Eğitim ve Bilim
2013, Cilt 38, Sayı 167

Education and Science
2013, Vol. 38, No 167

An Investigation on Web Designed Alternative Measurement and Assessment Approach

Web Deseni Üzerine Alternatif Ölçme ve Değerlendirme Yaklaşımı Araştırması

Erol TAŞ*
Ondokuz Mayıs University

Murat ÇETİNKAYA**
Ordu University

Çiğdem KARAKAYA***
Ondokuz Mayıs University

Zeki APAYDIN****
Ondokuz Mayıs University

Abstract

The purpose of the present study has been to explore the effect on students of an alternative measurement and assessment tool developed for the science unit on "Matter and Heat." Inspired by the teaching technique of concept development and the alternative measurement tool of the descriptive branched tree, an alternative measurement tool of web design was developed to conduct experimental research with 62 students at a primary school in Samsun. Results showed that, compared to the control group students who were instructed with traditional teaching approaches, the experimental group students who were tested with the web-based measurement tool recorded a statistically significant difference in achievement in the unit on "Matter and Heat." No significant difference, however, was observed in these students' attitudes toward the science and technology lessons. It is believed that developing an alternative measurement tool of web design encompassing all of the units of the 6th, 7th and 8th grade science and technology curriculum will be of benefit to students and will make an important contribution to the work of teachers.

Keywords: Web designed measurement and assessment, matter and heat, achievement, attitude.

Öz

Bu çalışmanın amacı, "Madde ve Isı" ünitesi için geliştirilen bir alternatif ölçme ve değerlendirme aracını tanıtmak ve öğrenciler üzerindeki etkinliğini araştırmaktır. Öğretim tekniklerinden görüş geliştirme ve alternatif ölçme araçlarından tanılayıcı dallanmış ağaçtan esinlenerek geliştirilen web tasarımlı alternatif ölçme aracı, deneysel bir araştırma yaklaşımıyla Samsun merkezde yer alan bir ilköğretim okulunda 62 öğrencinin katılımıyla gerçekleştirilmiştir.

* Yrd. Doç. Dr. Erol TAŞ, Ondokuz Mayıs University, Educational Faculty, Department of Primary Education, eroltas@omu.edu.tr

** Öğr. Gör. Murat ÇETİNKAYA, Ordu University, Ünye Vocational School, Department of Computer, mcetinkaya@odu.edu..tr

*** Arş. Gör. Çiğdem KARAKAYA, Ondokuz Mayıs University, Educational Faculty, Department of Primary Education, ckarakaya@omu.edu.tr

**** Yrd. Doç. Dr. Zeki APAYDIN, Ondokuz Mayıs University, Educational Faculty, Department of Primary Education, zapaydin@omu.edu.tr

Sonuç olarak, hazırlanmış olan web tasarımlı ölçme aracının kullanıldığı deney grubu öğrencilerinin başarılarında, geleneksel öğretim yaklaşımının kullanıldığı kontrol grubu öğrencilerine göre istatistiksel olarak anlamlı bir değişikliğin olduğu görülmüştür. Buna karşın, öğrencilerin fen ve teknoloji dersine yönelik tutumlarında ise anlamlı bir farklılık gözlenmemiştir. Web tasarımlı alternatif ölçme aracının 6, 7 ve 8. sınıf fen ve teknoloji müfredatının tüm ünitelerini kapsayacak şekilde geliştirilmesinin hem öğrencilere hem de öğretmenlere önemli katkılar sağlayacağı düşünülmektedir.

Anahtar Sözcükler: Web tasarımlı ölçme ve değerlendirme, madde ve ısı, başarı, tutum.

Introduction

The needs of contemporary education are changing in response to the population and information explosion, the increasing value placed on socioeconomic relations, the impact of scientific and technological evolution on education and the community, and the relationship between education and social demands (Alkan, 2011). The developments in these areas in recent years have enhanced the need for a contemporary educational system and accordingly, changes have been made in programs of education around the world. It is known that science and technology education is a severe competition on an international scale. Continuous efforts are spent to increase learning (Karip, 2005). Among the most important factors having an impact on learning are school curricula. Science and Technology curriculum encompass the main written reference materials that are used by the teacher and the student during the teaching of the lessons in a particular unit (Taş, 2006).

Efforts to develop high-quality teaching programs are the subject of many important studies both in Turkey and around the world. There is a very close relationship between learning theories that explore how learning takes place and actual school programs. Curriculum preparation relies on adopting the basic philosophy of one or more learning theory (Taş, Apaydın, & Çetinkaya, 2011). The science and technology syllabus in the textbook approved by the Ministry of National Education was prepared on the basis of the fundamental philosophy of the constructivist learning theory (Çepni, 2006).

The constructivist learning theory, developed through the contributions of scientists such as Bruner, Piaget, Ausubel and Vygotsky, became one of the basic learning theories adopted in school programs in many countries as from the 1980s (Fensham, 1992). This interest has instigated the need for change in Turkey as well (Bayrak & Erden, 2007). Turkey adopted the constructivist learning theory in 2004, after which current educational programs were modified. Thus, Turkey joined the rest of the world in this global change.

The constructivist learning theory is based on a concept of learning whereby an individual learns by constructing knowledge in the mind. This mental construction requires the integration of old and new knowledge (Glasersfeld, 1995). The science and technology teaching program created in the light of this theory is based on the assumptions that learning does not rely on direct transfer of knowledge but that it is affected by already existing knowledge, that the student internalizes the information, needing to rearrange present concepts in the mind, ultimately trying to make sense out of the world by either accommodating or rejecting this information. At the same time, the program accepts that individual differences, effective participation of the student, peer interaction and communication are vital parts of learning (MEB, 2006). As can be understood from these assumptions, guided by the framework of constructivism, many other learning theories also have an impact on the program. In other words, the assumptions make it clear that the constructivist learning theory is related to other theories. For example, how constructivist learning theory is related to the multiple intelligences theory can be seen in its consideration of different types of student and therefore of individual differences, its project-based learning approach, its emphasis on learning by experience, on producing something from what has been learned, and its defense of active participation (Özmen, 2006).

