekdal, 2002; Rodrigues, 1997).

A variety of computer applications have been developed and used in teaching physics, such as spreadsheets (Dory, 1988), computer-based laboratories (Thornton and Sokoloff, 1990), multimedia (Crosby and Iding, 1997; Wilson and Redish, 1992), simulations (Bayraket al., 2007; Andaloro et al., 1997), exploratory environments (Teodoro, 1993) and intelligent tutors (Karamustafaoğlu, 2007; Schulze et al., 2000). Furthermore, research has often been employed to direct educational software design and development, as well as educational software evaluation. CAT is highly efficient in teaching science classes as scientific concepts and principles abound. CAT will facilitate individual learning of hard-to-understand concepts through the use odd appropriate teaching techniques (Geban and Demircioğlu, 1996).

It is pointed out that a lot of work concerning simulations in science classes has been going on (Rodrigues, 1997). Some researches show that CAT evokes more alertness in teaching science than any other methods (Geban et al., 1992; Hounshell and Hill, 1989). Ailleo and Wolfle (1980) have verified that CAT applications have positive effect on students' achievements and attitudes in science. As we all know, by benefiting of already-existing software, computers are used as an aid to enrich the learning process (Demirci, 2003). As the software is not sufficient for students to understand science conceptually, there arises the need for new software (Yiğit and Akdeniz, 2003). The use of such CAT applications has developed a new research field in physics education, since it has radically changed the framework under which physics teaching is being understood and implemented. Among the various CAT applications, computer simulations are of special importance in physics teaching and learning. In this respect, this paper aims:

1. To measure how the software designed by author on SHM affects the conceptual learning of students of science,
2. To compare and contrast how the CAT and the traditional teaching methods affect students by carrying out simulations

MATERIALS AND METHODS

Research design

A quasi-experimental design in which participants are not randomly assigned to the groups, instead, there are naturally occurring groups or groups to which participants are assigned for reasons other than randomizing the sample was used in this study (Judd et al., 1991). One of the groups acts as an experiment group and the other as a control group and they are designed randomly (Robson, 1998; Cohen and Manion, 1994).

Sample

The sample of the study consists of 70 freshman students of Science at the Education Faculty of Amasya University. 45 of them were male while 25 were female. These students take Basic Computer Course in the mentioned term. The experiment group consists of 35 students and the rest is control group. All the students have been appointed randomly.

Data collection

Data were collected through a tool of measurement consisting of two open-ended questions which can be found at the appendix. This tool is based on the ideas suggested by the teaching staff of Fundamental Physics I Course and by those who are experts in the field. In addition, the measuring tool and the software were tested on 5 students of science as a pilot study according to which all the flaws were rectified. The software did not need rectifying.

Development of computer software

Using all the opportunities brought through the simulations, an individual program were created simulating the quantities of force, velocity and acceleration affecting the dynamic system making harmonic motion together with Interactive Physics (URL-1, 2009). This is impossible in the traditional ways of teaching. On the contrary, the software enabled us to measure both the values of force, velocity and acceleration at a desired point of the system and the quantities changes of these variables while moving. The aimed of this paper is to help students grasp the changes conceptually. In other words, students would be able to learn at their pace and to better visualize the abstract concepts.

The procedure

The measuring tool concerning the simple harmonic motion was applied to the experiment and the control groups as a pre-test before the main practices were put to use. After that, in two weeks the experiment group was presented the main practices through CAT while the control group was taught through the traditional ways of teaching (expression, question-answer method etc). Each student in the experiment group had access to a computer system in their seating plan. The practices were as follows:

