



Augmented Reality Applications Attitude Scale in Secondary Schools: Validity and Reliability Study

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Abstract

The aim of this study is to develop an attitude scale that will help to determine attitudes of secondary school students towards the use of augmented reality applications in education. With this aim, the Augmented Reality Applications Attitude Scale (ARAAS), which is developed in this study, has been presented. The ARAAS's validity and reliability studies have been done with 167 students (84 male, 83 female), which are studying in the 5th grade of 7 different secondary schools in Erzurum. As a result of the exploratory factor analysis applied to provide construct validity of the scale, a construct consisted of 15 items and 3 factors has been attained. The results of confirmatory factor analysis carried out to understand whether this construct adjusts very well to this construct's sample data obtained has shown the adjustment to the sample that the scale applied on is at a reasonable level. The ARAAS's internal consistency reliability coefficient has been found as .83 for the whole scale. Those results show that ARAAS is a valid and reliable measurement tool.

Keywords

Augmented reality
Attitude scale
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Introduction

Thanks to the advancements in computer technologies the question "Does the media affect learning?" has turned into the question "How will the technology change education?" (Banathy, 1991; Reigeluth, 1991). When a new technology is used in education, people wonder whether this new technology will make present learning environments better or not. One of the new technologies, the effect of which is an issue of concern, is the Augmented Reality (AR) technology that its use has become increasingly popular recently. AR is defined as a technology in which the real world and virtual images come together, and a simultaneous interaction is provided between real and virtual objects (Azuma, 1997). AR has featured its use in education by helping the applications prepared to turn an empty space into a rich learning experience (Alcaniz, Contero, Perez-Lopez & Ortega, 2010) thanks to the advanced technology it has. The educational potentials of AR have been investigated in

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recent years (Kesim & Özarlan, 2012), and it has been thought that it will provide important contributions to education in the future (Martin et al., 2011). Thus, it has been stated that technological tools used in education present new opportunities to increase individuals interaction and to provide learning by enjoying, make learning process more active, effective and meaningful, and trigger motivation (Alsumait & Musawi, 2013; Nischelwitzer, Lenz, Searle & Holzinger, 2007). AR technology has attracted attentions in education with its features like enabling individuals to interact with real and virtual objects, providing learning by experience, and increasing attention and motivation (Singhal, Bagga, Goyal & Saxena, 2012). Especially its use in teaching the objects and events that are not possible to see with eye, showing dangerous situations, materializing abstract concepts, and presenting complex information has been indicated to be more effective (Walczak, Wojciechowski & Cellary, 2006). While AR presents a rich interaction (Azuma, 2004), it provides a natural experience and increases attention and motivation (O'Brien & Toms, 2005). In addition, it improves interpreting, problem solving and creative thinking skills (Ivanova & Ivanov, 2011), presents a flexible learning environment to students (Schrier, 2006). Moreover, it is able to support learning approaches like authentic learning, situational learning and constructivist learning when it is integrated into education appropriately (Johnson, Smith, Willis, Levine & Haywood, 2011; Kirner, Reis & Kirner, 2012; Wojciechowski & Cellary, 2013; Yuen, Yaoyuneyong & Johnson, 2011).

When studies in the literature are investigated, in many studies, it has been seen that AR applications' use in education affects learning process positively (Billinghurst, Kato & Poupyrev, 2001; Farias & Dantas, 2011; Kaufmann & Papp, 2006; Kerawalla, Luckin, Seljeflot & Woolard, 2006; Oh & Woo, 2008). Especially children's describing AR as "magic" because of objects' transformation (Billinghurst et al., 2001; Bujak et al., 2013) makes learning process attractive and effective (Oh & Woo, 2008; Wojciechowski & Cellary, 2013). It has also been stated that AR applications can be considerably effective in increasing motivation towards lesson on children, which are in digital native group being hand in hand with technology (Wojciechowski & Cellary, 2013). In particular, because it provides an enjoyable learning environment by drawing very young children's attention, it has been thought that AR applications will become widespread at primary and secondary school levels.

