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THE EFFECTS OF WEB-BASED EDUCATIONAL SOFTWARE ENRICHED BY CONCEPT MAPS ON LEARNING OF STRUCTURE AND PROPERTIES OF MATTER

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Abstract. *Current study aimed to examine the effects of web-based instructional material enriched by concept maps, the academic achievement of 7th graders in "Structure and Properties of Matter" unit. The study utilized a quasi-experimental model with pretest-posttest control group design. A sample of the study was composed of 58 students. "Structure and Properties of Matter" unit was taught to the experimental group with computer assisted teaching method, while the same unit was taught to control group by using traditional teaching methods. "Structure of Matter Achievement Test", "Science and Technology Attitude Scale" and "Computer Attitude Scale" were used as data collection tools. The results showed that web-based teaching method was more effective compared to traditional teaching methods in increasing academic achievement in science and technology classes and there is no statistically significant difference in both group attitudes towards Science and Technology Class or computers.*

Key words: *academic achievement, concept maps, computer attitude, structure of matter, science and technology attitude.*

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Introduction

Nowadays, it has been focused on understanding learning process instead of what students need to learn. It has been realized that individuals who know how to reach information and use the information instead of memorizing should be trained. At this point, while designing effective learning environments, Ausubel's meaningful learning theory helps educators (Hao, Kwok, Lau and Yu, 2010). This theory is based on the idea, that reasoning capacity of a person is mainly connected with the person's concepted framework in a specific domain of knowledge (Bretz, 2001). Ausubel defines meaningful learning as"nonarhitrary, substantive, nonverhatim incorporation of new knowledge into cognitive structure" (Novak, 1984). Cognitive structure has been developed from childhood by storing information in our minds.

For meaningful learning, the learner should make connections between new knowledge and the old one s/he already has. Unfortunately, most of the learners learn in a rote manner, in which learning new information put into the cognitive structure by an arbitrary way (Novak, 1984). Ausubel identifies rote learning as incorporating new information into the cognitive structure without structuring and meaningful learning as integrating new information with the knowledge already the learner has (Novak, 2002). Novak (2002) expresses that depending on a strong emphasis on rote memorizing and recalling of answers of test questions, most of the students tend to rote learning at schools. In meaningful learning theory, the new information should be meaningful for the learner. According to Ares and Gorrell (2002), "meaningfulness" involves the learning substantive in content and useful in the future and connected to the real world. Ausubel's theory is very useful because of the simplicity in key concepts and relativity in terms of school learning (Novak, 1984).

According to Williams and Cavallo (1995), meaningful learning is forming viable relationships between ideas, concepts and information. Students with meaningful learning orientation, try to make connections between concepts instead of memorizing the given information. Ausubel supports the view that teaching is not only giving guidance, but also creating learning situations for

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students in which they achieve intended learning outcomes (Ango, 2002). According to Ausubel's Theory, people learn by summarizing, relating, and organizing concepts into their cognitive structures and concept maps are developed based on this theory (Wang, Cheung, Lee and Kwok, 2008). Concept maps can be identified as graphical tools for organizing and representing knowledge (Novak and Cañas,2006; Hilbert and Renkl, 2009). On these maps concepts written in circles or boxes and their relationships are displayed by some connecting lines. Novak and Cañas (2006) summarize the characteristics of the concept maps as given below:

- The concepts are given in a hierarchical way from most general to less.
- Concept maps are constructed around a focus question.
- There are cross-links between the concepts to make the relationships between them clearer.

Akisanya and Williams (2004) explain that concept maps help us to bring the already known information together and support integrating new information to the existing one and expand our understanding. Nousianinen (2012) explains that concept maps visualise the connections between concepts and they can be used to see the structure of knowledge in a subject.

