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Developing A Computer Assisted Education Material Related To Thermochemistry

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ABSTRACT

In this study, computer assisted education (CAE) material was developed according to the Meaningful Learning Theory and its effectiveness on the students' success and their attitudes towards computer and chemistry was researched. The research was applied to 10th class science students at Buca High School in İzmir. 56 students attending this research were randomly divided into two groups; experimental group (EG) and control group (CG). While the material was applied to EG by CAE, traditional method (TM) was applied to CG. In order to evaluate the effectiveness of the material, Scientific Success Test (SST), Chemistry Attitude Scale (ChAS) and Computer Attitude Scale (CAS) of which validity and reliability calculated before were applied to both EG and CG as pre-test and post-test. The data obtained from tests were analyzed by using SPSS program. The results of analysis indicated that Computer Assisted Education method has more effect on students' chemistry success, attitudes towards chemistry and computer than Traditional Method.

Keywords: Computer Assisted Education; Developing Material; Teaching Chemistry; Meaningful Learning.

INTRODUCTION

Computer Assisted Education (CAE) has been becoming more and more common for over three decades. Especially since 1990's, CAE process has extensively increased (Hayes, 1995; Reinhardt, 1995; D.P.T, 1988; Ayas et al. 1997).

The studies over CAE have showed that CAE has more useful effects than Traditional Method (TM) on students' achievement (Kulik et al., 1980; Kulik et al., 1983; Roblyer et al.,1988; Wise, 1988; Morgil et al., 2003; Morgil et al., 2005; Ngo, 2006). The level of the success in the classrooms, which CAE is applied, is observed to increase in Japan. The level of the success at mathematics increases from 42% to 99% with the help of CAE in Israel as well (Altın**,** 1992).

Using computer in learning-teaching processes in science education enables students to make cooperation and be able to solve problems. Also, computer increases students' interests in terms of focusing on learning and gives the students the opportunity to behave as if they were specialist in complex applications (Papert, 1992).

Students often have preconceptions about chemistry, chemistry is a science that has many concepts and processes of which are not visible with naked eyes. Therefore, chemistry is a difficult subject to teach (Jones et al., 2001). By the use of computer, the difficulties in chemistry teaching can be vitiated or removed. Computer can be used for various aims in chemistry teaching (Ayas et al., 1997).

a) Simulations With The Help Of Computers

With the help of CAE, students will be able to observe natural events that are unobservable because of being too big, too small, too fast, too slow or too complex (Singer et al., 2006). CAE is very important in chemistry education because it enables students to understand and imagine processes such as chemical and physical processes easily (Demirdağ, 2007). For instance, an animation of phase changes process is given in Figure1.

Figure 1. *Phase Changes Process* (Demirdağ & Kartal, 2007)

We can teach many chemical events with the help of simulation such as the movements of molecules and ions, radioactive events, acid-base titration etc. (Ayas et al., 1997).

b) Laboratory Based on Computer

Students are able to make very dangerous experiments with the use of computer and get the results of them without very expensive matters and equipment. Also the experiments, which are impossible or uneasy to be carried out, can be done easily by using computer (Orbay et al., 2003; Çallıca et al., 2001; EARGED, 1995; Güzel, 2001; Singer et al., 2006). Furthermore, computer enables students to behave in a free way to explore and increase problem solving skills (Demirci, 2003).

c) Exercise – Practice Activities with the Help of Computer

A teacher can not explain the same subject many times. Also it is not possible for students to learn a subject in the same pace. However, by using computer, students can study the subjects, do exercises and make practice many times in their own learning pace (Ayas et al., 1997).

d) Learning with Computer

No matter how careful and good the teacher teaches the subject, there may still be students who do not understand it. The students, who are grown back, can study the subjects from the computer and can easily fulfill their missing.

