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The Effect of Educational Software Based on Ausubel's Expository Learning on Students' Academic Achievement, Science and Computer Attitudes: "Human and Environment" Unit Example

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Authors' contributions

This work was carried out in collaboration between all authors. Author OE designed the study, wrote the protocol and performed the statistical analysis. Author EU supervised the work, wrote the first draft of the manuscript, managed the literature searches and edited the manuscript. Author DA developed the software used in the study. All authors read and approved the final manuscript.

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ABSTRACT

The authors examined the effect of an instructional material designed through Ausubel's expository learning related to the "Human and environment" Unit in 7th grade Science and Technology Curriculum on students' academic achievement, attitudes towards science and computers. The quasi experimental pretest-posttest controlled group design has been used in the study. The study has been conducted with K7 students in one of secondary schools in Kahramanmaraş/Turkey. The experimental and control groups have been attended randomly and each group has been consisted of 24 students. Totally 48 7th grade students have been participated in the study. Prior to the study Academic Achievement Test, Science and Technology Attitude Scale and Computer Attitude Scale have been administered as pre-test and following to the application, the mentioned data collection tools have been administered as posttest. The analysis of the collected data has reported that there

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has been a significant increase in favor of the experimental group related to the Academic achievement and computer attitude scores. There has been no significant difference between experimental and control groups students' science attitudes in both groups following to the application.

Keywords: Science and technology class; web assisted learning; expository learning; instructional software; science and computer attitude.

1. INTRODUCTION

The instructional approach based on traditional transmission of information which assumes students' minds as an empty mind has left behind [1]. Nowadays, in order to increase students' learning, teaching methods in which their active participation is prompted and teachers help them to construct their own learning have been preferred. Domin [2] states that according to the constructivist learning theory, knowledge should be structured by learners. At that point, the learning environment and the interactions between the learners and environment play an important role. Ausubel's cognitive learning theory proposes meaningful learning through organizing information hierarchically [3,4]. If the new learnt concepts not connected with the previous ones, they are memorized by the students and rote learning occurs [5]. For the realization of meaningful learning, new information must be presented to the students in a form in which it is a coherent whole. Students need organizers to make connections between the new information and the old one. These organizers are divided as expository and comparative [6]. While expository organizers give descriptive information about a subject not previously encountered, comparative organizers provide a comparison of the new information and the old one to make clear the similarities and contrasts between them.

Different methods and techniques are being been used for the realization of meaningful learning. Modern science education aims to make students active in learning process and construct their own learning [7]. Through new developed learning theories, many researchers focus on the development of engaging activities for students [8]. Through the understanding of the learning process, the role of the teacher in the classroom has changed. Sun, Lin and Yu [9] states that the role of teacher turn into a consultant who guides students. The importance of student centered methods has been increased, information technologies have been integrated learning environment in parallel with the rapid advancement of the technology [10]. Today, instructors are aware of the advantages of web based technologies and use it for creating learning environments [11]. At the present time, information technology has been used to increase the effectiveness of the instruction [12,13]. Traditional learning environments are limited by time, place and space, but by integrating technology in learning environments, the borders are expanded [14]. There are many benefits of web-based learning environments. These environments offer flexible, rich exploration environments [15]. Students move in accordance with their own learning speed and have limitless repetition opportunity with web based materials. When the learning is personalized, the learning can be increased and web based instruction provides personalized learning environments [1]. Web based applications not only increase students' achievement but also they increase student motivation and make students responsible for their own learning [16]. Similarly, Wang and Reeves [17] in their study reported that web based learning activities increased students' motivation.

Today, students are spending a lot of time with technological tools in their daily lives. They can learn how to use these tools easily and have positive attitudes towards technology.

Web-based applications attract students with their rich visual and audial aspects in learning environments. In the study, the students have been taught by a web based software designed for teaching ecosystems, environment and environmental problems which are very important subjects for our daily life. It is believed that the mentioned material will attracts the attention of students and makes their learning easier.