Instead of the result-based uniform traditional approaches to measurement and assessment, alternative measurement and assessment techniques that are process-based, that take into consideration individual differences in learning and that are in line with the constructivist learning theory are recommended for measurement and assessment processes in the Science and Technology program (Çepni, 2006). Examples of such techniques are projects, student product portfolios, concept maps, descriptive branched trees, and performance evaluation (MEB, 2006). In a study conducted by Sağlam-Arslan, Devecioğlu-Kaynakçı and Arslan (2009), it was reported that science and technology teachers did not use alternative measurement and assessment techniques such as the descriptive branched tree and concept development.

The descriptive branched tree technique is a technique that can be useful when questions on the same subject must be asked in progression. The technique is conducive to uncovering misconceptions that have settled in the student's mind (Yaman, Karamustafaoğlu, & Karamustafaoğlu, 2005). This aspect of the technique is believed to be of high value to the teacher in helping to receive process-focused feedback or in making a status evaluation. Besides, the materials and the technique itself can also be used as learning material in measuring learning processes. With all of these characteristics, the descriptive branched tree is in keeping with modern conceptual change theories. In conceptual change theories, conceptual changes, particularly in the case of theoretical concepts, occur slowly, in evolutionary fashion (Limón & Mason, 2002). Accordingly, to achieve a desired conceptual change and induce meaningful learning, the progressive relationship between context and activity diversity and concepts should be taken into consideration in learning processes (diSessa, 1988; diSessa, 1993).

The Science and Technology Teaching Program, prepared primarily under the influence of the constructivist learning theory and benefiting as well from other related theories, seeks not to create behavioral changes in students but to offer them the opportunity to gain knowledge and skills (Özmen, 2006). In line with these gains, new methods have been suggested for the learning and teaching processes of the program in order to focus on the student and ensure his/her active participation. One of these methods is the concept development technique. This is a technique in which students are asked to explain their concept of certain statements presented in progression in order of difficulty, to which they can answer as "I agree" or "I don't agree."They are later asked to respond to a new proposition and then observed to find out whether their concepts have changed. In general, the concept development technique is applied to the whole class and students first express themselves. Later, however, they may either continue to defend their concept or make a change depending upon the concepts accepted by their peers (Taş, 2011). It can be said that concept development is a technique in which the student experiences the full process of first expressing a view and then, in the face of a new concept that is presented, of reviewing, thinking in depth, and then either accepting or rejecting the statement.

According to the constructivist learning theory, the most important element of both teaching-learning processes and evaluation methods is the implementer of the school program—that is, the teacher. In the modified program, the role of the teacher has been determined not as a transmitter of knowledge but as a guide who directs students and creates the appropriate environment in which they can gain knowledge and skills by themselves. With the change that was made in the program, studies began to be conducted in order to probe into teachers' attitudes, viewpoints and interest toward the new techniques. It is known that teachers who have spent many years implementing traditional methods of measurement and assessment have difficulty in changing their accustomed conceptions (Lock & Munby, 2000; Sağlam - Arslan et al., 2009). Studies show that teachers are still in the process of adopting and implementing alternative measurement and assessment techniques (Bayrak & Erden, 2007; Çoruhlu-Şenel, Nas, & Çepni, 2008; Çoruhlu-Şenel & Nas, 2009; Gömleksiz & Bulut, 2007; Sağlam-Arslan et al., 2009). Although it is seen that teachers think positively about the functionality of new measurement and assessment techniques, they are still confronted with various problems in the implementation (Çakır & Çimer, 2007; Çoruhlu-Şenel, et al., 2008; Erdal, 2007; Metin & Özmen, 2010; Sağlam-Arslan et al., 2009).

There are many studies that point out that teachers find themselves deficient and inadequate in assessment techniques (Çoruhlu-Şenel et al., 2008; Çoruhlu-Şenel & Nas, 2009; Gelbal & Kelecioğlu, 2007; Metin & Özmen, 2010; Özsevgeç, 2007; Sağlam-Arslan et al., 2009; Şenel, 2008). It is reported that teachers come up against problems in using measurement and assessment methods. Some of the problems teachers cite as the most difficult to overcome are crowded classrooms, lack of time, and the preparation needed to work with measurement and assessment tools (Çoruhlu-Şenel & Nas, 2009; Gelbal & Kelecioğlu, 2007; Sağlam-Arslan et al., 2009). It is asserted that some of the fundamental factors that have an adverse impact on the implementation of alternative measurement and assessment methods are not enough time, over-populated classrooms and not enough accessible information about these methods (Sağlam-Arslan et al., 2009). Teachers who point to the time factor refer to the impossibility of reviewing the work of all the students in the classroom in a single class hour and that under present circumstances, the work of only one or two students can be read out to the rest of the class (Çoruhlu-Şenel & Nas, 2009; Gelbal & Kelecioğlu, 2007).

It is important that contemporary technology is included in the content of the revised science and technology program, which has been modified in an attempt to cater to contemporary approaches and technological advances. It was because a technological dimension was added to the curriculum, which was offered under the name of "Science" before 2004, that its name was changed to "Science and Technology" (MEB, 2006). The close connection between science subjects and technology as well as the fact that the curriculum was renamed to include technology in the program has increased the importance placed on using technology in teaching. Researchers have affirmed that there is a positive relation between constructivist learning theory and technology (Burns, Heath and Dimock, 1998; Taş et al, 2011). Besides the structure of the science and technology program, the importance of the use of technology in teaching the units in the curriculum has been emphasized. Researchers have suggested the use of web-supported teaching to increase productivity in science education and to ensure meaningful learning (Amadieu, Tricot, & Mariné, 2010; Baki & Mandacı-Şahin, 2004; Chuang & Tsai, 2005; Çepni, Taş, & Köse, 2003; Erginer & Dursun, 2009; Gabbard, 2000; Gedizgil & Deryakulu, 2008; Simone, Schmid, & McEwen, 2001; Taş et al., 2011, Tas, 2011; Wen, Tsai, Lin, & Chuang, 2004). Because technology is useful in setting up lines of communication between teacher, student and parent and in increasing teaching and learning competence and effectiveness (Wager, 1997), it is a valuable teaching aid.