While developing CAE materials, we can make use of many teaching approaches. One of them is Ausubel's Meaningful Learning Theory. Postman and Weingartner (1969) argue that all the students learn by giving meaning. Students constitute brain patterns with the help of knowledge's meaningful organization and classification (Nummela & Rosengren, 1986) and they try to contact between pre-knowledge and post-knowledge. When they achieve this, meaningful learning will come true (Ausubel, 1968). If we want our students to use their learning capacity effectively, our learning activities must depend on meaningful learning (Cermack & Craik, 1979). In the learning process, to have meaningful learning and effective chemistry teaching, it is important to take the students interest and attention to the subject (Yıldırım, 2001). In this research, CAE material is developed with the help of Ausubel's Meaningful Learning Theory. To provide meaningful learning, there are "Activities" and "Do You Know These?" sections. Also students are asked various questions in subtopics before the subject.

As mentioned before, the purpose of this study is to develop a material which is based on Meaningful Learning Theory and to research the effectiveness of it on students' chemistry success, attitudes towards chemistry and computer by using CAE method.

METHODOLOGY

This experimental research design was partially taken from Campbell and Stanley's (1963) pre and post-test control group model.

This research was carried on 56 students (37 girls, 19 boys) at 10th class at Buca High School in Izmir in 2005-2006 years. The students were randomly divided into two groups (EG, CG).

a) Application Process

Application process had 8 hours for each group. TM was applied to the CG. CAE method was applied to EG by using CAE material in computer lab. The subtopics; Energy, Enthalpy, Reaction Enthalpy, Endothermic Exothermic Events, Bond Energy, Molar Formation Enthalpy, Calorimeter Container, Hess Rules were instructed in the way of TM. Also, the same subtopics were instructed to the EG by using CAE material. Some questions at the subtopics were asked to the students to provide meaningful learning. Graphs, animations, concept maps, figures, interactions were used in the CAE material. To take students' attention, some samples from daily life related to thermo chemistry were used.

Figure 2. *A View of Material Prepared*

SST, ChAS and CAS of which validity and reliability calculated before were applied as pre-test and post-test to both EG and CG (Table1).

Table1. *Application Process*

Group	Pre-test	Method	Post-test
EG	SST, ChAs, CAS	CAE	SST, ChAs, CAS
CG	SST, ChAs, CAS	TM	SST, ChAs, CAS

b) CAE Material

The material is related to thermo chemistry, one of the topics of chemistry lesson in 10th class. CAE material was developed by using Macromedia Flash 2004 providing interaction and qualified view. The Material was developed by depending on "Meaningful Learning Theory" by Ausubel (1968). The material consists of subtopics: Energy, Enthalpy, Reaction Enthalpy, Endothermic Exothermic Events, Bond Energy, Molar Formation Enthalpy, Calorimeter Container and Hess Rules. There are "Test", "Terminology", "Do You Know These" and "Concept Map" sections in the material.

"Test" section was formed with 23 questions about thermo chemistry which were asked in university entrance examination (Figure3).

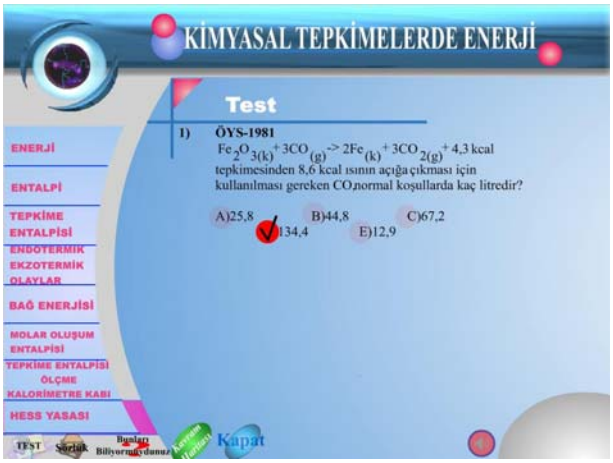

Figure 3. *Material's Test Section*

"Terminology" section has the meanings of the terms included in the CAE material (Figure4).