The effect of web based software designed through Ausubel's expository learning theory

relating to the "Human and Environment" Unit in 7th grade Science and Technology Curriculum on students' academic achievement, attitudes towards science and computers was examined. The hypotheses:

H1. The educational software relating to the "Human and Environment Unit effects students' learning positively.
H2. The educational software relating to the "Human and Environment Unit effects students' attitudes towards science and technology class positively.
H3. The educational software relating to the "Human and Environment Unit effects students' attitudes towards computers positively.

2. METHODS

In the study, the effect of the software titled "Let's learn our environment" on 7th grade students' academic achievement, attitudes towards science and attitudes towards computers have been investigated. The study was conducted in 2014-2015 Academic Year, Spring Term. For this aim, in one of the secondary schools in Kahramanmaraş, 2 classes have been randomly selected and one of the groups has been assigned as experimental group and the other has been assigned as control group. A quasi-experimental pre-test post test control group design has been used as research design. Both of the groups have been lectured by the same science teacher. Human and Environment Achievement Test, Science and Technology Attitude Scale and Computer Attitude Scale have been administered as pre-test prior to the application. Following to the pre-tests, the computer laboratory has been prepared for the application and each student has had a personal computer. The instructional software has been uploaded on computers and a headphone has been added to each one to listen the sounds in the software. The control group has been taught by traditional lecturing method by following the science and technology textbook. The application has been completed in 4 weeks time. Following to the application, Human and Environment Achievement Test, Science Attitude Scale and Computer Attitude Scale have been administered as post-test.

2.1 The Samples

The 7th grade students attend secondary schools (the number of the schools approximately 120) in the city center of Kahramanmaraş province have been the target population of the study. One of these schools has been chosen by considering convenience sampling method. In this school, two classes have been chosen randomly for the study. Forty eight (48) students attend 7th grade have participated in the study in 2014-2015 Academic year in Kahramanmaraş. The students have participated in the activities and filled the scales voluntarily. The demographic characteristics of the samples are displayed in Table 1.

Table 1. Demographic characteristics of the samples

		N	%
Gender	Male	23	47,9
	Female	25	52,1

24 students of the samples have been attended as experimental group and 24 students of the samples have been attended as control group.

2.2 Data Collection Tools

2.2.1 Science and Technology Attitude Scale (STAS)

Science and Technology Attitude Scale has been administered to the students to determine their attitudes towards science and technology class. The scale was developed by Geban, Ertepınar, Yılmaz, Atlan and Şahpaz [18]. It is consisted of 15 items and is a 5 point likert type scale (completely disagree= 1; disagree= 2; undecided=3; agree=4; completely agree=5). The unmarked items have been given 3 point, since students don't state any clear feeling. Geban, Ertepınar, Yılmaz, Atlan and Şahpaz [18] calculated the Cronbach Alpha reliability coefficient as 0,83, it has been calculated as 0,96 in this study.

2.2.2 Computer Attitude Scale (CAS)

Computer Attitude Scale developed by Yüksel [19] has been administered to the students to determine their attitudes towards computers. It is consisted of 28 items and is a 5 point likert type scale (completely disagree= 5; disagree= 4; undecided=3; agree=2; completely agree=1). The unmarked items have been given 3 point, since students don't state any clear feeling Negative statements are scored in reversed code. When the score closer to the 1, it means that students have positive attitudes towards computers. Yüksel [19] calculated the Cronbach

Alpha reliability coefficient as 0,90, it has been calculated as 0,85 in this study.