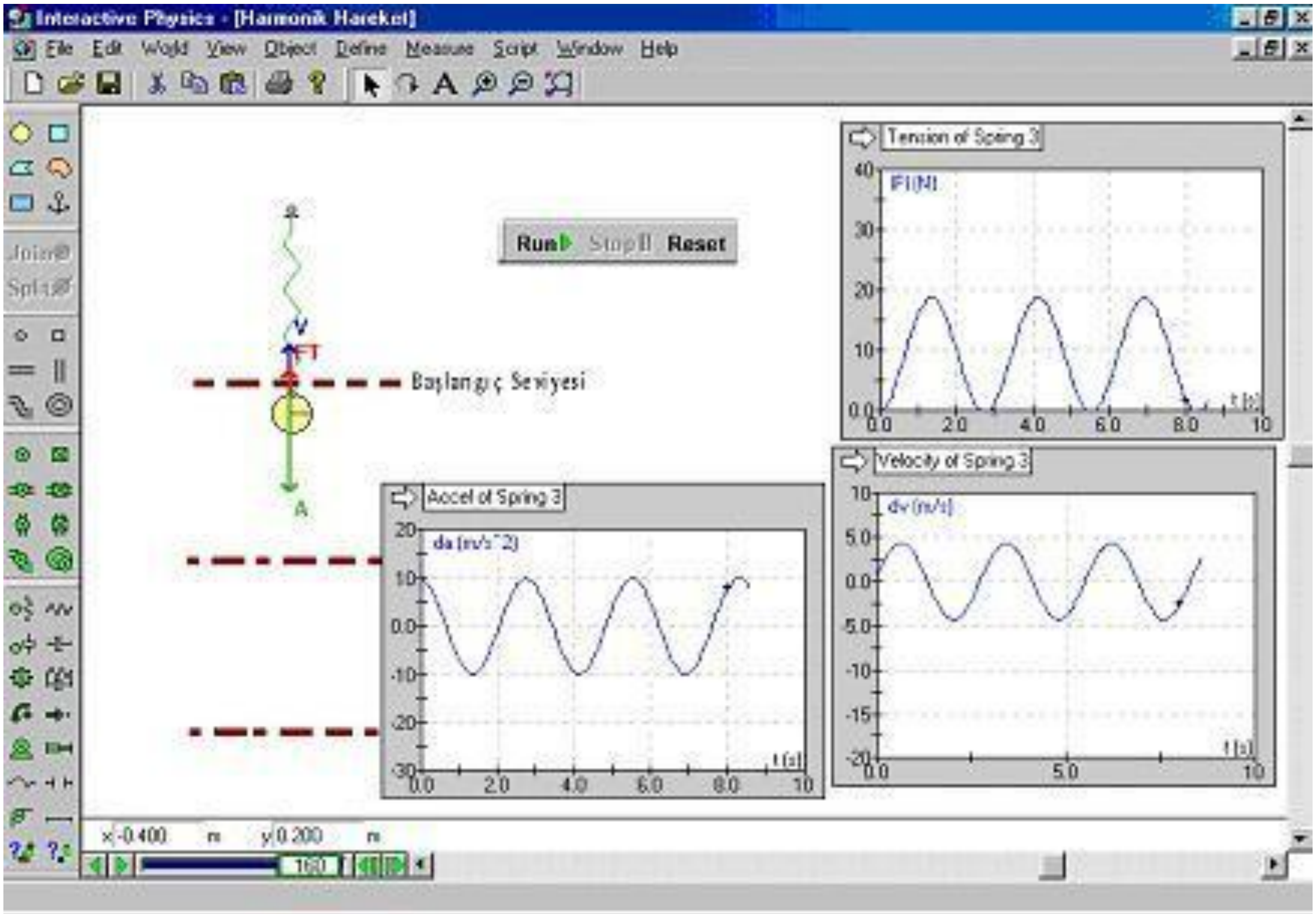


Figure 1. Harmonic motion simulation with interactive physics program.

1st week: Information on the menus for Interactive Physics Program and how to use the software was given to the students as this was needed for them to act effectively. Furthermore, the students were made to be aware of the basic concepts like acceleration, velocity, force, period and frequency.

2nd week: The students were asked to simulate the simple harmonic motion of an object with the mass of m attached to a spring, shown in Figure 1, in the system.

During the process

1. The harmonic motion starts when we press PLAY. The restoring force of the spring and the vectorial aggregate which is the net force, velocity and acceleration affecting the object appear on the screen.
2. As shown in Figure 1, the values of force, velocity, and acceleration appear in different colors. The magnitudes and values of the vectors change continuously.
3. Using PLAY, STOP or RESET, the students stop and resume the motion where it is stopped or resets the procedure.
4. The graphs show the changes in velocity, force and acceleration over a period on the screen. A three-step analysis was designed in order to collect data for the research. In the first step, the pre-test grades of the experiment group and the control group were compared using an independent t-test. In the second step, the answers to the questions in the measuring tool were analyzed in three categories to measure the level of understanding conceptually and the frequency distributions were expressed in tables. The categories and the explanations are as follows:

1. Effective and correct explanation (ECE): The answers were given scientifically and correctly.
2. Partially correct explanation (PCE): The answers were given at an acceptable level.
3. Irrelevant explanation (IE): The answers were given incorrectly and explained irrelevantly.

The test was graded out of 100. Below are the correct answers and the highest grades in Table 1. ECE gets 8 points, PCE gets 4 points and IE is graded as 0. The second question in the test is equivalent in weight to each of the choices a, b and c of the first question, so it is graded out of 9 points. In the final step, both the pre-test/final-test grades within the group based on the dependent t-test and the final test grades among the groups based on the independent were compared.

