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Augmented Reality for Learning English: Achievement, Attitude and Cognitive Load Levels of Students *

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Abstract

In this study, achievement, attitude and cognitive load levels of students in learning English by Augmented Reality (AR) is examined. Within this context, it is researched whether cognitive load and attitudes of students differ according to the achievement levels of students or not and the correlation between these variables were revealed. In the study, casual-comparative and correlational methods were used. The sample of the study is composed of 122 fifth-grade students (66 males and 56 females) from 5 different secondary schools in Erzurum. In data analysis, descriptive and inferential analysis methods were used. As the result of the study, it is found that secondary school students are pleased with learning English by the aid of AR, they have a low anxiety level and they want such applications to be used their courses in future. Moreover, it is found that the cognitive load levels of students in the process of self-directed learning in AR environment are low. Another important finding of the study is that the attitudes of successful students are significantly higher than others. In addition, the relationships between attitude, achievement and cognitive load levels were revealed in detail.

Keywords

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Introduction

The rapid advancement of technology give rise to new improvements in education. The occurrence of improvements raises a question mark whether these technologies may be efficient in education or not. Augmented Reality (AR) is one of the technologies which have become widely used and issue of concern. AR is defined as a technology where real world and virtual images are blended and a real-time interaction is ensured (Azuma, 1997). This technology may be implemented by using various types of technologies such as desktop computers, laptops, portable devices and smart phones (Kirner, Reis & Kirner, 2012). The applications created by using AR allows the usage of 3D objects, 2D images, videos and animations both separately and simultaneously (Wang, Kim, Love & Kang, 2013). In this sense, users can interact with incidents, objects and data by the aid of using natural ways

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(Wojciechowski & Cellary, 2013). AR applications are categorized as marker-based and location-based applications. Location-based applications are composed of 3 constituents as monitoring systems, where GPS (Global Positioning System) is used, devices that diagnose area and image. Moving to the marker-based applications, they include 3 fundamental components such as a manual with the marker in it, a gear that converts the data in the marker into digital data and a display unit which screens the digital data in 3D or 2D format (Chen & Tsai, 2012). In this study, marker-based AR technology was used.

AR technology has been in the limelight since it enables users to interact both with real and virtual objects, provides learning through experience and increases attention and motivation (Singhal, Bagga, Goyal & Saxena, 2012). AR technology is being used in different fields of education and it is emphasized that an effective use of AR technology can be held while teaching invisible objects and incidents, demonstrating hazardous situations, transforming intangible concepts into tangible and presenting complicated information (Walczak, Wojciechowski & Cellary, 2006). Especially the AR applications attract the attention of children because of the transformation of objects and make the continuum of learning process appealing (Billinghurst, Kato, & Poupyrev, 2001; Bujak et al., 2013; Oh &Woo, 2008; Wojciechowski & Cellary, 2013; Zhou, Cheok & Pan, 2004). Due to the potential of AR applications, it is evident that new applications are being developed in different fields of education which are directed towards primary and secondary education students. Teaching English to primary or secondary school students is one of the areas of AR applications.

It is important to organize activities and events that can increase the motivation of school-age children in order to make them eager to learn English (Mahadzir & Phung 2013; Musa, Lie & Azman, 2012). It is stated that learning English by using AR applications improves the motivation of the students while making them enjoy AR applications and have a positive attitude towards AR applications (Vate-U-Lan, 2012; Mahadzir & Phung 2013; Wei & Elias; 2011). In addition to this it is identified that the students who use AR applications in English courses acquired more of English reading, comprehension, listening and speaking skills compared to those who are taking their English courses according to traditional education (Barreira et al., 2012; Hsieh & Lee; 2008; Vate-U-Lan, 2012). On the other hand, AR applications require a student-centered education environment thus; they are quite different from traditional education methods, which are teacher-centered (Kerawalla, Luckin, Seljeflot & Woolard, 2006; Mitchell, 2011; Squire & Jan, 2007; Wu et al., 2013). In AR applications, the student should achieve the tasks given in the learning process and manage the technological tools as well at the same time. In order to achieve the tasks in the AR applications, the students should have spatial ability, technology self-efficacy, mathematical prediction, problem solving and collaboration qualifications. Teachers are expected to have the same qualifications as well to manage the process effectively. In the studies in literature too, it is stated that the students face difficulties with implementing in situations where they do not have these skills (Kerawalla et al., 2006; Klopfer & Squire, 2008; Wu, Lee et al., 2013).