2.2.3 Academic Achievement Test (AAT)

The Academic Achievement Test has been developed to evaluate understanding level of the students' related to "Human and Environment" Unit. First version of the test has been consisted of 28 items developed by the researchers. The items have been examined by 3 lecturers and 3 science teachers. 3 items have been removed from the test through expert views. The achievement test with 25 items has been accepted by the experts. This version of the test has been administered to 96 students who get this class before as pilot study. Following to the pilot application, one item has been removed from the test because of the lower item discrimination. The final version of the test consisted of 24 multiple choice items. Each correct item has been given 1 point, whereas incorrect ones given 0 points. The items unmarked by the students have been given 0 point, since it is assumed that students don't know the correct answer. The maximum test score has been 1x24=24. For item difficulty and item discrimination analysis, 27% segments from upper (N=26) and lower groups (N=26) have been selected. In an ideal test, item difficulty index of the items should be between 0,2 and 0,8, and the mean of item difficulty index should be above 0,5. The item difficulty index analyses conducted following to the pilot application displayed that the difficulty index values of the items have been between 0,35 and 0,88, and the difficulty index for the whole test has been 0,63. As a result of this, it is accepted that item difficulty of the test is sufficient. The discriminatory values of the items have been between 0,19 and 0,77. The mean of total discriminatory values of the items has been 0,43. The mean of total discriminatory values of the items should be above 0,30. As a result, it is accepted that the item discrimination of the test is ideal. KR-20 analysis for reliability is calculated as 0,85.

2.2.4 Data analysis techniques used in the study

In the study, relating to the students' demographic characteristics, arithmetic average, % and frequency analysis have been conducted. AAT, STAS and CAS post-test scores of experimental and control groups have been compared by independent samples t-test. The pre-test and post-test scores of the experimental group has been compared by paired sample t-test. The ANCOVA analysis has been conducted to determine if there is a significant difference between students' post test scores when the pre-test scores have been controlled. $p<0,05$ was considered to be significant. The Statistical Package for Social Sciences (SPSS) version 15.0 has been used for statistical analysis.

2.2.5 Technical properties of the software

In the content of the study, a software for "Human and Environment" Unit in K7 Science and Technology curriculum has been developed through Ausubel's Expository Learning approach. The software has been prepared by using C# programming language. In addition to the C # programming language, Adobe Flash CS6 for animations and Adobe Photoshop CS4 for the organization of pictures have been used. Visuals and animations used in the software is designed according to the age and developmental characteristics of the students. Multimedia design principles such as taking students' attention, reminding the goals of the lecture, reminding preliminary knowledge of the students, presenting stimulus materials, guiding students, evaluation and giving feedback have been considered. For this aim, an interesting image is presented in the entrance of the software, by this way students' attention is drawn to the material (Fig. 1). One of the basic principles of expository learning is active participation of students. Therefore, interesting visual material is chosen to draw the attention of the students.

Fig. 1. The entrance part of the Software
(Note 1: Let's learn our environment)

Following to the above displayed image, the goals of the learning process are presented to the students. It is aimed to inform students about the concepts they will learn during the process (Fig. 2).

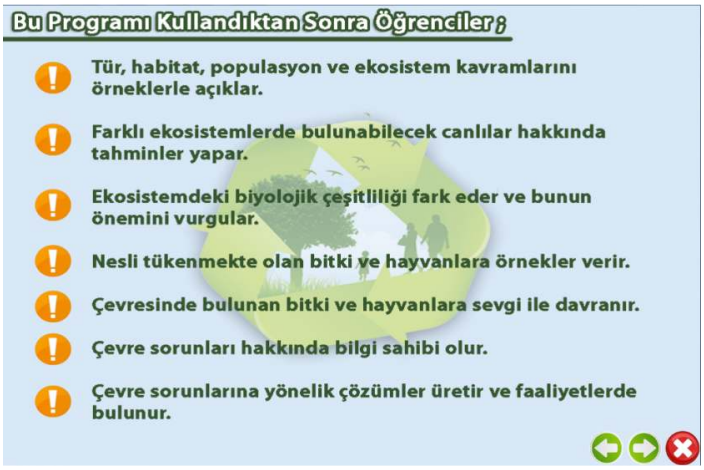

Fig. 2. The learning targets

Note 2: Following to the using this software, students:

- *Explain the concepts of species, habitat, population and ecosystem with examples.*
- *Guess the living organism in different ecosystems.*
- *Realize biological variety in the ecosystem and emphasizes the importance of this variety.*
- *Give examples to the plants/animals on the edge of extinction.*
- *Love plants and animals.*
- *Get information about environmental problems.*
- *Find solutions to the environmental problems.*

According to Ausubel's learning theory, students are required to relate the new information with prior knowledge. Therefore, students are required to remember the preliminary knowledge prior to the learning of new information. In the following section, preliminary knowledge related to the subject is reminded to the students. For this aim, "fill in the gaps" examples have been given. By this way, students will be motivated towards learning issues and thus pre-knowledge related to the subject will be determined (Fig. 3).