Edmondson and Smith (1998) express that concept maps can be effective in fostering meaningful learning. In their study, they search for the effect of using concept maps on students' understanding of fluid and electrolyte disorders. Their findings reveal that concept maps facilitate students' learning. Odom and Kelly (2001), search the effectiveness of concept mapping on understanding of diffusion and osmosis in biology classes. The results of the study reveal that the concept mapping/learning cycle and concept mapping treatment method effect students' learning of the concepts positively. Guastello, Beasley and Sinatra (2000) revealed that active participation in constructing concept maps helps students while forming cognitive schemas and assimilating new information. Similarly, Sungur, Tekkaya and Geban (2001) investigate the contribution of conceptual change texts accompanied by concept mapping instruction to 10th- grade students' understanding of the human circulatory system. The findings of the study revealed that the instruction method affected the students' understanding of the mentioned concepts positively. Wang and others (2008) explained that concept maps visualize one's inner cognitive structures and people need to identify, classify, analyze and clarify relationships between concepts in these maps. Charsky and Wessler (2011) advocate, that concept maps display the creator's conceptual organization and interpretation of the subject and they identify the benefits of the concept maps as given below:

I. Concept maps help students to identify the concepts and their relationships.
II. They encourage students to show their learning.
III. They give students a chance to revise their learning.

According to Daley, Canas and Stark-Schwitzer (2007), concept maps can be used for increasing conceptual learning, critical thinking, analysis and synthesis. Concept maps can be used in different disciplines and for different purposes. For example, Liu and others (2011) investigate the effect of the concept map approach on students' storytelling ability. The results demonstrate that the concept map and story grammars can develop students' storytelling ability and correct grammar usage. Kamble and Tembe (2013) investigate the effect of concept mapping strategy on students' problem solving ability. The results reveal that the students taught by concept mapping strategy have higher performance while solving well structured problems and they express that concept maps are helpful while identifying, understanding and connecting various concepts. Huang and others (2012) investigated the effect of multidimensional concept mapping instruction on students' learning in a web based computer course and the results displayed, that multidimensional concept map group performed significantly better than traditional textbook group. Furthermore, concept maps are used for developing nursing students' critical thinking ability (Senita, 2008). Senita (2008) mentions, that nursing students need to apply the theoretical knowledge to real patient situations. They need to see the big picture in a short time, for this reason they should see the relationships between the medical history, current situation, treatment and complications.

Various studies in the literature also report that the use of concept maps in education has positive effects on academic achievement of students. For instance, Hwang, Wu and Ke (2011) investigated the effect of an interactive concept map-oriented approach for supporting mobile learning activities of elementary school students in a natural science course. The results of the study demonstrated, that the mentioned approach both enhanced students' learning attitudes and improved their achievement. Similarly, Jedege, Alaiyemola and Okebukola (1990) revealed, that concept mapping is significantly more effective than the traditional teaching strategy and it increases learning in biology.

Today, it is inevitable using technology in learning environments designed for meaningful learning. One of the greatest benefits of using computers in education is individualizing learning (Öztürk, Duru, Özler and Harmandar, 2008). In the literature, the effect of technology assisted learning environments on students learning and some related concepts (attitudes and motivation) has been searched and its positive effect has been revealed by findings (Horzum and Güngören, 2012; Lin, 2006; Min-Hsiung, Jeng-Fung and Quo-Cheng, 2011; Chin-Fei and Chia-Ju, 2012). Tuysuz, Akcay and Aydın (2005) claim, that web based instruction provides a learning environment without time limitations and affects positively students' learning. Similar to our findings, Bintaş and Barut (2008) investigated web based educational applications of Turbo Pascal Lesson on students' success and compared the achievement level of these students with the success of students taught by traditional method. The results of the study displayed that web based instruction had a significant effect on student success. In their study; Sun, Lin and Yu (2008) compared the achievement level of students taught by traditional classroom instruction with the achievement level of students taught by web based virtual lab instruction. The results of the study demonstrated, that students using the web based virtual lab achieved better grades than those in the control group under traditional class instruction. Dori and Barak (2003) investigated the effect of a web based project on students' learning outcomes and compared those outcomes with the outcomes of students taught by traditional lecture format in general chemistry class. The results displayed that students in the experimental group received significantly higher scores than the students in the control group. Erdoğan, Bayram and Deniz (2008) in their study revealed that web-based education has a positive effect on the improvement of academic education.