In the light of the fact that technology is of significant help to the teacher, and considering that teachers experience problems in using alternative assessment methods, it can be suggested that the work of teachers can be facilitated by Web-supported alternative assessment techniques. Again, it is believed that the positive impact that technology has on teaching and learning will contribute to this facilitation. It was to explore these thoughts that Web-supported assessment materials were designed for this study, through the inspiration provided by the concept development method recommended by constructivist theory for teaching and learning processes and the alternative technique of the descriptive branched tree which the same theory recommends as a means of measurement and assessment.

It was decided that the Web-supported measurement materials that were expected to have a positive effect on student achievement would be designed, implemented and their effects evaluated, in the 6th-grade science and technology unit on "Matter and Heat" that was to be covered over the period of the study. The present work is a report of the experiment conducted with the materials developed in line with constructivist theory, one of the cognitive learning theories and of the results attained.

Method

Science and technology curriculum for sixth grade students has a unit called "Matter and Heat" which has a lot of abstract and difficult understandable concepts due to content

characteristics (Taş et al., 2011). For constructing better understandings in this unit, a web-supported material has been developed. This measurement and assessment material that was inspired by the concept development and descriptive branched tree techniques, which are already suggested by the curriculum, was designed to discover what the impact of such material on the students would be. An experimental model was used for this purpose. The sample consisted of 62 (31 girls, 31 boys) sixth grade students in two different classes with the same sample number of students who were taught by the same teacher. The big group was divided into two groups as study/experiment group and control group without prejudice, on a random basis. The unit on "Matter and Heat" was taught over a period of 4 weeks with classes convening four times a week. Traditional teaching methods which are related to pencil-paper and chalk-blackboard implementations were used in the control group but the study group was exposed to traditional methods plus the Web-supported material developed by the researchers. An analysis was made of the data obtained from the material whereby the frequency distribution of the status of the students' extent of learning was examined. The process was completed with the teacher performing a last review of the part of the material where achievement levels were low. In the experimental study, a program of education with the same content was offered to two randomly selected groups using two different methods and the assessment of the effectiveness of both methods was explored with the Independent Samples t-test (Aydede & Matyar, 2009).

The research employed data collection tools which had been tested for validity and reliability. These tools were the following:

Concept Attainment Test

There are a lot of learning outcomes for each unit in Turkish Science and Technology curriculum. The matter and heat unit is found in 6th grade science and technology textbook. At this point, the unit's gains were analyzed and then test that measure the gains questions were prepared. The test was multiple-choice and consisted of 25 items. Each item of the test belongs to one or more acquires of the "Matter and Heat" unit. Each question on the test had one correct answer and three misleading choices. The misleading choices were based on existing misconceptions related with the unit in the literature. To ensure the content validity of the questions of the test were checked by academicians, lecturers at science education subject area and experienced science and technology teachers. To ensure the reliability of the test, a pilot test was conducted with 28 students. To ensure the reliability of the test, a pilot test and pretest were conducted with 28 and 62 students respectively. The results of pretest before the study supported the results of pilot test in respect to reliability. The data obtained from data collecting tool were treated item analysis, split-half method and Cronbach-α by means of SPSS 15.0. In the item analysis, questions 4, 7 and 16 were removed from the test and replaced by new questions to achieve item reliability. For these questions, it was applied to area experts and science teachers. These questions had item difficulty index scores that were lower than 0.3 point. According to the split-half method, the reliability of the test was found 0.86. Also, Cronbach's Alpha Coefficient for internal consistency was calculated as 0, 93.

Attitude Scale

A Science and Technology Curriculum Attitude Scale developed by Taş (2006) was used to measure the students' attitudes toward the science and technology program. The attitude scale is a three-point Likert-type scale made up of 15 items. A pilot run was performed for the attitude scale and the data obtained was analyzed with the SPSS 15.0 package program. The reliability coefficient or Cronbach-α value was found to be .82 (Taş, 2006).

Material Design

The principles and strategies adopted by the constructivist learning theory were employed in the design of the web materials. The materials were prepared with the help of the Adobe

Flash CS4 program and the Adobe Dreamweaver CS4 Web editor. The Adobe Flash CS4 is widely used to create striking applications using videos, graphics and animations. It is one of the most advanced programs that facilitate working with both static and dynamic texts, transferring video and sound files, creating animations and other rich and interactive creative content environments. Besides producing both simple and high-speed animated designs, more advanced interactive animations are created with the help of Adobe Action Script. An image of the material is shown below:

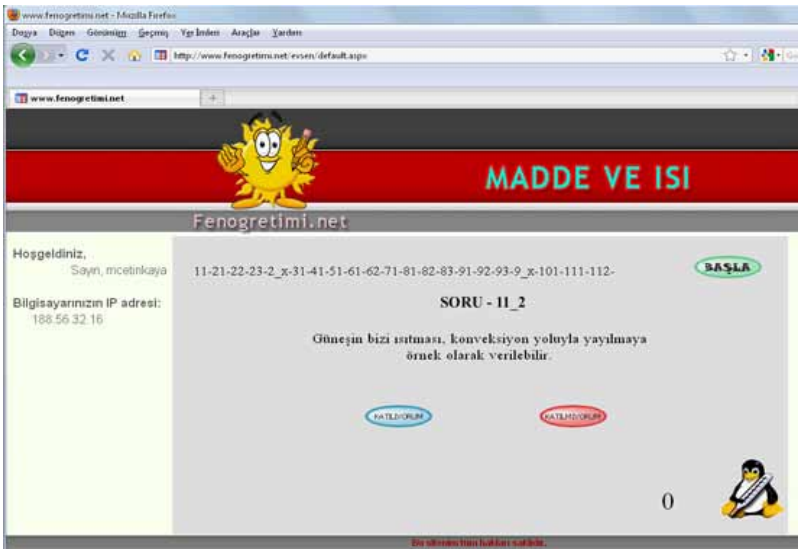

Figure 1. Web-supported alternative measurement tool question send interface

One aspect of the material that differs from existing assessment tools is the capacity of this tool to reveal not only the level of general achievement but also individual achievement levels. This aspect constitutes a similarity with the descriptive branched tree technique. In other words, as with the descriptive branched tree method, this technique is capable of discerning from the student's response the route through which the student arrived at the answer. Since it is web-supported, the tool is able to measure each learning achievement separately and the program automatically sends the results to the science and technology class teacher in the form of electronic mail. As the teacher reviews the results and evaluates students' individual achievements, he/she is able at the same time to ascertain the achievement of the entire class for each topic of learning. The system provides feedback on which topics are difficult for the students, thereby helping the teacher to plan for the last review of the unit. All the data obtained through electronic mail is transmitted to Microsoft Excel 2010 program. They are analyzed by system.

This unit has total 16 learning outcomes under three main acquires. Three main categories are gains with related to granular structure of matter and heat, propagation paths of heat, technological measures of heat insulation. In this direction, the researcher developed total 48 questions as online, by taking into consideration from scientists, science and technology teachers. These three questions for each acquire were created according to cognitive domain. Thus, content validity was provided. Three different questions at each categories from hard to easy (such as 1.1, 1.2, 1.3,) were asked and two options were presented to the students in the form of agree and disagree (Figs. 1 and 2). If the students answer the first question they pass to the next question. Otherwise, they pass to sub-question (1.2). If also this question (1.2) is not answered correctly, they move to the other sub-question (1.3).

The point scoring system of the test has followed this way: 10 points for each high-level question, 5 points for each midlevel question and 2 points for each low-level question according to cognitive domain of Bloom Taxonomy. A student has first seen the high-level one of a certain acquisition (also acquisitions are in order from the lowest to the highest level), if she/he fails; the

midlevel one comes and if the student fails again, the low-level one comes. If the student can't give a correct answer to the low-level question of the acquisition, he/she can't get any points, but he/she is allowed to go on the test, so he/she can see the questions about the other acquisitions.

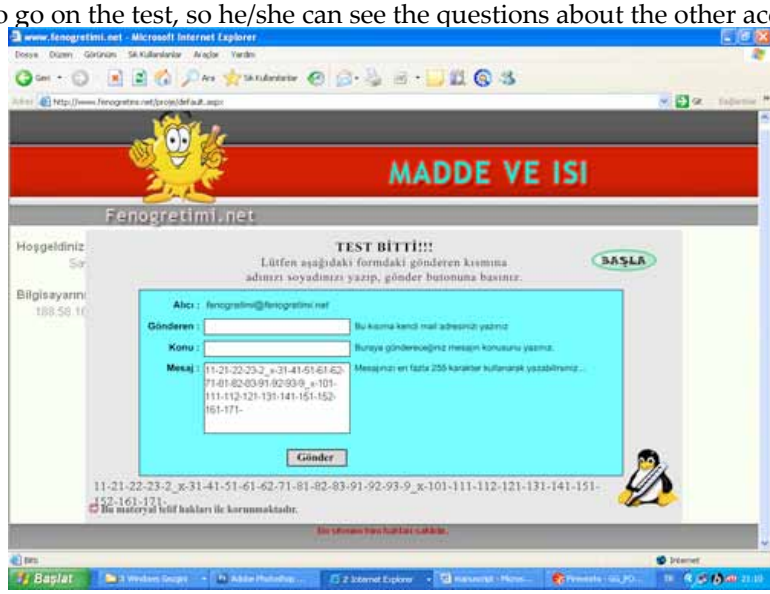

Figure 2. Web-supported alternative measurement tool send interface

The point at which the Web-supported measurement material is inspired by the concept development technique is the way in which it gives the student the opportunity to agree or disagree with a statement, later asking the student to focus on another statement and decide whether to agree or disagree with this new premise. To soften the effect of a question and answer format, the material was set up not as questions but as statements which necessitate not a "True" or "False" answer but as a freely expressed "I agree" or "I disagree" response. This approach was used in the belief that this method might enhance the extent of the students' learning of the unit. The format of the material is such that, if the student cannot give the correct response to the first statement, a second and easier question on the same topic appears before them. In the event they are again unable to provide the correct response, they are asked to focus on the third and easiest statement on the same topic. If there is any student who could not respond correctly to this last statement, that student is not removed from the test but directed to the first question of the next topic. This sequence is charted in the student's map and the teacher is made aware of this with the feedback sent from the system. The program reports all results separately for each student. All questions answered by the students are coded by the program according to question numbers and these codes are followed until the end of the test. Thus, a road map is formed from the first question to the end of the test as a visual. All the results are reported separately for each student by the program. Realization level of gains related with the unit and follow-up success for the students can be seen as on-line by teachers in both individual and class-wide by means of feedbacks sent by the program.

Results

In order to examine the impact on student achievement of the Web-supported assessment tool prepared for the teaching of the unit on "Matter and Heat," the results of the pre- and post-academic achievement tests were analyzed in both study and control groups.

Another aspect that was analyzed was how the Web-supported assessment tool prepared for teaching the unit on "Matter and Heat" affected the attitudes of students in the science and technology lessons.

Results of the Concept Attainment Test

The pre-test results of the study and control groups are given below.

Table 1.