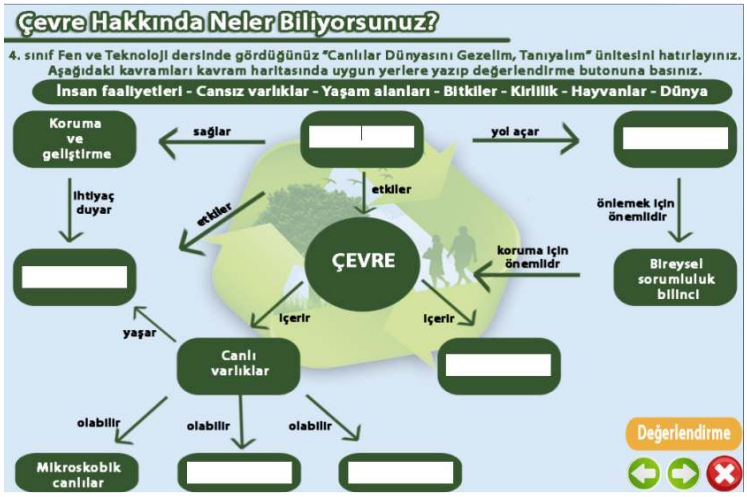

Fig. 3. Reminding pre-knowledge

Note 3: What do you know about environment?

Remember the unit titled "Visit and learn the world of living organisms" in the 4th grade. Write the given concepts in the suitable places in the concept map and press the evaluation button: Human activities-non-living thing- living space- plants-pollution-animals-world (In the middle of the concepts map, the center concepts "ENVIRONMENT" is written)

In the next phase, the students are directed to the main page of the software, and the knowledge has been taught by step by step. The content of the software is collected under six headings (Fig. 4). Ecosystems, Biodiversity and Environmental Issues are designed through expository learning approach. Concept maps, Activities and Evaluation parts are prepared for promoting persistence in students' learning. They are prepared through learning with fun principle. In the evaluation part, text exams are administered to determine if the students' reach the instructional goals or not.

Fig. 4. The main page of the software

Note 4: The content of the software: 1. Ecosystem; 2. Biological variety; 3. Environmental problems; 4. Concept map; 5. Activities; 6. Evaluation

In the software, before teaching new concepts, students are reminded the prior concepts which they have. In the lecturing part students encounter some examples related to the subject (Fig. 5). While giving examples, some visual materials related to the concepts are used. By this way, it is aimed to increase students' motivation on the learning subject.

Fig. 5. Giving examples and making identifications

Male wolf + Female wolf = cubs
When these wolfs living in Siberia mate, they have cubs and their generation continues

In the next stage, some contrasting examples are presented to the students (Fig. 6). Thus, at this stage, students can compare the characteristics of the examples and contrasting examples.

Fig. 6. Presenting and identifying contrasting examples

Note 6: Horse+donkey= mule
Horse and donkey are different species but the mule isn't a species

In the next stage, the students are requested to ask questions related to the new learnt concept following to the comparison of samples and contrasting samples (Fig. 7). It is aimed students to understand the relationships, the characteristics of the concepts.

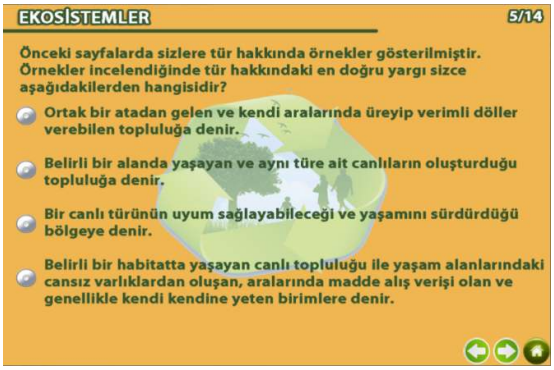

Fig. 7. Students' explanations

Note 7: Some examples to the species are given on the previous pages. When the given examples examined, what is the best explanation for species?