Although it has been mentioned that AR applications will bring a lot of gains together in educational terms, the researches about this topic are just at the beginning level (Martin et al., 2011; Wu et al., 2013). Therefore, it is important doing research by dealing with different educational levels and different variables in learning process. In revealing the potential of AR applications in educational environments there is a need for applications carried out with bigger sample groups and valid data collecting tools (Wu et al., 2013). However, it seems that there is no attitude scale work of which validity and reliability studies have been done towards secondary school students using AR in the literature. This study may fill in the gap in literature in terms of presenting an attitude scale for secondary school level applications. Besides, this study will contribute to the studies, which are going to be carried out in this field in our country, in the sense of providing a Turkish attitude scale that its validity and reliability have been studied. Accordingly, in this study, it is aimed to develop an attitude scale that will help to determine secondary school students' attitudes towards the use of AR applications in education.

Method

In this study, the sequential exploratory mixed method has been used. In this method, at first the qualitative data about the research problem are collected and analyzed; then, in terms of the data obtained from this process the quantitative data are collected, analyzed and interpreted. This method, besides giving advantage to researchers in many ways, it is also indicated in the literature that its use in scale development studies will produce effective results (Creswell, 2014). In this way, at first, by interviewing with secondary school students via qualitative methods and investigating the studies in literature, the items of attitude have been generated in the study. Then, the scale has been put into its final form by applying tests via quantitative methods to the attitude scale prepared.

The Process Steps of the Study

In this study, it is aimed to develop an attitude scale that will help to determine secondary school students' attitudes towards the use of AR applications in education. In the qualitative part of the study, 15 students, which were studying at different secondary schools in Erzurum and used AR applications in their lessons, have been interviewed. In addition, similar studies in the literature and attitude scale development studies for different educational technologies have been investigated (Chang, Chen, Huang & Huang, 2011; Sad, 2012; Yusoff, Zaman & Ahmad, 2011; Wojciechowski & Cellary, 2013). In terms of the data obtained, an item pool, which consists of 26 items (19 positive, 7 negative) in 5 point Likert type (1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree), has been established. With the aim of providing content and face validity, the scale has been checked by four field experts and one Turkish language expert, and necessary changes have been made.

In this study, the data have been collected from 167 secondary school students (84 male, 83 female) from 7 different schools. The sample has been comprised of students, who were studying at the 5th grade. In the implementation step of the study, an AR applications book, which covers 9th Unit (Animal Shelter) of 5th Grade English lesson curriculum, has been designed in cooperation with instructional designers and teachers of the lesson. In this book, multimedia materials like 3D objects, 3D and 2D animations, videos and sounds related to the subjects in this unit. The magic book containing these educational materials has been prepared by using Metaio Creator software with marker-based AR technology. In marker-based AR applications, students can interact with the content of the lesson via computer, web camera and printed lesson materials. When pictures, which take place in printed material, or marker cards, which are prepared, are shown to web camera, those come alive as 3D objects, animations and videos on the book. It has been provided for students to study the unit's first part individually with the magic book prepared under the guidance of teachers in the computer lab. After the implementation process, the data have been collected from students with Augmented Reality Applications Attitude Scale (ARAAS), which has been prepared for the study.

With the aim of ensuring the scale's construct validity, exploratory factor analysis and then confirmatory factor analysis have been done. Exploratory factor analysis (EFA) is one of the statistical techniques, which transforms a lot of connected variables into a few meaningful and independent factors, and which is widely used. Confirmatory factor analysis (CFA), on the other hand, is a statistical technique used to determine whether the variable groups, which take place in the factors decided via EFA, are represented enough with these factors or not (Büyüköztürk, 2010; Tabachnick & Fidell, 2007). In this study, CFA has been performed on the same data set to support determined structure with EFA. After these analyses, the scale has been finalized by interpreting the data. The process steps of the study have been summarized in Figure 1.