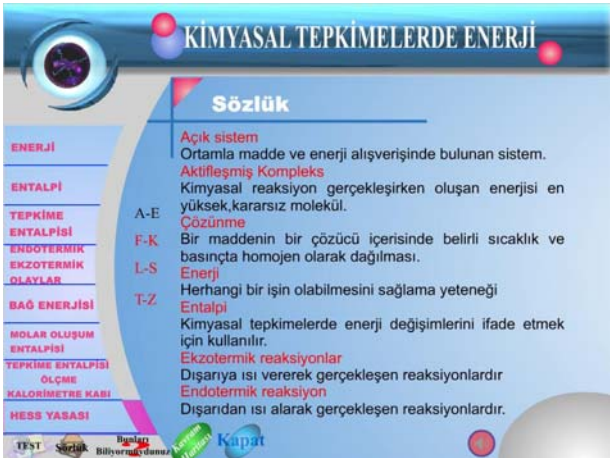

Figure 4. *Material's Terminology Section*

In "Do You Know These" section, some samples from daily life about thermo chemistry were given to the students (Figure5).

Figure 5. *Material's "Do You Know These?" Section*

There is a concept map related to thermochemistry in "Concept Map" section (Figure6).

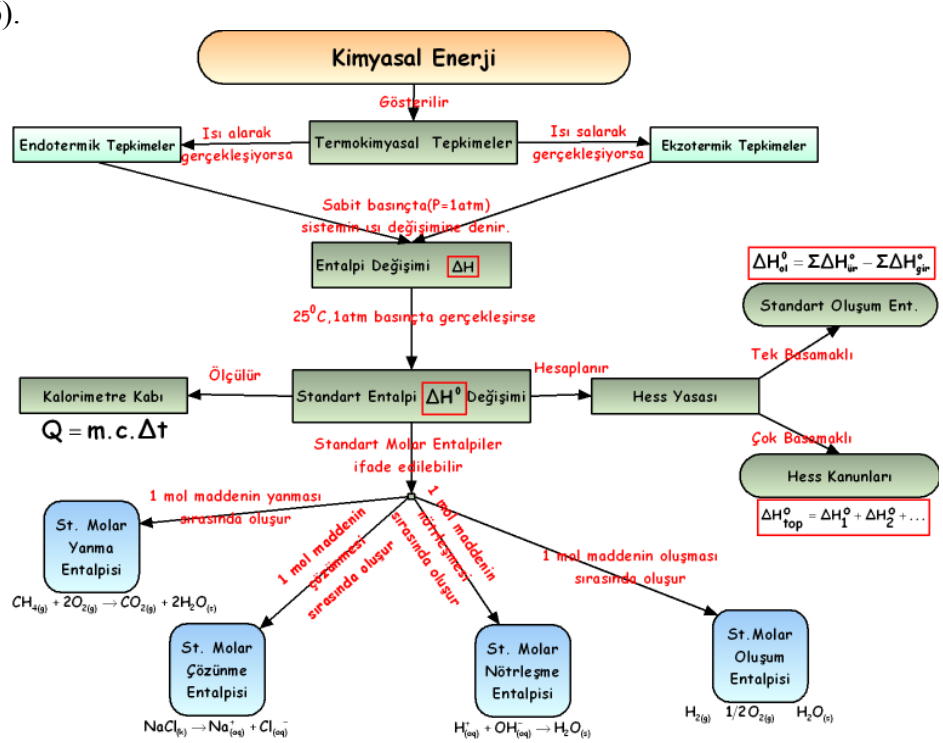

Figure 6. *Material's Concept Map Section*

c) Measurement Instruments

Scientific Success Test (SST): SST, consisted of 20 multiple-choice questions related to thermo chemistry lesson, was developed to measure the students' success.

In SST development process, firstly multiple-choice questions were prepared. A scale consisted of 39 items was prepared and applied to 114 students at Buca and Gaziemir high schools in Izmir. Factor analyses were implemented to the results gained. With the results of factor analyses, the items of which factor values were less than 0.30 were

omitted from the scale. Finally SST was composed of 20 items. The Cronbach α-reliability coefficient was found 0.86 for SST.