FINDINGS AND DISCUSSION

The data were divided into 3 subtitles: (1) findings of the pre-test results, (2) findings of the levels of conceptual comprehension and (3) findings of the final-test results after the practice.

Table 1. The points for the correct answers to the questions in the test (the figure in brackets is the highest point for each question).

Question	Physical quantity	Point	Yes/ no	Direction	Magnitude (max and min)	Explanation
1a	The restoring force	C	No (1)	-	-	The spring is on equilibrium, so there is no restoring force on the object. (8)
		D	Yes (1)	Up (1)	Medium (1)	The further the object gets from point C, the point of equilibrium, the more the restoring force gets as the restoring force gets the object close to the point of equilibrium. Only if the value of the restoring force increases can it bring back the object moving away. The value of the restoring force in the mid-point is medium. (8)
		E	Yes (1)	Up (1)	Max (1)	The restoring force increases if the object moves away from the point of equilibrium. It is max at the edge. (8)
1b	Velocity	C	Yes (1)	-	-	The object is at equilibrium, so the velocity is at maximum. (8)
		D	Yes (1)	Down (1)	Medium (1)	The displacement decreases irregularly until the object gets from C to D under the effect of its weight and the restoring force. Therefore, so does the velocity. (8)
		E	No (1)	-	-	The displacement of the object decreases irregularly and dwindles to zero at this point. (8)
1c	Acceleration	C	No (1)	-	-	As the force is zero, the acceleration is zero. (8)
		D	Yes (1)	Up (1)	Medium (1)	Acceleration is the time-rate of change of velocity. The velocity increases irregularly until the object gets from D to C. However, the acceleration slows down gradually. The change in velocity around C is close to zero and the acceleration is different from zero at point D. (8)
		E	Yes (1)	Up (1)	Max (1)	The object has an irregular and reverse acceleration after point D. Right at point E, the acceleration is equal to that of gravity.(8)
2	At the end of T/2, the object will arrive at point B. (1)					The object will go up when it is pulled down as there is no friction at all. Therefore, the object will arrive at point B at the end of T/2. (8)

Findings of the pre-test results

The weighted average of the results from the pre-test concerning SHM was calculated and the comparison of their achievement was made based on the independent t-test. The results are stated in Table 2. As shown in Table 2, there is no a statistical difference between the groups in terms of the pre-test results ($t_{(68)}$=-0.13; p>0.05). The groups can be said to be equal at the beginning. This equivalence is thought to be useful when we wish to compare the results of the pre-test with those of the final test.

Findings of the levels of conceptual comprehension of both groups

The results from the final test were scrutinized and the values of frequency and percentage were shown.

An analysis of the results about the restoring force effecting the object at points C, D, and E

At Table 3, the students in the experiment group have a higher percentage of ECE and a lower percentage of IE for each point than those in the control group. The students answered questions on the restoring force in terms of ECE, PCE and IE and they are as follows.

Irrelevant/wrong explanation (IE)

IE_1: There is no restoring force on the object at point C as it came back where it started off.
IE_2: The restoring force equals zero at point D as it is the point of equilibrium.
IE_3: The object went up after it gets to point E affected by k, the spring invariable.
IE_4: The restoring force is constant at each point.

Table 2. The pre-test results of both groups.

Group	No. of students	Means	Standard deviation	t	df	p
Experiment	35	20.31	9.71	-0.13	68	0.898
Control	35	20.57	6.69			

Table 3. The results of the students in both groups on the restoring force.

Categories	Point C				Point D				Point E			
	Control group (N=35)		Experiment group (N=35)		Control group (N=35)		Experiment group (N=35)		Control group (N=35)		Experiment group (N=35)	
	f	%	f	%	f	%	f	%	f	%	f	%
ECE	6	17	11	31	1	3	7	20	8	23	21	60
PCE	15	43	14	40	19	54	17	49	20	57	11	31
IE	14	40	10	29	15	43	11	31	7	20	3	9

Table 4. The results of the students in both groups on the velocity of the object at different points.

Categories	Point C				Point D				Point E			
	Control group (N=35)		Experiment group (N=35)		Control group (N=35)		Experiment group (N=35)		Control group (N=35)		Experiment group (N=35)	
	f	%	f	%	f	%	f	%	f	%	f	%
ECE	5	14	13	37	0	0	7	20	2	6	13	37
PCE	19	65	15	43	22	63	20	57	23	65	17	49
IE	11	31	7	20	13	37	8	23	10	29	5	14

IE_5: The spring is at its maximum in flexibility at point E and therefore the object can not go any further down. The restoring force at this point is zero.