- *The population that have a common ancestor and capable of reproducing fertile offspring*
- *The population that lives in a particular area and consists of the same species.*
- *A geographical area in which a species can find water, food etc.*
- *A unit which composed of a group of living organisms and their abiotic environment.*

Visual materials are presented to the students in addition to the texts. It is aimed to make students imagine the concepts in their minds and learn meaningfully. The applications such as flash animations, visual images, audios, videos, educational agents make students have fun and they attract students' attention.

3. FINDINGS

Prior to the applications, AAT, STAS and CAS was administered to experimental and control groups as pre-test. Independent samples t-test has been conducted to compare pre-test scores of both groups. The findings related to the independent samples t-test has been reported in Table 2.

Table 2 displays that there is not a statistically meaningful difference between the pre test AAT scores of experimental group and control group ($t(46) = 1,704$; $p = 0,095 > 0,05$); there is not a statistically meaningful difference between the pre test STAS scores of experimental group and control group; ($t(46) = 1,477$; $p = 0,147 > 0,05$); there is not a statistically meaningful difference between the pre test CAS scores of experimental group and control group ($t(46) = 1,815$; $p = 0,076 > 0,05$). The results of the independent samples t-test has been displayed in Table 3.

Table 3 displays that there is a significant difference between post test AAT scores of experimental group and control group, in favor of the experimental group ($t(46) = 2,030$; $p = 0,04 < 0,05$). This finding indicates that the software has a positive effect on students' learning in the experimental group. Table 2 displays that there is no significant difference between the post test STAS score of the experimental and control groups ($t(46) = 0,565$; $p = 0,57 > 0,05$). Table 2 that there is a significant difference between post test CAS scores of experimental group and control group, in favor of the experimental group. The findings of the paired sample t-test have been displayed in Table 4.

Table 4 displays that there is a significant difference in favor of the post test scores of AAT ($t(23) = 13,544$; $p = 0,000 < 0,01$). This result reports that the software has helped to increase students' academic achievement. Table 3 also reports that the software has also affected students' attitudes.

In the study, there is a significant increase in favor of the post test scores of STAS ($t(23) = 4,182$; $p = 0,000 < 0,01$) and also post test scores of CAS ($t(23) = 5,410$; $p = 0,000 < 0,01$). The findings of the ANCOVA analysis has been displayed in Table 5.

Table 5 reports that the model implemented in ANCOVA is meaningful ($p = 0,000$ for the model) and the model has explained 47 % of the conceptual achievement in "Human and Environment" Unit ($R^2 = 0,469$). Table 5 displays that, when the pre-test scores have been controlled the web based instructional software have affected the academic achievement of the students in the experimental group.

Table 2. The comparison of pre-test results of experimental and control groups

Group	AAT		STAS		CAS		p
	M	SD	M	SD	M	SD	
Experimental	11,13	3,33	3,35	1,24	2,20	0,43	0,095
Control	13,00	4,24	3,81	0,89	2,43	0,42	

Table 3. The comparison of the post test scores of experimental and control groups

Group	AAT		STAS		CAS		p
	M	SD	M	SD	M	SD	
Experimental	20,67	1,79	3,73	1,03	1,90	0,44	0,04
Control	18,88	3,94	3,89	0,98	2,44	0,47	

Table 4. The comparison of pre and post test scores of the experimental group

Group	AAT		STAS		CAS		p
	M	SD	M	SD	M	SD	
Pre-test	11,13	3,33	3,35	1,24	2,20	0,43	0,000
Post-test	20,67	1,79	3,73	1,03	1,90	0,44	

Table 5. The ANCOVA analysis results when the pre-test results controlled*

Source of data	MS	df	F	p
Model	219,518	6	6,025	0,000
AAT (Pre- test)**	27,506	1	4,530	0,039
STAS**	8,980	1	1,479	0,231
CAS**	2,624	1	0,432	0,515
Group	57,774	2	4,757	0,014
Error	468,479	47		