Results of the pre-testing of the independent samples t-test for study and control group

Tests	Groups	No. of Students	Mean	Standard Deviation	t value	p
Pre-Test	SG	31	43.0476	15.2789	0.545	0.589
	CG	31	40.9524	8.7548		

A review of Table 1 reveals that there was no statistically significant difference between study and control groups in the results of the pre-test ($t_{(60)}$ =0.545, p>0.05). This indicates that the study and control groups started out on a similar learning level.

The results of the post-test for the study and control groups are given below.

Table 2.

Independent samples t-test post-test results of concept attainment test for the study and control groups

Tests	Groups	No. of Students	Mean	Standard Deviation	t value	p
Post-Test	SG	31	72.5714	15.609	3.197	0.003
	CG	31	56.9524	16.045		

A review of Table 2 reveals a statistically significant difference in the post-test results between the study and control groups ($t_{(60)}$ =3.197, p<0.05). These results show that the achievement of the study group students was significantly higher than that of the control group.

The Independent Samples t-test pre- and post-test results showing the differences between the study and control groups are presented below.

Table 3.

Independent samples t-test pre- and post-test results of study and control group students on the concept attainment test

Groups	Tests	No. of Students	Mean	Standard Deviation	t value	p
SG	Pre-Test	31	43.0476	15.278	6.194	.001
	Post-Test	31	72.5714	15.609		
CG	Pre-Test	31	40.9524	8.7548	4.011	.001
	Post-Test	31	56.9524	16.045		

A review of Table 3 reveals a statistically significant difference between the pre- and post-tests of the study group students ($t_{(60)}$ = 6.194, p<0.05). It can be seen that the study group students raised their pre-test achievement mean scores from 43.04 to 72.57 ($t_{(60)}$ = 4.011, p<0.05). The mean achievement scores of the students in the control group rose from 40.95 to 56.95. The graph below

displays the results of pre-test and post-test achievement in the study and control groups.

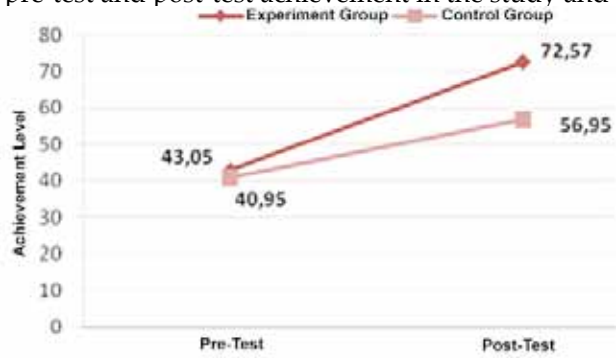

Figure 3. Pre-test and post-test results of concept attainment test for study and control groups

It can be seen from the graph that the level of knowledge attainment of the study group students is noticeably higher compared with the control group.

Results of the Attitude Scale related to the Science and Technology Courses

The pre- and post-test results on the Attitude Scale, used to measure students' attitudes toward the science and technology lessons are given below.

Table 4.

Independent samples t-test pre- and post-test results of testing study and control group students' attitudes toward the science and technology courses

Groups	Tests	No. of students	Mean	Standard Deviation	t value	p
SG	Pre-Test	31	28.2381	1.72930	0.560	0.579
	Post-Test	31	28.5714	2.11119		
CG	Pre-Test	31	27.9048	2.14254	0.426	0.672
	Post-Test	31	27.6190	2.20173		

A review of Table 4 reveals that no statistically significant difference existed between the pre- and post-test results of the study group students in the measurement of their attitudes toward the science and technology lessons ($t_{(60)}$ = 0.560, p>0.05). There was also no statistically significant difference between the pre- and post-test results of the control group students in the measurement of their attitudes toward the science and technology lessons ($t_{(60)}$ = 0.560, p>0.05). It can be seen that study and control groups showed similarity in their mean scores, both within the respective groups and between the groups as well.

Results Obtained from the Web-Supported Material

A review of the status of the students can be made by setting out in tables the percentage of correct responses that the students made in each topic in the teaching program and guidebook for the "Matter and Heat" science and technology unit taught in sixth-grade elementary school. The table below shows the results obtained from the use of the measurement tool with the study group students and gives the teacher an idea about the general status of the class.

Table 5.

Frequency distribution of data obtained from web-supported material

Main categories and students' acquisition in matter and heat unit	Students' achievement percentages by degree of difficulty of statements (1=Most difficult, 2=Medium, 3=Least difficult)							
	1		2		3		Failure	
	f	%	f	%	f	%	f	%
Concerning heat and the molecular structure of matter, the students…								
1.1 Arrive at the conclusion by observation that molecules of matter move faster as they heat up.	28	90	-	-	3	10	-	-
1.2 See the relationship between heat transfer between substances and the collision of atomic molecules.	28	90	-	-	3	10	-	-
Concerning heat transfer, the students…								
1.1 Can demonstrate heat transfer in solids.	27	87	3	10	1	3	-	-
1.2 Identify solids that easily transfer heat as heat conductors.	28	90	3	10	-	-	-	-
1.3 Identify solids that do not easily transfer heat as heat insulators.	28	90	3	10	-	-	-	-
1.4 Can conclude from everyday observations and experiments that heat can be transferred without direct contact.	19	61	11	36	1	3	-	-
1.5 State that heat can be spread through radiation.	28	90	-	-	3	10	-	-
1.6 Can explain why the earth's surface grows cold at night.	30	97	1	3	-		-	-
1.7 Can explain why dark-colored objects heat up faster than light-colored objects.	19	61	8	26	4	13	-	-
1.8 Can explain why heat insulation materials have shiny surfaces.	27	87	3	10	-		1	3
1.9 Can demonstrate with an experiment how heat spreads through convection in fluids.	21	68	4	13	6	19	-	-
Can distinguish how heat is transferred through conduction, convection and radiation.	31	100	-	-	-	-	-	-
Concerning the technological significance of heat insulation, students…								
1.1 Can conjecture under which conditions insulation would be needed.	24	78	6	19	1	3	-	-
1.2 Can give an example of when conduction would be preferred to insulation.	15	48	12	39	4	13	-	-
1.3 Can give examples of widely used insulation materials.	12	39	18	58	-	-	1	3
1.4 Can explain the relationship between building insulation and energy consumption.	26	84	4	13	1	3	-	-

Table 5 shows achievement percentages for each of the questions the study group students were asked about each learning topic.