Partially correct explanation (PCE)

PCE_1: The restoring force on the object is in reverse motion of the object.

PCE_2: Moving from point C to point E the object moves through G the gravity while it moves back from point E to point C with the help of the restoring force.

Effective and correct explanation (ECE)

ECE: The restoring force is applied to the object due to the spring and the object can oscillate between point A and point E.

An analysis of the results about the velocity of the object at points C, D, and E

The frequency and the percentage values of responses related to the velocity of the object at C, D and E points during the motion are shown at Table 4. Table 4, the students in the experiment group has a higher percentage of ECE for each point than those in the control group. The students answered questions on the velocity in terms of ECE, PCE and IE and they are as follows.

Irrelevant/wrong explanation (IE)

IE_1: While the object is at point D right in the middle, the restoring force F is at its minimum, so the velocity is at its maximum due to the gravity.
IE_2: The velocity is in direct proportion to the flexibility of the spring which is maximum at point E, and so is the velocity.
IE_3: The velocity is at the minimum where the restoring force on the object is zero.
IE_4: The velocity goes up if the restoring force increases.
IE_5: At each point above, the kinetically energy is equal to the potential energy. $V_C>V_D>V_E$ because the potential energy changes with height.
IE_6: The more the potential energy decreases during the motion, the more the kinetically energy increases. Therefore, the velocity increases.
IE_7: The velocity of the object changes regularly.

Table 5. The results of the students in both groups on the acceleration of the object at different points.

Categories	Point C				Point D				Point E			
	Control group (N=35)		Experiment group (N=35)		Control group (N=35)		Experiment group (N=35)		Control group (N=35)		Experiment group (N=35)	
	f	%	f	%	f	%	f	%	f	%	f	%
ECE	6	17	11	31	2	6	7	20	2	6	5	14
PCE	11	31	15	43	17	49	19	54	21	63	20	57
IE	18	52	9	26	16	45	9	26	11	31	10	29

Table 6. The results of the students in both groups on the point where the object is at the end of T/2.

Categories	Control group (N=35)		Experiment group (N=35)	
	f	%	f	%
ECE	13	37	20	57
PCE	9	26	11	31
IE	13	37	4	12

Partially correct explanation (PCE)

PCE_1: Moving from point C to point D, the object speeds up due to the gravity and reaches its maximum at point D and then slows down because of the reverse acceleration.
PCE_2: The object reaches its maximum velocity. After that, the restoring force is strong enough to overcome gravity at point E. The velocity is zero at this point.

Effective and correct explanation (ECE)

ECE: Since the object changes direction at point E, the velocity is zero at that point.

An analysis of the results about the acceleration of the object at points C, D, and E

The frequency and the percentage values of responses related to the acceleration of the object at C, D and E points during the motion are shown at Table 5. Table 5, the students in the experiment group has a higher percentage of ECE and a lower percentage of IE for each point than those in the control group. The students answered questions on the acceleration in terms of ECE, PCE and IE.

Irrelevant/wrong explanation (IE)

IE_1: The system is affected by *g* the gravitational acceleration which remains stable as it is constant all around the world.
IE_2: The velocity is in proportion to the acceleration, so the acceleration has the highest value when the velocity is highest at point D.
IE_3: The acceleration is zero at point C and point E where the object stops and starts moving again.
IE_4: The acceleration is zero at point E since the object has stopped.

Partially correct explanation (PCE)

PCE: The acceleration is moving in the opposite direction of the restoring force all the way through.

Effective and correct explanation (ECE)

ECE: The restoring forces at points C, D and E are $F_E > F_D > F_C$, so the acceleration is $a_E > a_D > a_C$.

An analysis of the results about the point where the object is at the end of T/2

The responses of the students related to the probable points after the T/2 period of the object in the system with harmonic motion under the effect of weight are examined and the frequency and percentage values of responses are shown at Table 6. Table 6, the students in the experiment group (57%) are 20% higher than those in the control group (37%) in terms of ECE. The students answered the questions on the point where the object is at the end of T/2 in terms of ECE, PCE and IE.

Irrelevant/wrong explanation (IE)

IE_1: But for the weight, the object could have gone to point B.

Table 7. The t-test results of the pre-test/final-test comparison based on the students in the control group.

Control	No. of students	Means	Standard deviation	t	df	p
Pre-test	35	20.57	6.69	-9.58	34	0.000
Final-test	35	31.00	9.32			

Table 8. The t-test results of the pre-test/final-test comparison based on the students in the experiment group.