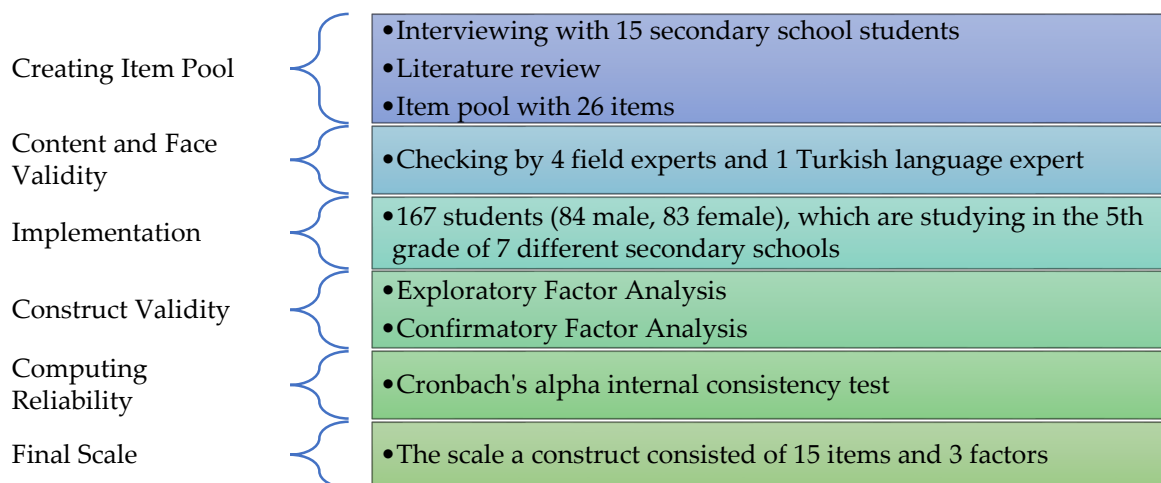


Figure 1. The Process Steps of the Study

Results

Pre-analyses

In the study, at first, the fitness of data has been checked for EFA on ARAAS. To do this, missing values, reverse items, extreme scores, normality of the data set, relationships between items, sample size and sample fitness (KMO and Bartlett's Sphericity Test) have been taken into account (Buyukozturk, 2010; Field, 2009; Tabachnick & Fidell, 2007). In this direction, missing values have been filled in terms of "median of nearby point" since it is Likert type questionnaire with SPSS's "Replace Missing Value" option. In addition, in the questionnaire, 2, 5, 8, 10, 21, 22, 23, 24 items in which negative statements take place, have been reversed. For the normality tests of the data set, Kolmogorov-Smirnov test ($p>.05$), histogram graphics, closeness of mode, median, mean values to one another, and Kurtosis and Skewness coefficients (between +2 and -2) have been considered (Field, 2009; Kalaycı, 2010). As a result, 1., 3., 4., 9., 11., 13., 14., 15., 18., 19., 20., 25., 26. items have been decided to be negatively skewed (Skewness value between -2.61 and -2.02). Hence, the data set has been normalized by applying logarithmic transformation in SPSS.

The Results of Exploratory Factor Analysis and Reliability Study

After the data made suitable for the factor analysis, the relationships between items that take place in EFA's hypotheses have been checked on the correlation matrix and those relationships between items have been determined. In the study, the fitness of sample has been decided as statistically significant since the KMO coefficient was .838 and the Bartlett's Sphericity test's χ^2 value was 1030,36 ($p<.05$). In the study, since higher than .30 level of relationship detected between factors ($r_{1,2}=.291$, $r_{1,3}=.345$, $r_{3,2}=.356$), the Promax, which is a oblique transformation technique, has been decided to be used in the analyses (Brown, 2009). While specifying factor loads of items, Field (2009, p.644) determined the cut values as .512 for a sample group of 100 individuals and .364 for a sample group of 200 individuals. Accordingly cut value in this research is determined as .40. For the communalities table, Pallant (2007, p.196) has stated that items with values under .3 are not suitable with other items in their own factor. For this reason, the communalities table has been checked for each item removed, however, no values have been found less than .3 in any steps. On the other hand, as a result of the first factor analysis, 26 items have been categorized under 5 factors. At this point, items took place under two or more factors have been removed one by one starting from the less useful ones for the scale. Then, Cronbach's alpha coefficient has been controlled for the scale, which has collected under 4 factors. As a result, two items that took place under the fourth factor have been removed from the scale because they decreased the reliability of the scale to $\alpha=.690$ and fourth factor's reliability, which was determined as $\alpha=.420$. Finally, the scale has been collected under 3 factors and consisted of 15 items. The scree plot graph of break point indicates three factor in the scale. As a result, graph have been presented Figure 2.