The table indicates the following for Learning Topic 1.1. At the end of the unit, all of the students understood through observation that there is a direct relationship between the heating up of substances and the way molecules move faster; out of 31 students, a significant majority of 28 were able to respond correctly when faced with the most difficult statement at the first try; the remaining 3 students answered correctly at the third try with the easiest statement. The fact that there was no student who failed to record an achievement score provides feedback for the teacher, indicating that the topic has been learned. Some striking points that stand out in the table can be summarized as follows: Students had difficulty responding correctly at first try to the statements set forth for Topics 2.4, 2.7, 3.2, 3.3 and most of the students who were not able to answer correctly the first time did respond correctly to the second statement. The students who could not answer the second question were asked a third (relatively the easiest) question on the same topic. It was seen that all or almost all of the students were successful in their answers. There were two students who did not provide the correct answer, one for Topic 2.8, the other for Topic 3.3. The table thus provided the teacher with an indication of the level at which the topics were learned—well, average, poor—and in which topics student achievement and learning was lowest.

Discussion and Conclusion

In parallel with rapidly developing technologies, web-supported teaching techniques have been steadily growing in importance and are now being used more frequently to achieve increased productivity in science education and to ensure meaningful learning (Amadieu et al., 2009; Baki & Mandacı-Şahin, 2004; Chuang & Tsai, 2005; Çepni et al., 2003; Erginer & Dursun, 2009; Gabbard, 2000; Gedizgil & Deryakulu, 2008; Simone et al., 2001; Taş, 2011; Wen et al., 2004). The conclusion has been reached that the Web-supported materials prepared for the unit on "Matter and Heat" are significantly effective in teaching the students the topics of the unit. From this, it is further deduced that classwork that makes use of the web-supported measurement tools, inspired by the descriptive branched tree and concept development techniques, is more effective than traditional methods of teaching. Web-supported teaching with this measurement tool took place on computer which recent population of students is very familiar and good at using. Also, the tool is able to teach and remind knowledges about the subject while asking questions. These two properties are consistent with the new assumptions in learning: Assessment must take more realistic and holistic forms" which is pointed by Gradinger (1996; p. 667).

Student gains are like a road map for teachers in terms of Turkish Science and Technology curriculum. Learning and teaching processes is planned according to gains. To achieve this, the mental state of the students according to constructivist pedagogy is of great importance to effective science education such as pre-knowledge, incorrect information, and misconceptions (Çetinkaya & Taş, 2011). As it is known, teachers use several methods with aim to determine mental state of students before the start of the course such as class and group discussion, question-answer, brain storming. In addition, it is known that these approaches are insufficient to achieve these gains. Besides, other methods such as interviews, conceptual change texts, and graphical illustrations are not mostly preferred by science and technology teachers. Because, these techniques take too time. Also, teachers have not sufficient knowledge and skills to apply these techniques (Sağlam-Arslan et al., 2009). To overcome these difficulties, web-supported alternative assessment tool can provide great convenience and flexibility by means of Active Server Pages (ASP) concerning both individual and whole class.

This finding shows that the type of teaching material discussed here, which is in keeping with constructivist learning theory, is also consistent with the "synthetic meaning" theory of Vosniadu, the theory of "knowledge in pieces" of diSessa, the concept of "misconception repair"

of Chi & Roscoe, and the sociocultural view of Ivarsson, Schoultz and Saljö (Limón & Mason, 2002). According to these theories, conceptual change is not a sudden paradigmatic change of mental construction, but to the contrary, a very slow process. To achieve the correct conceptual construct, there is need for time, different contexts relative to the same concept, and multiple learning environments (Limón & Mason, 2002). The teaching material used in the present study had to do with the theoretical concepts of matter and heat and was designed to treat every topic related to these concepts. According to Maskill and de Jesus (1997), students aged 15-16 have learning difficulties about heat and related subjects which depend mostly upon logical interconnections in the subject. The teaching material has items for each gain categorized as difficult, normal and easy levels for ensuring logical interconnections. Also, this is also because of the students who aged from 11 to 12 and can be both at concrete and formal operation stages according to Piaget's theory of cognitive developments. A reference has thus been made to each basic concept that forms the foundation of the conceptual ecology and coordination class of theoretical concepts, providing students with different contexts and a variety of activities from which to benefit.

It can be seen that the prepared web-supported material did not have an effect on the attitudes of students toward the science and technology lessons. This was an expected outcome due to the fact that the assessment was made in a relatively short time. There are many studies that report that attitudes, one of the elements of emotional learning, are difficult to change in the course of a few weeks (Ersoy & Bayram, 2004; Lim, Lee, & Grabowski, 2009; Taş, 2006; Çetinkaya & Taş, 2011). In this sense, the findings of the present study are consistent with the results of previous research. Though there seems like no effect on the attitude, there can be in the future because of the experience. It is frequently emphasized by constructivist researches that making direct connections between subject and object is very important. This has a meaning called learning with own first-hand experiences or learning by doing as Dewey (1938) mentioned both.

A look into the results obtained from the web-supported material shows how the material can be helpful in terms of determining status in order to map out teaching plans. The table obtained at the end of each topic is useful to the teacher in the review made of the particular topic, providing a key as to which aspects of the topic still have to be the focus of attention. It can be said that this characteristic of providing insight into the process of teaching is a common quality of techniques of alternative assessment.