Experiment	No. of students	Means	Standard deviation	t	df	p
Pre-test	35	20.31	9.71	-9.31	34	0.000
Final-test	35	46.09	15.93			

IE_2: Pulled up to point D, the object would make harmonic motion between C and D.

IE_3: The object stops between B and C owing to the restoring force of the spring on the object.

IE_4: The object can't go to B due to its weight.

IE_5: Point C is where the forces are equal, so the object can go up to point C.

Partially correct explanation (PCE)

PCE: The restoring force on the object will make the object move a little higher than the point of equilibrium C.

Effective and correct explanation (ECE)

ECE_1: Since there is no friction, the lower the object is pulled, the higher it gets to from the equilibrium point. Supposing the distance between point C and point D is χ, after the object starts to move, it goes up to a height of χ from the equilibrium point. Therefore, it needs to be at point B.

ECE_2: Since there is no friction, the object comes back to where it starts off, which is point D at the end of T. It needs to be at point B at the end of T/2.

We have observed through the measuring tool of SHM with an aim to see the levels of conceptual comprehension of both the experiment and the control group. The teaching with the simulation program applied to the experiment group is more rewarding than the traditional method of teaching applied to the control group. The comparative percentage data of both groups in terms of the restoring force, the velocity, the acceleration and where the object stops at the end of a period of T/2 are given in Tables 2 to 5.

What we can infer here is that things are in favor of the experiment group. Parallel conclusions were drawn to the related research done in the field (Jimoyiannis and Komis, 2001). In teaching concepts through computer simulations, Hewson (1985) did quite well in the concept of velocity and Tao (1997) in mechanical concepts and Pena and Alessi (1999) in the concept of free fall.

Findings of the final-test results of both groups

After calculating an arithmetic mean of the final-test results of both groups, a comparative analysis of the pre-test/final-test results are found regarding both groups. The analysis is based on a dependent t-test and a comparative analysis of the final-test results based on an independent t-test.

The average pre-test/final-test results compared on a dependent t-test regarding the students in the control group can be seen at Table 7

As shown in Table 7, there is a significant difference between the pre-test and the final-test results of the students in the control group ($t_{(34)}$=-9.58; $p<0.01$). The difference is in favor of the final-test results. This is what we have already expected.

The average pre-test/final-test results compared on a dependent t-test regarding the students in the experiment group can be seen at Table 8

As shown in Table 8, there is a considerable difference between the pre-test and the final-test results of the students in the control group ($t_{(34)}$=-9.31; $p<0.01$). The difference is in favor of the final-test results. This is what we have already expected.

The average final-test results compared on an independent t-test regarding the students in the experiment and the control group can be seen at Table 9

As shown in Table 9, there is a considerable difference between the final-test results of the students in the experiment and the

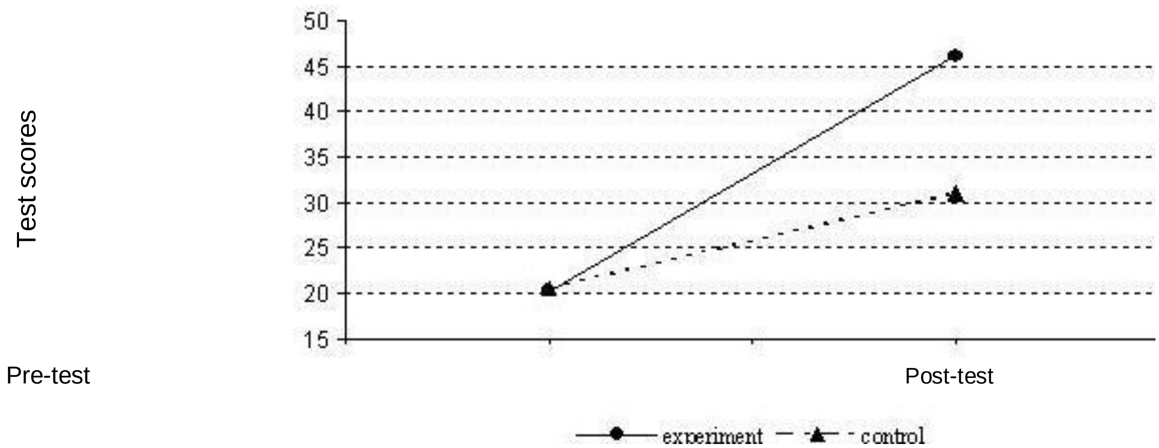


Figure 2. Samples' pre-test and post-test performance in SHM Test.

control group ($t_{(68)}=4.84$; $p<0.01$). In the comparative analysis done on the pre/final test results there has been an increase in favor of the students in the experiment and the control group. It is as we have expected. However, the independent t-test comparative results are of higher importance when we think of what we aim to measure in this study: How well the students in the experiment group do with the help of CAT? The results are in favor of the experiment group rather than the control group. The data show that, statistically speaking, there is a considerable difference between the pre-test and the final-test results of the students in the control group. However, the average pre-test results of the students in the control group showed an increase of 10% in the final-test results while the increase is 26% for the students in the experiment group.