With the rapid advancement of computer technology, some concept map softwares have been prepared too. In several studies, the effect of computer-aided concept maps on students' achievement has been investigated. For example, in their study, Kwon and Cifuentes (2009) investigate comparative effects of individually constructed and collaboratively constructed computer based concept mapping on students' science learning. The results of the study display that both collaborative and individually-constructing a computer based concept mapping had a positive effect on students' science learning. Mavers, Somekh and Restorick (2002) in their study mention about an image based concept mapping method in ImpacT2 and its effect on students' learning. The results of the study reveal, that the samples have complex cognitive representations of networked Technologies and they have fun while using ImpacT2. Hung and others (2012) develop a concept map-integrated mobile learning design for ecology observation and examined the implementation effect for elementary school students. The results of the study displayed that the concept map-integrated learning system enhanced students''mobile observation competence.

Aim of the Research

The study aims to investigate the effects of web assisted instructional material enriched by concept maps on the academic achievement in "Structure and Properties of Matter" unit, science and technology attitudes and computer attitudes of 7th graders. On the basis of this aim, the following research questions are prepared:

1. Does the instructional material make significant differences in students' academic achievement in "Structure and Properties of Matter" unit?
2. Does the instructional material make significant differences in students' attitudes towards science and technology?
3. Does the instructional material make significant differences in students' attitudes towards computers?

Methodology of Research

Model of Research

The utilized research model was "Pretest-Posttest Control Group Quasi Experimental Design". In pretest-posttest control group quasi experimental design, one of the two groups selected by random sampling is assigned as the experimental group while the other is used as the control group. Selected experimental and control groups have implemented some pre and post experimental procedures (Gall et al., 1996).

Sample Selection

A sample of the study consisted of 58 students (29 in the experimental group and 29 in the control group) attending a state secondary school in Kahramanmaraş during 2012-2013 academic year.

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Application

In this context, a state secondary school in Kahramanmaraş was visited in the second semester of 2012-2013 academic year before the unit "Structure and Properties of Matter" was not studied in 7th grade Science and Technology Classes and 2 classes were randomly selected. One of these classes was assigned as the experimental group and the other was used as the control group. Instructional software "Science and Technology House" was used to teach experimental group while the unit "Structure and Properties of Matter" was taught by following the textbook (Turkish Ministry of National Education, 2012) for four weeks during the study which utilized pretest-posttest control group design. Instructional software was uploaded on computers and hardware related problems were resolved. After the implementation of pre-tests, the computer lab for the experimental group was organized in a manner that would allow each student to have a personal computer, education materials were uploaded and each computer was equipped with a headphone to allow listening to the sounds that the materials included. One week after the completion of the pre-tests, experimental group students were taken to the computer lab to learn with the help of the "Science and Technology House" instructional software. Students were given the necessary information about the use of the software. Students in the experimental and control groups were given "Structure of Matter Achievement Test", "Science and Technology Attitude Scale" and "Computer Attitude Scale" as pre-test and post-test. The implementation continued for four weeks and arrangements were done to prevent any problems that could hamper the study. Table 1 presents the experimental design of the study.

Table 1. Experimental design of the study.

GROUP	Pre Implementation	Implementation Method	Period	Post Implementation
Experimental	SMT CAS SAS	Computer Assisted Teaching Method Enriched by Concept Maps Based on Meaningful Learning Theory	4 weeks	SMT CAS SAS
Control	SMT CAS SAS	Traditional Lecture Method	4 weeks	SMT CAS SAS

Technical Properties of Instructional Material

Web-based instructional material was prepared to remove barriers during the teaching process since subjects in science and technology lessons were difficult for students to comprehend and traditional teaching methods were not highly effective. This material was called "Science and Technology House" (Figure 1).

Figure 1: General appearance of science and technology house.

Multimedia principles were followed in Science and Technology House Software and audio and visual instructions were used. Colors, symbols and educational agent, that were thought to arouse students' interest, were preferred in the software. Subjects in the software progressed from simple to complex so that different individual characteristics of the students can be addressed.

Figure 2: Subject list.