In educational AR applications, multimedia materials such as images, texts, audios, 3D objects, 2D or 3D animations and videos are used depending on the learning objectives (Wang et al., 2013). In this kind of multimedia materials, sensuous, interactive and well-designed multimedia lets the learner to participate in the learning process actively and helps maintaining a permanent learning at the same time. Mayer's (2001) Multimedia learning theory is a guide for the formation of these kind of environments. Multimedia learning environments effects the cognitive loads of individuals as well. As Paas, Renkl and Sweller (2003) states, cognitive load theory deals with creating new teaching methods to help individuals with using their information processing capacity effectively. AR applications provide students with multimedia learning environment. AR learning environments that are well designed upon the principles of multimedia learning theory have an important potential for decreasing the cognitive load of individuals and providing an effective learning process (Nedim, 2013; Klatzky, Wu, Shelton & Stetten, 2008; Plass, Moreno, & Brünken, 2010). In addition to this, AR learning environments give opportunity to students to see 2D objects as 3D (Arvanitis et al., 2007; Wu

et al., 2013), to analyze objects from various perspectives and to learn through experience. In this way, a more permanent and effective learning occurs where the students are more active (Chen, Chi, Hung, & Kang, 2011; Dunleavy, Dede & Mitchell, 2009; Wojciechowski & Cellary, 2013; Wu et al., 2013).

In literaure, it is stated that AR applications provide important aids to education process. However, researches in this fiels is early stage (Martin ve diğ., 2011; Wu ve diğ., 2013). Implementation examples are needed in order to integrate the AR technology into the areas of education. Accordingly, the AR applications should vary in different fields and levels of education. Additionally, investigating the different variables and the relationships between these variables where AR technology is integrated into different fields of education can offer important data to researchers. In literature, it is emphasized that inner judgment period is rather important in the adaptation process of new technologies by individuals. The individuals' manners are positive when they find the new technologies as easy and useful (Venkatesh, Morris, Davis & Davis, 2003). For this reason, determining of students' attitudes is important for new technologies integration. Also, achievement and cognitive load of students is important variables for determining of instructional method efficiency (Clark, Nguyen & Sweller, 2005). In spite of existing researches in the literature about the attitudes, achievements and cognitive load levels of students in different AR applications from different fields of education, there are not enough extensive studies focusing on revealing the relationships between those variables. Likewise, the studies in the literature are short-dated applications for a limited amount of students. In this sense, the quantitative researches done with big sample groups may be a guide for the researchers (Wu et al., 2013). This study focuses on how learning English by using AR applications affects secondary school students. In this study, choosing secondary school students as level of education, handling English learning, studying on a high number of students, investigating important variables in the period of education are the factors that will contribute to the further studies in this area. Within this context, the answers for the following research questions are to be found out in this study.

1. What are the achievement, attitude and cognitive load levels of students who use AR applications?
2. Is there a difference the attitude and cognitive load levels of students, who use AR applications, depending on their achievement levels?
3. What is the relationship between achievements, attitudes and cognitive loads of students who use AR applications?

Method

In the study, casual-comparative and correlational methods, which are nonexperimental, were used. The aim of casual-comparative research is to determine the casual relationship between the dependent and independent variables. This kind of studies aim to determine the causes of a new onset of circumstance, the variables that affect these causes or the results of the cause. In this sense, the attitudes of secondary school students towards AR applications and the cognitive loads occurred after the application were compared according to their achievement levels. Correlational researchs are done to describe the relationships between two or more variables where the described relationships are later analyzed in dept (Buyukozturk et al., 2008; Fraenkel, Wallen & Hyun, 2012; McMillan & Schumacher, 2010; Sozbilir, 2014). In this study, correlational research was used to determine the relationships between attitude, cognitive load and achievement in learning English with AR applications.