As is shown in the second columns of Tables 7 and 8, although the results of both groups have been higher when compared to the first achievements, the experiment group has performed better than the control group. The teaching process contributes positively to the success of both groups whereas the experiment group has a higher percentage than the control group. Table 9 shows that there is a respectable difference of $p<0.01$ in the t-test comparative analysis of the final-test results between the groups. This is a 15% increase of higher results in favor of the experiment group. Figure 2 specifically shows pre-test and post-test scores for both groups. Simulated teaching of SHM through CAT enables the students to do better in teaching concepts than the one through the traditional method of teaching in which teaching concepts is not at an acceptable level (Whitaker, 1983; Trowbridge and McDermoot, 1980 and 1981). Some new applications have been developed in the light of the effectiveness of teaching through simulations (Andaloro et al., 1997).

Conclusion

With the introduction of computers into educational institutions thanks to the rapid changes in technology, CAT activities have increased. This work is a contribution to Interactive-Physics software which intends to teach simple harmonic motion to students of science. The percentage of ECE is lower that the percentage of PCE and IE which are higher in the control group. For instance, about the restoring force on the object in the system the students in both groups said, "*the restoring force does not affect the object as it comes back where it starts off at point C, and the restoring force is constant at both points*" and this is one of the PCE and IE. The misconception that *the restoring force is constant during the motion* is very common and has been seen in the works before (Demirci, 2003). Another irrelevant explanation of the students in both groups about the velocity is that "where the restoring force F increases, the velocity increases. If the force on the object is zero, the velocity is the lowest. There is a common misconception among the students that if the force effecting to the object is zero then velocity is zero. Furthermore, the explanation about the acceleration of the object that the acceleration is zero where the object stops and starts again, and as the force on the object is the highest; the acceleration is the highest" which is irrelevant. The misconception that "the pendulum accelerates at the lowest point of the oscillation" is common (Demirci, 2003). The explanation about where the object will be at the end of a period of T/2 that "C is the point where the forces are equal, therefore, the object goes up to point C" is irrelevant. This is treated in the literature, too (Demirci, 2003).

The statistical data indicate that CAT is more successful than traditional teaching methods. This result is supported by the studies carried out by Andaloro et al. (1997), Rodrigues (1997) and Marshall and Young (2006) on science education. Furthermore the results of this study are in accordance with the previous study we made on the same subject (Karamustafaoğlu et al., 2005). Here are some suggestions relating to the results. CAT must be made common not only in SHM but in the other subjects of science as well. Velocity, acceleration, heat, temperature, intensity of light and other science concepts can be taught in a shorter time.

Taking the misconceptions into account, various simulations can be developed to test the students on different subjects of science and then it can be observed at what level these misconceptions are corrected. Additional programs and software can be developed as supplementary for the teaching of science. With the help of animations and simulations through CAT, experiments will be inexpensive, take less time and be safer. If students participate, learning will be more effective, so CAT practices will motivate students more easily and make them more willing to take part in the activities in the lab (Sharp et al., 2007; Marchal et al., 2006; Collette and Chiappetta, 1989). Therefore, this is thought to enhance student achievement in the concepts of science and all other subjects (Hennessy et al., 2007). It should not be forgotten that CAT is not an all-cure solution on its own. It has to be supplemented with related programs. In addition, a teaching plan must be made in detail and the parameters must be set clearly. This is believed to lead to ever lasting learning.

REFERENCES

Aiello NC, Wolfle LM (1980). A meta-analysis of individualized instruction in science. Paper presented at the Annual Meeting of the American Educational Research Association: Boston. (ERIC Document Reproduction Service No. ED190404).

Andaloro G, Bellomonte L, Sperandeo-Mineo RM (1997). A computer-based learning environment in the field of Newtonian mechanics. Int. J. Sci. Educ., 19: 661-680.

Banerjee AC, Yager RE (1995). Changes in student perceptions about science classes and the study of science following science-technology-society instruction. Sci. Educ., 4: 18-24.