*R^2= 0,469 ** Controlled variables

4. RESULTS

In the content of this study, the effect of web based software developed by considering Ausubel's expository learning approach related to the "Human and Environment" Unit in 7th grade science and technology curriculum on students' academic achievement, science and computer attitudes has been investigated. The software has been titled as "Let's learn our environment". The experimental groups has been taught by web based educational software designed through expository learning approach and the control group has been taught by traditional lecturing by using the text book. The comparison of the pre-test scores displays that there is no significant difference between experimental and control group students' academic achievement, science and computer attitudes prior to the application. This finding indicates that the experimental and the control group have similar characteristics according to their pre-test scores.

As a result of the study, when the post test results AAT and CAS of experimental group and the post test results AAT and CAS of control group examined, there has been a significant increase in favor of the experimental group.

The findings of the study reveal that there has been no significant difference between experimental and control group students' science attitudes level prior and following to the application. However, there has been a significant difference between the experimental group' pre-test STAS scores and post-test STAS scores in favor of the post test, but there has been no significant difference between control groups' pre-test and post test STAS scores.

5. DISCUSSION

The comparison of the pre-test scores reports that students in experimental and control groups have similar characteristics associated to the achievement and attitudes. Following to the application, the comparison of post test results displays that the experimental group students which is taught by web based instructional software have been more successful than the control group students which is taught by traditional lecturing method and as a result of the application the experimental group students have developed more positive attitudes towards computers. This finding displays the two dimensional results of web based education: Students have enjoyed using computers in their daily lives and using computers as an instructional tool, and it is makes learning more enjoyful. Web based instructional material with strong visual and audial characteristics enables students to learn by their own learning speed and improve their learning and also attitudes towards computers at the same time. The causes of this result may be using visual-audial learning environment, transferring the learning material to the student by using computers, making abstract concepts more concrete by using some models in the software. With the help of web based instructional software, students understanding and motivation towards learning have been increased and this may have had a positive impact on students' academic achievement. There are some studies which report similar findings. Ural and Ercan [20] searched for the effects of web-based instructional material enriched by concept maps on, the 7th graders' academic achievement in “Structure and Properties of Matter” unit. The results reported that web-based education was effective in increasing academic achievement. Sun, Lin and Yu [9] search for the effect of a Web-based virtual science laboratory for elementary school students with different learning styles. The results of the study revealed that web based learning environment improved students' learning. Hopkins [21] searched for the effectiveness of computer-based expository and discovery instructional methods developing the understanding of some musical concepts. The results of the study reported that students'

understanding improved as a result of the implemented instructional methods. Chou and Liu [13] searched for the effectiveness of technology-mediated virtual learning environment. The results of the study displayed that students learnt better and they were more satisfied with the learning environment than the traditional learning environment.

As a result of the application, there has been an increase in the experimental group students' attitudes towards science, but this increase hasn't been so high. The reason of the low level increase in experimental group students' science attitudes has been thought to be teaching a particular and limited subject in a limited time. In a similar study Ünal and Ergin [22] searched for the effect of science teaching with discovery approach on students' academic achievement, learning approaches and science attitudes. The result of the study displayed that there was no significant difference in students' science attitudes following to the application and they thought that the reason of this was lack of time.

In the study, experimental-control group pre test-post test method has been used. By this method, the effect of the application on the chosen variables can be compared between groups and a conclusion can be stated relating to the application. The chosen method strengthens the study. The study is limited with the randomly chosen samples.

6. CONCLUSIONS

At the end of the application, there has been no significant difference between students science attitudes prior and after the application. Considering this result, it can be said that long-term activities should be designed to make changes in students science attitudes. Changing attitudes requires more time. In the schools, affective computer laboratories should be designed and students use computers and related technology in the classes effectively. The instructional software that attracts students' interest should be used in learning activities. The teachers should learn how to use computers and instructional technology assisted materials. They should be given information about the current promotion and use of science and technology education software.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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