Chemistry Attitude Scale (ChAS): ChAS including 19 items (6 negative, 13 positive) was applied for measuring attitudes of students towards chemistry. ChAS was developed by Geban et al. (1994). The Cronbach α- reliability coefficient of ChAS was 0.88.

Computer Attitude Scale (CAS): CAS including 50 items (27 negative, 23 positive) was applied for measuring the interest and attitudes of students towards computer. CAS was developed by Berberoğlu and Çalıkoğlu (1992). The Cronbach α- reliability coefficient of CAS was 0.90.

ChAS and CAS are likert type scales and consist of attitudes expressions (Strongly Agree - Agree - Undecided - Disagree - Strongly Disagree).

d) Data Analysis

The data were analyzed by using SPSS statistics program. Paired samples t-test was used to find out significant differences between pretest and posttest in the groups. Independent samples t-test was used to state significant differences between groups. *p* values were considered in order to understand significant differences between the groups and in the groups.

RESULTS

Scientific Success Test (SST): The results of analyses between and in the groups are presented in Table 2 and Table 3.

Table 2. *SST Results between Groups*

SST	Group	N	X	S.S.	δ	t	p
Pretest	EG	28	6,3214	1,36228	0,25745	1,360	0,180
	CG	28	5,8214	1,38921	0,26254		
Posttest	EG	28	18,2857	2,27478	0,42989	5,991	0,000
	CG	28	14,5714	2,36375	0,44671		

SST results showed that there was not any difference between CG's and EG's pretests (p=0,180). However, there were significant differences between EG's and CG's posttests (p=0,00)

Table 3. *SST Results in Groups*

Group	SST	N	X	S.S.	δ	t	p
CG	Pretest	28	5,8214	1,38921	0,26254	-14,295	0,000
	Posttest	28	14,5714	2,36375	0,44671		
EG	Pretest	28	6,3214	1,36228	0,25745	-22,231	0,000
	Posttest	28	18,2857	2,27478	0,42989		

The results showed that there were significant differences between CG's pretest and posttest (p=0.00). There were significant differences between EG's pretest and posttest (p=0.00).

Chemistry Attitude Scale (ChAS): The results of ChAS analyses are presented in Table 4 and Table 5.

Table 4. *ChAS Analyses Results in Groups*

Group	ChAS	N	X	S.S	δ	t	p
CG	Pretest	28	73,0357	6,73565	1,27292	-1,731	,095
	Posttest	28	74,5000	7,76745	1,46791		
EG	Pretest	28	69,5357	14,32036	2,70629	-3,823	,001
	Posttest	28	79,4642	5,80218	1,09651		

These results showed that there were not significant differences between CG's pretest and posttest (p=0,095). Whereas, there were significant differences between EG's pretest and posttest (p=0,001).

Table 5. *ChAS Analyses Results Between Groups*

SST	Group	N	X	S.S.	δ	t	p
Pretest	EG	28	69,5357	14,32036	2,70629	-1,170	,247
	CG	28	73,0357	6,73565	1,27292		
Posttest	EG	28	79,4643	5,80218	1,09651	2,709	,009
	CG	28	74,5000	7,76745	1,46791		

The results showed that there was not any difference between CG's and EG's pretests (p=0,247). However, there were significant differences between EG's and CG's posttests (p=0,09)

Computer Attitude Scale (CAS): The results of CAS Analyses are presented in Table 6 and Table 7.

Table 6. *CAS Analyses Results*

Group	CAS	N	X	S.S	δ	t	p
CG	Pretest	28	188,9643	32,95618	6,22813	0,056	,955
	Posttest	28	188,7143	22,83574	4,31555		
EG	Pretest	28	189,8571	29,18868	5,51614	-2,385	,024
	Posttest	28	198,8571	15,19921	2,87238		

The results showed that there was not any difference between CG's pretest and posttest (p=0.955), but there were significant differences between EG's pretest and posttest (p=0.024).