Bayrak BK, Bayram H (2010). Effect of computer aided teaching of acid-base subject on the attitude towards science and technology class. Procedia Soc. Behav. Sci., 2: 2194-2196.

Bayrak B, Kanli U, Đngeç ßK (2007). To compare the effects of computer based learning and the laboratory based learning on students' achievement regarding electric circuits. The Turkish Online J. Educ. Technol., 6(1): 15-24.

Binta J, Çamli H (2009). The effect of computer aided instruction on students' success in solving LCM and GCF problems. Procedia Soc. Behav. Sci., 1: 277-280.

Chang CY (2002). Does-computer-assisted instruction + problem solving = improved science outcomes? A pioneer study. J. Educ. Res., 95(3): 143-150.

Cohen L, Manion L (1994). Research methods in education. 4th ed. London: Roudledge.

Colletta AT, Chiappetta EL (1989). Science introduction in the middle and secondary schools. 2nd ed. Ohio-USA: Merrill Publishing Company.

Crosby ME, Iding MK (1997). The influence of a multimedia Physics tutor and user differences on the development of scientific knowledge. Comp. Educ., 29: 127-136.

Demirci N (2003). Teaching strategies effectively with computer and physics education, Ankara: Nobel Press.

Dory RA (1988). Spreadsheets for physics. Comput. Phys., 6: 70-74.

Fraij F (2010). The impact of feedback in computer-aided Instruction. Int. J. Soft Comp., 5(2): 67-71.

Geban Ö, A kar P, Özkan Đ (1992). Effects of computer simulations and problem solving approaches on high school students. J. Educ. Res., 86(1): 5-10.

Geban Ö, Demircioğlu H (1996). Computer-assisted teaching in science instruction and compared traditional problem solving activities with achievement. Hacettepe J. Educ., 12: 183-185.

Hacker RG, Sova B (1998). Initial teacher education: a study of the efficacy of computer mediated courseware delivery in a partnership concept. Br. J. Educ. Technol., 29(4): 333-341.

Harwood WS, McMahon MM (1997). Effects of integrated video media on student achievement and attitudes in high school chemistry. J. Res. Sci. Teach., 34(6): 617-631.

Hennessy S, Wishart J, Whitelock D, Deaney R, Brawn R, la Velle L, McFarlene A, Ruthven K, Winterbottom M (2007). Pedagogical approaches for technology-integrated science teaching. Comp. Educ., 48(1): 137-152.

Hewson P (1985). Diagnosis and remediation of an alternative conception of velocity using a microcomputer program. Am. J. Phys., 53(7): 684-690.

Hounshell PB, Hill SR (1989). The microcomputer and achievement and attitudes in high school biology. J. Res. Sci. Teach., 26(6): 543-549.

Đ man A, Baytekin Ç, Balkan F, Horzum B, Kiyici M (2002). Science education and constructivist approach. The Turkish Online J. Educ. Technol., 1(1): 41-47.

Jimoyiannis A, Komis V (2002). Computer simulations in physics teaching and learning: A case study on students' understanding of trajectory motion. Comp. Educ., 36(2): 183-204.

Judd C, Smith E, Kidder L (1991). Research methods in social relations (6th ed.). San Francisco: Holt, Rinehart and Winston, Inc.

Karamustafaoğlu O (2009). Active learning strategies in physics teaching. Energy Education Science and Technology Part B: Soc. Educ. Stus., 1(1): 27-50.

Karamustafaoğlu O (2007). Evaluation of novice physics teachers' teaching skills. Paper presented in the AIP Conference Proceedings Sixth International Conference of the Balkan Physical Union, 899(1): 501-502.

Karamustafaoğlu O, Aydin M, Özmen H (2005). Effects of computer aided physics activities on achievements of students: SHM sample. Turk. Online J. Educ. Technol., 4(4): 67-81.

Marchal M, Provent P, Ruyer F, Djoharian P, Neyret F (2006). Computer-assisted teaching in class situation: a high-school math lab on vectors. Lecture Notes Comput. Sci., 3942: 281-290.

Marshall JA, Young ES (2006). Preservice teachers' theory development in physical and simulated environments. J. Res. Sci. Teach., 43(9): 907-937.

Pena CM, Alessi SM (1999). Promoting a qualitative understanding of physics. J. Comp. Math. Sci. Teach., 18(4): 439-457.

Robson C (1998). Real world research. Blackwell Publishers ltd., Oxford, UK.

Rodrigues S (1997). Fitness for purpose: a glimpse at when, why and how to use information technology in science lessons. Aust. Sci. Teach. J., 43(2): 38-39.