The teacher's views are another important aspect of the alternative assessment techniques that provide feedback to the teacher. It is known how difficult it is for teachers who have worked for many years with traditional approaches of measurement and assessment to change their concepts of teaching (Lock & Munby, 2000; Sağlam-Arslan et al., 2009). Studies have shown that teachers are still in a process of adaption as regards adopting and implementing alternative approaches to measurement and assessment (Bayrak & Erden, 2007; Gömleksiz & Bulut, 2007; Çoruhlu-Şenel & Nas, 2008; Çoruhlu-Şenel et al., 2008 ; Sağlam-Arslan et al., 2009). Sağlam-Arslan et al., (2009) have reported that teachers have positive thoughts about the use of alternative measurement and assessment tools but that they worry at the same time about lack of time, having to deal with an overpopulated class, and not having enough information about the alternative methods. Another finding that is frequently reported is that teachers have a positive view about the functionality of the new measurement and assessment tools but that they encounter certain problems in the implementation (Erdal, 2007; Çakır & Çimer, 2007; Çoruhlu Şenel et al., 2008; Metin & Özmen, 2010; Sağlam-Arslan et al., 2009). Çoruhlu-Şenel & Nas (2009). The issues indicated to be the most problematic for teachers are crowded classrooms, lack of time, and the difficulties involved in the preparation of measurement and assessment tools (Çoruhlu-Şenel & Nas, 2009; Gelbal & Kelecioğlu, 2007; Sağlam-Arslan et al., 2009). It is believed that Web-supported measurement materials are important in terms of presenting to teachers a practical means of utilizing alternative measurement and assessment techniques. These tools, prepared in line with constructivist theory, a branch of cognitive learning theory, are clearly seen to make a significant contribution to class achievement. Besides increasing academic achievement, the

technique has also been designed to address the problems identified by teachers as lack of time, overpopulated classrooms and inadequate knowledge about alternative methods. The time saved by a simple ten minutes spent at the computer, the convenience of being able to implement the technique individually in computer-equipped classrooms, the fact that the teacher needs only to know how the program works in order to implement the method are all part of the essential design. These qualities, as well as the capacity of the program to present the results to the teacher in report form, constitute the strong aspects of using web-supported material in the classroom.

The web-supported measurement material designed and prepared for use in the elementary school 6th-grade science and technology teaching program for the unit on "Matter and Heat" can be recommended for adaptation to and use in other class levels, other courses or topics. Materials designed for the web that would cover a wider scope of measurement and that would encompass all science and technology topics would be of great benefit in encouraging teachers to use alternative measurement and assessment tools, which at this point they refrain from using for a variety of reasons. The research results show that the use of web-supported materials leads to higher achievement compared with traditional methods and that therefore, such materials should be used more in teaching. This study of Web-supported material has interpreted feedback results. The teacher can obtain an important road map in how to proceed with the teaching program if this process can be undertaken at the beginning of the teaching program. The use of this material is also recommended in the light of the benefit that it provides in this aspect. In the light of information obtained from this study, the research can be accepted as the first study including web-supported branched tree technique in alternative measurement and assessment. However, because of insufficient sample, the study should be repeated on a larger sample.

References

Alkan, C. (2011). *Education Technology as a Discipline (8th printing)*. Anı Publications, Ankara.

Amadieu, F., Tricot, A. & Mariné, C. (2010). Interaction between prior knowledge and concept-map structure on hypertext comprehension, coherence of reading orders and disorientation. *Interacting with computers*, 22(2), 88-97.

Aydede, M. N. & Matyar, F. (2009). Fen Bilgisi Öğretiminde Aktif Öğrenme Yaklaşımının Bilişsel Düzeyde Öğrenci Başarısına Etkisi, *Türk Fen Eğitimi Dergisi*, 6(1), 115-127.

Baki, A. & Mandacı-Şahin, S. (2004). Assesment of preservice teachers' mathematical learning through computer aided concept mapping method. *The Turkish Online Journal of Educational Technology*, 3(2), 91-104.

Bayrak, B. & Erden, A. M. (2007). The Evaluation of Science Curriculum. *Kastamonu Journal of Education*, 15(1), 137-154.

Burns, M., Heath, M. & Dimock, V. (1998).Constructivism and technology. *TAP Learn*, *4, 1-8.*

Chuang, S. C. & Tsai, C. C. (2005). Preferences toward the Constructivist Internet Based Learning Environments. *Computer in Human Behavior*, 36(1), 97-100.

Çakır, İ. & Çimer, S. O. (2007). Fen ve Teknoloj Öğretmenlerinin Alternatif Ölçme-Değerlendirme Konusundaki Yeterlilikleri ve Uygulamada Karşılaşılan Problemler. 1st National Elementary Education Congress. Ankara, November 15-17.

Çepni, S., Taş, E. & Köse, S. (2003). Fotosentez konusu için geliştirilen bir web destekli kavram haritası materyalinin kavram yanılgıları üzerine etkisi. Pamukkale University, May 1-4, Denizli, Proceedings Book, 287-289.

Çepni, S. (2006). Bilim, fen, teknoloji, kavramlarının eğitim programlarına yansımaları. In S. Çepeni (Ed.) *Kuramdan uygulamaya fen ve teknoloji öğretimi,* (1st ed.). 1-22, Pegem A: Ankara.

Çetinkaya, M. & Taş, E. (2011). Investigation of effectiveness of web supported concept maps and semantic features analyses on classification of living things. *Dicle University Ziya Gökalp Faculty of Education Journal*, 16, 185-195.

Çoruhlu-Şenel T., Nas Er, S. & Çepni, S. (2008). Reflection of an in-service education course programme for science and technology teachers about alternative measurement and assessment techniques: Trabzon sample. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, 2(2), 1–22.

Çoruhlu-Şenel,T. & Nas E. S. (2009). Fen ve Teknoloji Öğretmenlerinin Alternatif Ölçme-Değerlendirme Tekniklerini Kullanmada Karşılaştıkları Problem: Trabzon örneği, *Yüzüncü Yıl University Faculty of Education Journal*, 4(1), 122-141.