Subjects were listed according to Science and Technology Teaching Program (Turkish Ministry of National Education, 2005). Students using the software come across the elements, the structure of the atom, atom models, electron configuration, chemical bonds, compounds and mixtures. The software includes activities and assessment for each subject listed. The appropriateness of the software for student level and the teaching program was ensured by the views of 2 instructors in the field and 3 teachers. The suitability of the software in terms of use and technical characteristics was ensured by an instructor employed in Computer Education and Instructional Technologies Department. During 32-hour instruction, the classes were divided into two-hour periods and the researcher asked probing questions at the beginning of each new subject to determine students' prior knowledge. In this phase, students were shown the concept map of the subject by the researcher. Following this phase, the students were asked to use their headphones distributed earlier and follow the instructions in the software to complete the related activities. After this phase was over, the subject was summarized by the researcher and the students were asked to fill in the concept maps regarding the concepts just learned. In the case of errors in the concept maps, they were asked to study using the software and correct their mistakes. After finishing the assessment questions, new subjects were taught in the order they were displayed and all classes were taught in this manner in the experimental group.

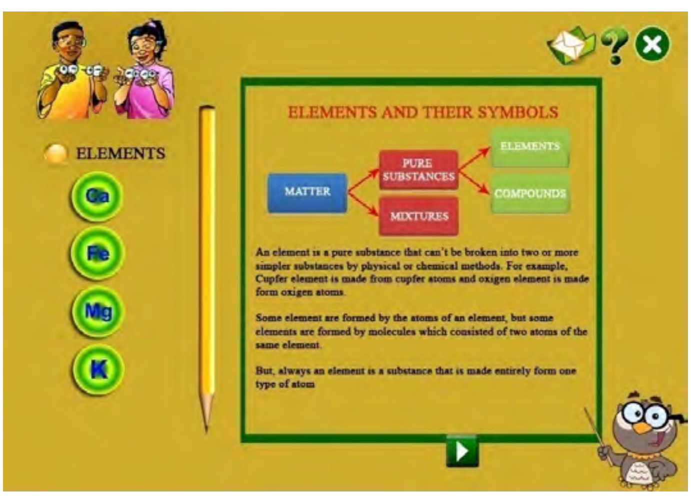

Figure 3a: Example of a concept map.

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Figure 3b: Example of a concept map.

Data Collection Tools

Science and Technology Attitude Scale

"Science and Technology Attitude Scale" was used to identify the attitudes of students participating in the study towards science and technology. The scale was developed by Geban et. al. (1994). The renewed reliability and validity work provided the Cronbach Alpha coefficient as 0,83. Science and Technology Attitude Scale is composed of 15 statements of attitude, 10 of which are positive and 5 are negative. The highest score that can be obtained from the scale is 75 and the lowest possible score is 15. It is a five point likert type scale and for positive statements as "completely agree=5, agree=4, undecided=3, disagree=2 and completely disagree=1). Negative statements were coded in reverse. Reliability analysis was undertaken according to the data obtained from the scale and Cronbach Alpha coefficient was calculated to be 0.871.

Examples of items

1. Science and technology is a field that I like.
2. I like reading books related to science and technology.
3. Science and technology are not important in daily life.

Computer Attitude Scale

Computer Attitude Scale, whose reliability and validity studies were done by Yüksel (2010), was used in the study to assess students' attitudes towards computers. The scale which consisted of a total of 107 questions at the beginning of the scale development phase was later reduced to 67 questions by eliminating 7 questions as a result of expert review and 33 questions based on total item correlation. The final format of the scale included 28 questions after the factor analyses. Cronbach Alpha coefficient of the total scale was 0.902. Alpha coefficient for CA-B dimension (Benefits of Computers) was found as 0.839; for CA-A dimension (Anxiety towards Computer Use) it was 0.875 and for CA-SC dimension (Self Confidence in Computer Use) it was 0.884. In the current study, reliability analysis was undertaken based on the data obtained from computer attitude scale and Cronbach Alpha coefficient was calculated to be 0.887. The scale is a 5-point Likert scale with a total of 28 (11 negative and 17 positive) statements. The positive statements were scored as "completely agree=1, agree=2, undecided=3, disagree=4 and completely disagree=5". Negative statements were scored in reverse code as seen in the following: "completely agree=5, agree=4, undecided=3, disagree=2 and completely disagree=1". According to the scoring, computer attitude close to 1 displays high attitude, whereas computer attitude close to 5 shows low attitude.