Rong Z, Zhao K (2008). Research and practice of Internet-based intelligent tutoring platform for science teaching, Paper presented in the Computer Science and Software Engineering 2008 International Conference, 5: 442-445.

Schulze KG, Shelby RN, Treacy DJ, Wintersgill MC (2000). Andes: An active learning, intelligent tutoring system for Newtonian Physics. Themes Educ., 1(2): 115-136.

Sharp JS, Glover PM, Moseley W (2007). Computer based learning in an undergraduate physics laboratory: interfacing and instrument control using Matlab. Eur. J. Phys., 28(3): 1-12.

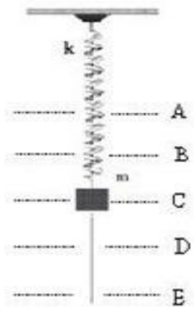
ßahin TY, Yildirim S (1999). Teaching technology and material development, Ankara: Ani Press.

Tao PK (1997). Confronting students' alternative conceptions in mechanics with the force and motion microworld. Comp. Phys.

11(2): 199-207.
Tekdal M (2002). Development and implemented of interactive physics simulations effectively, Paper presented in the V. National Science and Mathematics Education Congress, 1: 605-611. METU, Ankara.
Teodoro VD (1993). Learning with computer-based exploratory environments in Science and Mathematics. In S. Vosniadou, E. de Corte, and H. Mandl, Technology-based learning environments, Berlin: Springer-Verlag. NATO ASI Series F., 137: 26-32.
Thornton RK, Sokoloff DR (1990). Learning motion concepts using real-time microcomputer-based laboratory tools. Am. J. Phys., 58(9): 858-867.
Trowbridge DE, McDermoot LC (1980). Investigation of student understanding of the concept of velocity in one dimension. Am. J. Phys., 48(12): 1020-1028.
Trowbridge DE, McDermoot LC (1981). Investigation of student understanding of the concept of acceleration in one dimension. Am. J. Phys., 49(3): 242-253.
URL-1 (2009). Interactive physics program. Retrieved May 14, http://interactivephysics.design-simulation.com/IP/index.php.
Wilson J, Redish F (1992). The comprehensive unified physics learning environment: part I. Background and system operation. Computers in Physics, Mar/Apr., pp. 202-209.
Winey KA, Squibb B (1991). Effective teacher preparation experiences: student perspectives. J. Res. Educ., 1: 79-86.
Yalçinalp S, Geban Ö, Özkan Ö (1995). Effectiveness of using computer-assisted supplementary instruction for teaching the mole concept. J. Res. Sci. Teach., 32: 1083-1095.
Yenice N (2003). The effect of the computer assisted science teaching method on the attitudes of students towards science and computer. The Turkish Online J. Educ. Technol., 2(4): 79-85.
Yiğit N, Akdeniz AR (2003). The effect of computer-assisted activities on student achievement in physics course: electric circuits sample. J. Gazi Educ. Fac., 23(3): 99-113.

Appendix: SHM test

1.



An object with a mass of m is suspended from a flexible spring which is fixed on the ceiling, and then let loose. The object makes simple harmonic motion between points A-E and point C which is the equilibrium under the effect of the acceleration of gravity.

Suppose *there is no friction* and the distance between the points is equal.

(a) What is the direction and magnitude of the restoring force on the object at points C, D, and E? And justify them?

Magnitude	Direction	Justification
C.........	....	....
D.........	....	....
E.........	....	....

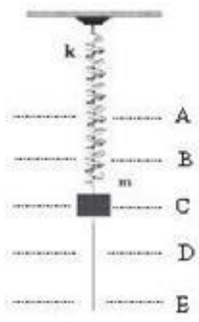
(b) What is the direction and magnitude of the velocity of the object at points C, D, and E? And justify them?

Magnitude	Direction	Justification
C.........	....	....
D.........	....	....
E.........	....	....

(c) What is the direction and magnitude of the acceleration of the object at points C, D, and E? And justify them?

Magnitude	Direction	Justification
C.........	....	....
D.........	....	....
E.........	....	....

2.



An object with a mass of m is suspended from a flexible spring which is fixed on the ceiling, and is *on equilibrium*. The object is pulled up to point D and then is let loose. The object makes simple harmonic motion between point C and point E under the effect of the acceleration of gravity. At which point or between which points could be the object at the end of a period of T/2? Justify this.

Suppose *there is no friction* and the distance between the points is equal.

(a) It could be at point A because
....
.....

(b) It could be at point B because
....
......

(c) It could be at point C because
....
......

(d) It could be between point A and point B because
....
....

e) It could be between point C and point B because
....