Table 7. *CAS Analyses Results Between Groups*

SST	Group	N	X	S.S.	δ	t	p
Pretest	EG	28	189,8571	29,18868	5,51614	,107	,915
	CG	28	188,9643	32,95618	6,22813		
Posttest	EG	28	198,8571	15,19921	2,87238	1,957	,046
	CG	28	188,7143	22,83574	4,31555		

The results showed that there was not any difference between CG's and EG's pretests (p=0,915). However, there were significant differences between EG's and CG's posttests (p=0,056)

DISCUSSION AND CONCLUSIONS

In this study, The CAE material was developed related to thermochemistry topics for 10th class science students in High School. While TM was applied to the CG, CAE was applied to the EG. It was researched CAE's affects on chemistry achievement, attitudes towards chemistry and computer. The results show that there are considerable differences at students' success, attitudes towards chemistry and computer favoring EG. According to these results, we can say that considerable differences arise from usage CAE in EG. CAE method was more useful than TM.

The results of the study were supported by many other studies (Kulik, Bangert & Williams, 1983; Roblyer, 1988; Tüysüz, 2002; Feyzioğlu, 2002; Morgil et al., 2003; Morgil et al., 2005; Ngo, 2006). In a comprehensive study of the effect of CAE in high school, students learning with CAE method showed that they have higher academic achievement by 57.2 % than students leaning with TM (Jenks & Springer, 2002). Another study, Yaakub (1998) compared CAE instruction with TM in the technical education and training in the military and civilian setting. This study stated that the students' academic success in the traditional class would have improved from 50th percentile to the 64th percentile with CAE method (Yaakub, 1998). In another study at Hacettepe University, student achievement posttest scores exposed an average increase of 12% , favoring CAE over TM. Moreover, CAE using higher level technology improves student learning and produces higher academic achievement over TM (Morgil et al. 2005).

While there are studies that support to the current study, there are also some other studies that do not support to this. Other comparative studies on student academic achievement did not show that CAE has superiority over TM. A research on the effectiveness of CAE to TM in an agricultural education revealed CAE was no more effective than TM. Student achievement scores on the demand knowledge test were essentially equal between the instructional groups. In the same study, student perceptions were assessed. And generally, students preferred learning with both CAE and traditional lecture environments (Marrison & Frick, 1993; Akpınar et al., 2005). Another similar study compared knowledge acquisition and retention between students learning with CAE and TM. The results released that EG's scores were better than CG's scores in acquisition; but, there were not statistically any differences in the means scores. The same study showed that the EG is significantly better on the knowledge retention tests than the CG (Yıldırım, Özden & Aksu, 2001).

It is believed that developing computer programs are very important, because it is very difficult for students to learn a subject or a topic which is not easy to maintain. Only the programmes that are prepared clear, understandable, useful and pedagogically good can be used effectively. Attention must be given to both individuals learning and group activities in the CAE application process, because group activities improve students' social skills.

CAE materials must be prepared by expert teachers in a planned way. Teachers must give attention to an important point; students can use CAE materials out of the class and in their free time. CAE materials must be prepared by taking into consideration the important point. Besides, it is very important if there is adequate computer at the school. There must be computer labs having adequate hardware not to encounter problems in CAE application process and one computer teacher at least in schools (Köksal &Yavuz, 1989).

The difficulty is that the teachers are insufficient at developing CAE material. Therefore, the skill of developing CAE material and practice should be brought to the teacher candidates throughout their education in the university (Artar & Aydın, 1990).

Those teachers who will develop materials and using it by CAE method must be trained by courses and be encouraged to do it.

In the course of teaching the topics and concepts in chemistry programmes, softwares that will take the students attention and keep it alive must be chosen. CAE materials must address to students' sense organs and have high interaction.

Computer becomes widespread and the benefits of it are increasing day after day. For this reason, CAE materials can be used in the internet aiming at removing time and location limitations by universities and schools.

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