Examples of items

1. Computer is just like a best friend.
2. Computer saves me being boring.
3. Everyone should learn to use computer.

Structure of Matter Achievement Test

Achievement Test was prepared by the researchers to evaluate how well the students understood the concepts in "Structure and Properties of Matter" unit and how they internalized the concepts after the experimental and control groups were taught with the help of computer assisted method and traditional method respectively. The Test was used in the framework of the study, according to expert views in line with the goals of the unit. The test was implemented on both experimental and control groups as pre and post-test before and after the unit was studied in the second semester of 2012-2013 academic year. Before students were given the test, they were informed about the test and necessary adjustments were made. The test consisted of 25 multiple choice items and each correct answer was given 4 points, whereas incorrect answers received 0 points. The highest test score that students get 4x25=100. Examples of test items are given in Appendix 1.

27% segments from upper (N=31) and lower groups (N=31) were selected for item difficulty and item discrimination analyses of the test. Item difficulty analysis was calculated for each item and it was decided that the obtained values were suitable for an ideal test. For an ideal test, item difficulty index of the items in the test should be between 0.20 and 0.80 and the item difficulty index means of the whole test is expected to be above 0.50. Item difficulty values for the items in the academic achievement test were calculated to change between 0.26 and 0.84 and the item difficulty value for the whole test was 0.54. Values display that item difficulty of the test is sufficient.

The discriminatory values of the test items are above 0.30 (D = 0.50). Accordingly, it was decided that item discrimination of the test was ideal. KR-20 analysis was implemented for reliability analysis and the value was calculated to be 0.810 for the 25-item test.

Results of Research

The data, obtained from pre-post test results of experimental and control groups, are analyzed and the following findings were obtained. SMT, CA and SA prê-test scores of the experimental and control group students were compared by using independent samples t-test and the findings are provided in Table 2.

Table 2. Comparison of Experimental and Control Groups' pre-test scores.

		Academic Achievement		Attitudes Towards Science		Attitudes Towards Computers	
Group	N	M	SD	M	SD	M	SD
Experimental	29	41.10	11.21	60.52	10.41	2.25	0.55
Control	29	37.66	6.97	63.93	7.36	2.44	0.58

Examination of Table 2 shows a significant difference between the pre-test SMT scores of experimental and control group students in favor of the experimental group ($t(56) = 1.407$; $p = 0.165 > 0.05$). This result shows that academic achievements of experimental and control group students regarding the subject of implementation before the study were not the same. As can be seen in Table 4, there was not a significant difference between the pre-test CA mean score of the experimental group (M = 2.25) and pre-test CA mean score of the control group (M = 2.44) [t (56) = 1.279; p = 0.206 > 0.05]. In the same vein, there was not a significant difference between the pre-test SA mean score of the experimental group (M = 60.52) and pre-test SA mean score of the control group (M = 63.93) [t (56) = 1.442; p = 0.155 > 0.05].

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SMT, CA and SA post-test scores of the experimental and control group students were compared with the help of independent samples t-test and the findings are provided in Table 3.

Table 3. Comparison of Experimental and Control Groups' post-test scores.

		Academic Achievement		Attitudes Towards Science		Attitudes Towards Computers	
Group	N	M	SD	M	SD	M	SD
Experimental	29	78.07	8.98	63.66	7.62	2.48	0.50
Control	29	49.52	15.51	63.28	8.94	2.45	0.59

Independent samples t-test results displayed that post-test AAT mean scores of the experimental group (M = 78.07) were higher than those of the control group (M = 49.52) and that the difference was significant [t (56) = 8.58; $p = 0.000 < 0.01$].

No meaningful differences were detected between the post-test SA mean scores of the experimental group (M = 63.66) and post-test SA mean scores of the control group (M = 63.28) [t (56) = 0.174; $p = 0.863 > 0.05$].

No meaningful differences were detected between the post-test CA mean scores of the experimental group (M = 2.48) post-test CA mean scores of the control group (M = 2.45) [t (56) = 0.181; $p = 0.857 > 0.05$].

Paired samples t-test was undertaken to identify whether there were significant differences among the SMT, CA and SA pre and post-test scores of the experimental group and findings are provided in Table 4.