Dewey, J. (1938). *Experience and Education*. New York: The Macmillan Company.

diSessa, A. A. (1988). Knowledge in pieces. In G. Forman , P. B. Pufall (Eds.), Constructivism in the computer age. Hillsdale, NJ: Lawrence Erlbaum, Associates, 49–70.

diSessa, A. A. (1993). Toward an epistemology of physics. *Cognition and Instruction*, *10*(2 & 3), 105-225.

Erdal, H. (2007). The investigation of measurement and evaluation parts in the new elementary school mathematics curriculum (Case of Afyonkarahisar). Unpublished Master Dissertation, Afyon Kocatepe University, Turkey.

Erginer, E. & Dursun F. (2009). The meanings attributed to the future characteristics of teachers by prospective teachers: a concept map study. *Procedia Social and Behavioral Sciences* 1, 1389–1395.

Ersoy, N. & Bayram, H. (2004). Kavram Haritası ve Deney Yönteminin Fen Öğretiminde Başarıya Etkisi. 6th National Science and Mathematics Education Congress. İstanbul: Book of abstracts, 54.

Fensham, P. J. (1992). Science and technology. In P. W. Jackson (Ed.), *Handbook of research on curriculum*. New York: Macmillan.

Gabbard, R. (2000). Constructivism, hypermedia, and the World Wide Web, *Cyber Psychology & Behavior*, 3(1), 103-110.

Gedizgil, Z. & Deryakulu, D. (2008). The effects of concept mapping liking and mativation to computer course. *Hacettepe University Faculty of Education Journal*, 34, 106-115.

Gelbal, S. & Kelecioğlu, H., (2007). Teachers' proficiency perceptions of about the measurement and evaluation techniques and the problems they confront. *Hacettepe University Faculty of Education Journal*, 33, 135-145.

Glasersfeld, E. V. (1995). A constructivist approach to teaching. In Steffe P. L. and Gale J. (Eds), *Constructivism in education.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Gömleksiz, M. N. & Bulut, İ. (2007). An assessment of the implementation of new science and technology curriculum. *Hacettepe University Faculty of Education Journal*, 32, 76-88.

Grabinger, S. (1996). Rich environments for active learning. In D. Jonassen (Ed.), *Handbook of research for educational telecommunications and technology* (pp. 665-692). New York: MacMillan.

Lim, K., Lee, H. & Grabowski, B. (2009). Does concept-mapping strategy work for everyone? the levels of generativity and learners' self-regulated learning skills. *British Journal of Educational Technology, 40*(4), 606-618.

Limón, M. & Mason, L. (2002). *Reconsidering conceptual change: Issues in theory and practice*. Kluwer Academic Publishers: New York.

Lock, C. & Munby, H. (2000). Changing assessment practices in the classroom: A study of one teacher's challenge. *Alberta Journal of Educational Research,* 46(3), 267-279.

Karip, E. (2005). Küreselleşme ve Lizbon eğitim 2010 hedefleri. *Kuram ve Uygulamada Eğitim Yönetimi Dergisi*, 42, 195-209.

Maskill, R. & de Jesus, H. P. (1997). Pupil's questions, alternative frameworks and the design of science teaching. *International Journal of Science Education,* 19(7), 781-799.

Metin, M. & Özmen, H. (2010). Determination of science and technology teachers' in-service education (inset) needs on performance assessment. *Kastamonu Journal of Education*, 18(3), 819-838.

Ministry of National Education, Educational Council Presidency (2006). *Syllabus for Elementary School Science and Technology teaching program [6th, 7th, 8th grades]*.M.E.B., Ankara-Turkey.

Özmen, H. (2006). Yapılandırmacı (Constructivist) öğrenme kuramı S. Çepni (Ed.), *Kuramdan Uygulamaya Fen ve Teknoloji 5th ed.*, 45-61, Pegem A: Ankara.

Özsevgenç, T. (2007). Determining effectiveness of guided materials about "force and motion" unit based on the 5E model for elementary students. Unpublished Doctoral Dissertation, Karadeniz Technical University, Turkey.

Sağlam-Arslan, A., Devecioğlu-Kaynakçı, Y. & Arslan, S. (2009). Problems concerning alternative evaluation methods: the case of science and technology teachers, *Ondokuz Mayıs University Faculty of Education Journal*, 28, 1-12.

Simone, C., Schmid, R. F. & McEwen, L. A. (2001). Supporting the learning process with collaborative concept mapping using computer-based communication tools and processes. *Educational Research and Evaluation*, 7(3), 263-283.

Şenel, T. (2008). Investigating the effectiveness of in-service courses programme for science and technology teachers about alternative measurement and assessment technics, Unpublished Master Dissertation, Karadeniz Technical University, Turkey.

Taş, E. (2006). Developing, implementing and evaluating of a web designed science material. Unpublished Doctoral Thesis, Karadeniz Technical University, Turkey.

Taş, E. (2011). A new web designed material approach on learning and assessment in science education. *Energy Education Science and Technology Part B: Social and Educational Studies*, 3(4), 567-578.

Taş, E., Apaydin, Z. & Çetinkaya, M. (2011). Research of efficacy of web supported science and technology material developed with respect to constructivist approach. *Energy Education Science and Technology Part B: Social and Educational Studies*, 3(4), 455-468.

Wager, W. (1997). Instructional Technology and Teacher Educator. *Teacher Education and Special Education*, 20(4), 378-388.

Wen, L. M., Tsai, C. C., Lin, H. M. & Chuang, S. C. (2004). Cognitive metacognitive and content-technical aspects of constructivist internet based learning environments: A Lisrel analysis, *Computer & Education*, 43, 237-248.

Yaman, S., Karamustafaoğlu S. & Karamustafaoğlu, O. (2005). Fen ve Teknoloji Eğitiminde Öğrenme ve Öğretim Materyalleri. In M. Aydoğdu & T. Kesercioğlu (Eds.) *İlköğretimde Fen ve Teknoloji öğretimi*. Anı Yayıncılık: Ankara.