Sampling and Implementation Process

The sample of the study is composed of 122 fifth-grade students (66 males and 56 females) from 5 different secondary schools in 2014 spring term in Erzurum. Within the scope of the study, AR applications for English courses are designed and implemented. Primarily, the chapters included in the spring term fifth grade English course curriculum are analyzed by instructional designers to decide on an appropriate chapter for the AR applications. As a result of this process, it is decided to design multimedia materials for the topics of Chapter 9 (Animal Shelter). By the collaboration of instructional designers and teachers, Chapter 9 of fifth grade English course book is transformed into a magic book by designing AR applications. The book includes several multimedia materials, designed for the topics of Chapter 9, such as 3D objects, 3D and 2D animations, videos and audios. In accordance with the acquisitions of the chapter, thirty 3D animal models are found online or created by using Autodesk Maya software. In addition to this, two 3D characters, one 3D zoo models are created. Within the scope of the study, seventeen short time (1-3 minutes) 3D animations and twelve 2D animations are created using Muvizu and Adobe Flash softwares. These materials are supported by English pronunciation. The magic book application, which includes the educational materials, is created by the aid of marker-based AR technology and Metaio Creater software. In the marker-based AR applications, the students can interact with the course content by using computer, web camera and printed course material. When the images and the prepared marker cards, which are placed on the printed material, shown to the web camera, they are activated on the book as 3D object, animation and video. The students were provided with learning that chapter by using the live book, which is designed by AR applications, under the guidance of teachers in computer laboratories. The implementation phase was held for two weeks and two lessons for each week. (Figure 1).

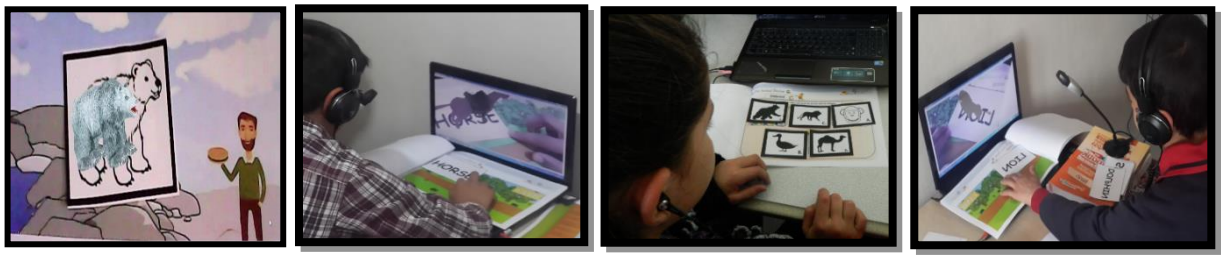

Figure 1. Images from the Implementation

Data Collection Tools

In this study, AR applications attitude scale, cognitive load scale and achievement test were used as data collection tools. AR applications attitude scale is developed by Kucuk, Yilmaz, Baydas and Goktas (2014), includes 5 point Likert scale (1: Strongly disagree, 2: Disagree, 3:Indecisive, 4:Agree, 5:Strongly Agree) and composed of 15 items. Cognitive load scale, found by Paas ve Van Merrienber (1993), was used in order to quantify the amount of effort exerted by students by using the magic book. Cognitive load scale is composed of a rating scale which goes from 1 to 9. The customization of the cognitive load scale in Turkish was done by Kilic and Karadeniz (2005) and the data intervals are classified as 1 to 4.49 unloaded, 4.50 to 5.50 in between and 5.51 to 9 loaded. The students filled the cognitive load scale two times, one in the first week and one in the second week. The cognitive load levels of students were calculated by using the mean value of the results from the two weeks gives. An achievement test that consists of 7 multiple-choice questions and 13 gap-filling questions to determine the learning levels of students. The achievement test was controlled by two English teachers to gain validity in terms of scope and appearance. After the pilot implementation with 20 students, the achievement test was improved and came to its final version by taking the feedbacks of field experts into consideration. Each single question is worth 5 points and the maximum grade that can be gained from the test is 100. The students were categorized under 2 headings as high level of achievement and low level of achievement by converting their test points into Z point.