Table 4. Comparison of pre and post- test scores of experimental group.

		Academic Achievement		Attitudes Towards Science		Attitudes Towards Computers	
Group	N	M	SD	M	SD	M	SD
Pre-test	29	41.10	11.21	60.52	10.41	2.25	0.55
Post-test	29	78.07	8.98	63.66	7.62	2.48	0.50

As shown in Table 4, there is a significant difference between the SMT mean scores of the experimental group (M = 78.07) after being taught with the help of computer assisted instructional method prepared through content enrichment by concept maps based on meaningful learning and their AAT scores before the implementation (M = 41.10) in favor of the post-test results [t (28) = 14.83; $p = 0.000 < 0.01$]. The study also checked whether statistically meaningful differences existed between experimental and control groups' post-test achievement scores when pre-test achievement scores were controlled and covariance analysis (ANCOVA) was implemented on data. Findings are presented in Table 5.

Table 5. ANCOVA analysis results when pre-test scores are controlled*.

Source of Data	MS	df	F	p
Model	12791,961	4	21.130	0.000
SM**	765,560	1	5.058	0.029
SA**	58,569	1	0.387	0.537
CA**	132,616	1	0.876	0.353
Group	9565,426	1	63.201	0.000
Error	8021,556	53		

** R^2= 0.615 ** Controlled Variables*

According to Table 5, the model implemented in ANCOVA analysis is meaningful (p = 0,000 for the model) and the model explains 62% of conceptual achievement ($R^2 = 0.61$) in 'Structure of the Matter' unit. Table 5 shows that the implemented software had meaningful impact on experimental group students' academic achievement when the pre-test scores of groups were controlled ($p = 0.000 < 0.01$).

Discussion

The findings of the study show that the academic achievement of the experimental group in "Structure and Characteristics of the Matter" unit was higher than that of control group as a result of web-based implementations (Table 3 and Table 5). It is thought that there are mainly three reasons of the difference between the achievement of the groups in the mentioned unit. The first reason is that the web assisted applications provide learning environments suitable for the individual's learning speed and limitless replay option. Each individual's learning speed is different. In learning environments in which traditional teaching methods are applied, instead of each of the students' individual learning speed the class average speed of learning is taken into account. Since information is hierarchically ranked, individual learning speed is very important in learning. A disconnection in hierarchical rank will harm learning. Another problem faced during the lesson, because of humiliation or fear of being ridiculed. Students avoid asking the teacher to repeat when they can't understand. Web assisted applications eliminate this problem. Students are proceeding according to their own learning speed and they can make several repeats when they have difficulty while learning.

In addition, rich audio-visual content of web-based applications also has a positive impact on learning. In the study, the rich audio-visual content of the software is thought to be one of the reasons for increase in experimental group students' achievement. In learning environments, parallel to appealing many senses, students' learning increases. Students' positive attitudes towards the use of computers and related technologies and their predisposition is thought to increase the learning. Today, students spend an important time by using computers and similar technologies in their daily lives. Therefore, they have a predisposition against the use of this technology. This predisposition is thought to be one of the reasons of the increase of students' success in the experimental group.

The other reason is that the instructional material is prepared by considering meaningful learning theory. Current study aimed to enable meaningful learning for students and have them active in classes instead of learning clichéd positions in science and technology classes through rote learning methods. The instructional material used in the study was designed with this aim in mind. It will be possible for students to check their prior knowledge with the help of concept maps in the instructional software and it will be easier for them to mentally associate the visual elements with the correct models with the help of the prior knowledge. Similarly, the learning process in classroom will not be limited to the short period allocated to the lesson and the students will be able to use the material when needed. The fact, that students will be able to repeat and do exercises whenever they want to, will help them be active in the learning process and will increase the permanence of the information learned during the study.

The fact that subjects in science and technology classes are abstract in nature causes misconceptions and students simply memorize these concepts without any meaningful learning. The existence of concept maps in the instructional material prepared for the study allowed the students to visualize the subjects holistically and the students were able to generate meaningful learning by associating their prior knowledge and the new concepts. Mentally replacing the abstract concepts with visual schemas allowed basic concepts to be learned correctly and it is believed that it helped prevent the formation of misconceptions regarding the other concepts related to the subject studied in class. Use of the instructional materials, both in and out of the classroom, according to individual paces of the students, created a richer learning environment and limitations based on time and space were eliminated with the help of repetitions and practices that the material offered. It is believed, that all these factors cited above contributed to student learning.

Since the concept maps in the instructional material were prepared according to meaningful learning theory, and since they allowed the use of prior knowledge, they generated more impact compared to traditional method. One of the reasons why the achievements of the students in the experimental group are higher than the control group students' is making connections with prior knowledge of students in the applications of the software. According to the constructivist approach, the prior knowledge of students should be linked to new information. While associating new information with the prior knowledge, the knowledge is constructed by the student and it is easier to learn. Moreover, since concept maps revealed the connections between information units clearly, they make learning easier.

The findings of the current study demonstrate no significant differences between experimental and control

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group students' post-test SA and CA scores (Table 3). In other words, the methods used for these groups did not affect them in such a degree to allow changes in their attitudes towards science and computers. Since, attitudes are emotional components and may require a longer time to change. The fact that attitudes towards science and computers did not change in the current study may be related to the short period of implementation.

Conclusions

Rapidly advancing technology is effective in every field of students' lives. Due to the age of technology in which they were born, students have more positive attitudes towards technology compared to the previous generation before them. Therefore, web-based materials prepared especially in subjects that the students have comprehension problems, will facilitate student learning. Use of additional instructional materials by the teacher during the learning-teaching process will help increase students' cognitive and affective qualities and unexpected in-class performances will be prevented.

In the traditional approach, students, who are good at the subject or hardworking, are expected to be active during class and lessons are usually taught to these students. The instructional material which aims to remove this situation, undesirable in modern approaches, will help each student to have a grasp of the subject and actively participate during class. With the known fact that students are interested in using computers, each student will try to use the material and will be motivated to do the related activities. The instructional material will reach the target audience with the help of student interest and desire and will increase the limited active participation to a great extent. The instructional material will not only increase student performance, but will facilitate classroom management by providing great benefits to teachers.

It is imperative to allow the development of the cognitive structure of each student by using new teaching methods and techniques that take individual differences into account. The fact, that instructional material used in the current study increased academic achievement and contributed to the development of each student, supports the belief that such instructional software should be included in the teaching curriculum.

Computer skills of teachers and students should be developed so that both teachers and students can effectively use the computer assisted instructional materials in the teaching-learning process. Also, support should be provided to create, develop and increase the computer labs equipped to facilitate this process. In synch with the rapidly advancing technology, computer labs should be redesigned to increase productivity in education and this process should be deliberately followed to ensure maximum success.

Concept maps should be used in classes so that students can associate prior knowledge with new concepts while studying a new unit and continuance of information should be ensured. Development of students' mental skills should be made a priority with the use of concept maps.

Without being dependent on any single teaching method, teachers should use instructional materials that address multiple intelligences with audio and visual elements based on the idea, that each student has different dominant intelligence modalities. In order for the instructional materials to carry the desired quality in this process, teacher-student interaction should be provided and classroom environment should be rearranged to generate desired conditions.

Concept map technique, that was used in "Structure and Properties of Matter" unit, should be utilized in other Science and technology units in order to expand the framework of the study. In addition, studies undertaken with different teaching methods and techniques in science and technology classes should be investigated and compared.

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Appendix 1: Examples of Test Items

4.

Hülya creates the model given above that belongs to oxigen element. Which of the information given below is not necessary for by Hulya while creating this model? (Option C is not necessary)

a) Protons and neutrons stay together in nucleus.
b) Electrons stay on orbits.
c) The mass of protons and neutrons' are close to each other.
d) Electrons can be at different distances from the nucleus.

10. Which of the charts that display atomic particles and their numbers can belong to a cation?

20. X: It is a heterogeneous matter that cinsists of different atoms.
Y: It is a homogeneous matter that shows the characteristics of its' components.
Z: It is a matter that contains different atoms but the same molecules.

What are these matters?

X	Y	Z
Salty water	Iron	Water
Ayran	Water	Tin
Milk	Salty water	Salt
Salt	Sherbet	Water

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