Data Analysis

In data analysis process, descriptive and inferential analysis tests were used. Before analyzing data, tests were applied for normality, homogeneity and equality of variances to ensure internal consistency and the data that do not show normal distribution were normalized by using logarithmic transformation. In the study, MANOVA Test was used to decide whether there is a difference between the attitudes and cognitive loads of students depending on the achievement levels of students or not and Pearson's Multiple Correlation Test was used to identify the relationships between achievement, attitudes and cognitive loads of students.

Results

While analyzing the data, priority was given to descriptive data. Later on, one-way MANOVA test and correlation tests with multiple ways were applied. Some prerequisites should be fulfilled to apply these tests. As a result of this, findings that are related to prerequisites have been introduced and then obtained findings were included respectively within the frame of research questions.

Assumptions

Sample size, normality or outliers, linearity, variance equality, multicollinearity and singularity are the prerequisites for applying one-way MANOVA test (Pallant, 2007). It was seen that the assumed data did not show normal distribution and the dependent variables were normalized by using logarithmic transformation. After sorting the outliers out, it was seen that the data shows linearity. The results of Box's M test and Levene's test were analyzed to determine whether the variances are equal or not. Both the result of Box's M test (p=.29) and the result of Levene's test ($p_{attitude}$=.417, $p_{cognitive\ load}$=.269) indicates the equality of the variances (p>.05). It is considered inappropriate for the MANOVA test when the values of the relationship between the dependent variables are bigger than 0.9. To prove this assumption, the values of the relationship between the variables were identified. It was observed that all the values are below 0.9. Moreover, the data types and their distributions should be the same to decide on the relationships between the variables (Field, 2009). The prerequisites directed towards this circumstance were provided in the data set.

1. ***What are the levels of achievement, attitude and cognitive loads of students who use AR applications?***

In this study, the levels of achievement, attitude and cognitive loads of students who use AR applications were determined. The findings are presented in Table 1.

Table 1. Descriptive Data for the Variables

	Achievement		Attitude		Cognitive Load	
	$\overline{X}$	SS	$\overline{X}$	SS	$\overline{X}$	SS
Female (N=56)	76.39	18.08	4.36	0.66	3.68	2.45
Male (N=66)	76.52	19.84	4.51	0.45	2.81	1.43
Total (N=122)	**76.46**	**18.97**	**4.44**	**0.56**	**3.21**	**2.01**

According to the obtained data, it was seen that the students have high mean levels of achievement ($\overline{X}$ =76.46) and attitude ($\overline{X}$ =4.44). In terms of cognitive load, it was determined that the load levels ($\overline{X}$ =3.21) of students are slightly low ($\overline{X}$ <4.50). When the results were examined in terms of gender, the females and males have similar averages in terms of achievement ($\overline{X}_{female}$=76.39, $\overline{X}_{male}$=76.52). Even the attitude levels of males ($\overline{X}$ =4.51) are high compared to the attitude levels of females ($\overline{X}$ =4.51), females have higher cognitive load than that of males ($\overline{X}_{female}$=3.68, $\overline{X}_{male}$=2.81). As a conclusion, it was revealed that the students who use AR applications have high level of achievement, show positive attitude towards technology and effort low amount of cognitive effort during the implementation process. On the other hand, the data for the sub factors of the scale are presented in Table 2.

Table 2. Descriptive Data for the Attitude Scale

	Willingness		Anxiety		Satisfaction	
	$\overline{X}$	SS	$\overline{X}$	SS	$\overline{X}$	SS
Female (N=56)	4.55	0.69	1.74	0.87	4.40	0.67
Male (N=66)	4.40	0.83	1.52	0.52	4.56	0.55
Total (N=122)	**4.47**	**0.77**	**1.62**	**0.71**	**4.49**	**0.61**

According to the obtained data, the mean of willingness ($\overline{X}_{female}$=4.55, $\overline{X}_{male}$=4.40) and satisfaction ($\overline{X}_{female}$=4.40, $\overline{X}_{male}$=4.56) factors are close to each other for both males and females. In addition, it was seen that the females have a higher mean of anxiety compared to the mean anxiety level of males ($\overline{X}_{female}$=1.74, $\overline{X}_{male}$=1.52). In this sense, the final result is that the students who used the AR application have an intention to use it again in the future, they are satisfied with the application and they have a low level of anxiety while using the application.

2. ***Is there a difference between the attitudes and cognitive loads of students, who use AR applications, depending on their achievement levels?***

In the study, it was seen that there is a significant difference between the attitudes and cognitive loads of students (*Roy's Largest Root* = .097, $F_{(2,98)}$=4.75, p<.05). The data obtained according to the MANOVA test are presented in Table 3.

Table 3. MANOVA Results Related to the Attitude and Cognitive Load Levels

	Λ	F	p	R^2
Intercept	2.055	99.68	**.000**	.673
Achievement Level	.097	4.75	**.011**	.088

As the differences formed by the levels of achievement are analyzed, a significant difference is seen in terms of attitude ($F_{(2,98)}$=4.40, p<.05, R^2=.082). In this way, it was observed that the successful students ($\overline{X}$ =4.65, SS=0.25), develop a more positive attitude compared to the unsuccessful student ($\overline{X}$ =4.30, SS=0.62). On the other hand, there is no difference in cognitive load depending on achievement level ($F_{(2,98)}$=0.07, p>.05, R^2=.002). Hereby, it was found that achievement level has no effect on cognitive load level. Nevertheless it was seen that successful students' cognitive levels are higher than others ($\overline{X}$ =3.46, SS=2.44). The findings related to the differences in achievement level and cognitive load are represented in Table 4.

Table 4. The Differences between Attitude and Cognitive Levels Depending on Achievement Levels

Independent Variables	Dependent Variables	Sum of Squares	Mean of Squares	df	*F*	*p*	R^2
Revised Model	Attitude	1.247	.623	2	4.406	.015	.082
	Cognitive Load	.011	.006	2	.076	.926	.002
Intercept	Attitude	5.712	5.712	1	40.378	**.000**	.292
	Cognitive Load	9.573	9.573	1	128.910	**.000**	.568
Achievement Level	Attitude	1.247	.623	2	4.406	**.015**	.082
	Cognitive Load	.011	.006	2	.076	.926	.002

3. ***What is the correlation among the achievement, attitude and cognitive loads of students who use AR technology?***

In the study, Pearson's Multiple Correlation Test was used to identify the relationships between achievement, attitudes and cognitive loads of students. The obtained data are presented in Table 5.

Table 5. Pearson's Correlation Coefficient between Factors

	Achievement	Attitude	Cognitive Load
Achievement	1		
Attitude	.261**	1	
Cognitive Load	-.140	-.207*	1

*p < .05 **p < .01

When Table 5 is examined, a low positive relationship (r=.261, p<.01) seen between achievement and attitude whereas a low negative relationship is seen between cognitive load and attitude (r=-.207, p<.05). On the other hand, no relationship is seen between achievement and cognitive load (r=-.140, p>.05). Accordingly, it was revealed that the students with a high level of achievement level show a positive attitude towards AR application. Additionally, it was observed that the students with a low level of cognitive load have a positive attitude.

Discussion, Conclusion and Suggestions

Discussion

In this study, the achievement, attitude and cognitive load levels of secondary school students who learn English by using AR applications are examined. In this sense, it is researched whether there is a relationship between the attitudes and cognitive load levels of students depending on their achievement levels and the relationships between these variables are revealed.

In this study, the emerging fact is that the students who use AR applications in English learning have a high level of achievement, show a positive attitude towards this technology and exert low amount of effort during the implementation process. Besides, the result of the research is that the students who have used AR applications have an intention to use these applications in the future, satisfied with the implementation and have a low level of anxiety while using this technology. This situation can be explained by the fact that the AR applications attract the attention of the students, offers a effective learning environment and increases the motivation of students about learning the topics. In addition, the underlying reason that turns the attitude of students into positive may be the fact that the students come across a different education style other than traditional education and interact with the learning content. Also in the literature, the underlined case is that learning English by using AR applications increases motivation and the students who use these applications enjoy using them and have a positive attitude towards the applications (Vate-U-Lan, 2012; Mahadzir & Phung 2013; Wei & Elias; 2011). Besides, it is observed that the students who use AR applications in their English courses increase their English reading, understanding, listening and speaking skills more than the students who learn English in traditional education (Barreira et al., 2012; Hsieh & Lee; 2008; Vate-U-Lan, 2012). In addition to this, it is stated in the literature that the students should have some skills and abilities such as spatial ability, technology self-efficacy, mathematical estimation, problem solving and team work not to face any difficulties. When the students have difficulty during using the application, this situation may affect the attitude of the students negatively (Kerawalla et al., 2006; Klopfer & Squire, 2008; Wu et al., 2013). In this study, implementing the AR applications in computer labratories under teacher's guidance would have resulted in having no difficulty while using the applications and having low levels of anxiety with the students. The intention of students to use AR applications in the future may be explained by the means of the objects that go under transformation to attract the attention of students and increase the motivation of students (Billinghurst, Kato, & Poupyrev, 2001; Bujak et al., 2013; Oh &Woo, 2008; Wojciechowski & Cellary, 2013; Zhou et al., 2004). On the other hand, the fact that the students have low levels of cognitive load levels while learning English by using AR applications may be the sign of effective materials which are designed in accordance with the cognitive load theory principles. In the literature, it is stated that the well-designed AR applications that are in accordance with the principles of multimedia learning theory have a potential to decrease the cognitive load of individuals and ensure effective learning (Nedim, 2013; Klatzky et al., 2008; Plass et al., 2010).

In the study, as the attitudes of students towards the application and the cognitive load levels of them are analyzed it is decided that the successful students have more positive attitudes towards the application but there is not a significant difference between cognitive load levels. When the mean of attitudes of students both in successful and unsuccessful groups are analyzed, it is observed that the members of both groups have positive attitudes towards the application. The higher attitude mean of successful students may be a sign that the successful students may have increased their engagement levels by being more interested in the application. The increase of engagement duration of students may have resulted in students' attitudes to be more positive. Accordingly, it can be stated that this situation may be effective in increasing the achievement of the students.

In the study, the correlation among achievement, attitude and cognitive load are determined. As a result of this; a positive low relationship was seen between achievement and attitude whilst a low negative relationship was identified. On the other hand, no relationship was seen between achievement and cognitive load. The relationship between achievement and attitude shows that the students who have positive attitude towards AR applications are more successful compared to the other students. In the study, it is observed that the cognitive load levels of successful and unsuccessful students are close to each other. This situation may be the reason of arising of a low relationship between attitude towards AR applications and the cognitive load levels and also the reason of non-existence of the relationship between achievement and cognitive load level. In the literature, contrary to this, it is stated that the cognitive load level closely correlates with satisfaction state of students in the learning environment and achievement (Bradford, 2011; Salomon, 1983; Tuckman, 2003).

Conclusion and Recommendations

In this study, multimedia learning materials were designed by using AR technology for the English lessons on the basis of multimedia learning theory and cognitive load theory and these materials were applied to 122 secondary school students individually. At the end of the research, the attitude towards AR application, achievement and cognitive load levels of students and the relationships between these variables were analyzed. The high number of sample and the application of instructional design process under theoretical framework decided in the integration of AR technology into education are the strengths of the research. Obtaining data in a systematical process is important for accomplishing valid and reliable results. The usage of valid and reliable attitude is strengthened the research to find out the relationships between variables. However, the study is limited with a topic of English lesson.

At the end of the study, it is determined that the secondary school students are satisfied with learning English by using AR applications, they have a low anxiety-level and they want to use these applications in future lessons. Moreover, it is identified that the students have low levels of cognitive load during the learning process in the AR environment. Another important result is that, Learning English by using AR applications affects the achievement of students in a positive way. One remarkable result of the research is that the successful students have significantly higher levels of attitude towards AR applications compared to that of unsuccessful students. When the relationship between attitude, achievement and cognitive load levels of students are analyzed at the end of the English learning process by using AR applications, it is seen that the students with high levels of achievement have better attitudes towards AR applications compared to unsuccessful students. In accordance with the results of the research, the below recommendations can be made.

- Well-designed AR applications can be used to create effective and efficiency learning environment that will provide low level cognitive load and high level achievement to students.
- To increase the attention and motivation of students, new learning environments can be created that allows individual usage of AR applications.
- English course books that include AR applications can be designed in the future to give opportunity to the students to study at home.
- Comparative studies can be held by analyzing the attitude, achievement and cognitive loads of students for AR applications in different fields of education.

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