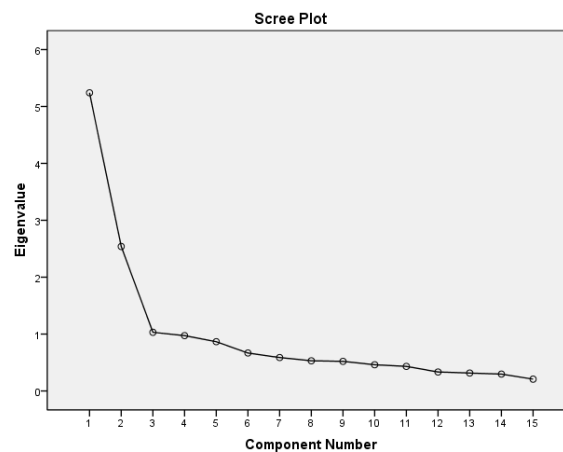


Figure 2. Scree Plot Graph

With the items collected under 3 factors, the variance total that the scale explains has been decided as 58.741%. In addition, the reliability coefficient of the scale has been decided as Cronbach's $\alpha=.835$. In the light of all these information, ARAAS's transformed factor loads, variance information that factors explain and their reliabilities have been presented in Table 1.

Table 1. ARAAS's Transformed Factor Loads, Variance Information, and Reliabilities

Items	Communalities	Factor 1	Factor 2	Factor 3
15 I enjoy the lessons instructed with AR applications.	.713	.879	.081	-.248
12 Demonstration of 3D objects, videos, and animations on the book in AR applications increases my curiosity.	.694	.781	.003	-.045
17 I study harder for the lesson thanks to AR applications.	.585	.776	-.026	.150
14 3D objects in AR applications give sense of reality in the environment	.550	.773	-.024	-.082
13 I come to the class more eagerly when AR applications are used.	.607	.724	-.176	.211
11 I can concentrate better on the lesson when AR applications are used.	.499	.664	.003	.098
26 I enjoy studying lesson at home with AR applications.	.372	.459	.077	.225
22 AR applications do not attract my attention.*	.705	-.185	.818	-.073
23 AR applications make my learning difficult because they confuse my mind. *	.626	-.036	.799	.077
24 There is no need to use AR applications in the classes. *	.559	-.124	.732	.071
21 Using AR applications in the classes causes waste of time.	.586	.200	.695	.219
2 I get bored while I am using AR applications. *	.511	-.014	.687	-.235
8 It is difficult to use AR applications. *	.413	-.024	.644	-.001
20 I want AR applications to be used in other lessons, as well.	.772	.273	-.022	.899
18 I want AR applications to take place in course books in the future.	.623	-.185	.157	.567
Explained total variance (Total=%58.741)		%34.938	%16.943	%6.872
Cronbach's alpha $\alpha=.835$		$\alpha=.862$	$\alpha=.828$	$\alpha=.644$

As it is seen in Table 1, according to items' statements, the first factor has been named as "the use satisfaction", the second factor has been named as "the use anxiety", and the third factor has been named as "the use willingness". In addition, the use satisfaction has consisted of 7 items and factor loads have changed between .879 and .459; the use anxiety has consisted of 6 items and factor loads have changed between .818 and .644; the use aim has consisted of 2 items and factor loads have changed between .899 and .567. It is recommended that no fewer than three items per factor be adhered to throughout in the literature. However, if there is two items per factor, these should be as the exception (Raubenheimer, 2004).

The Results of Confirmatory Factor Analysis

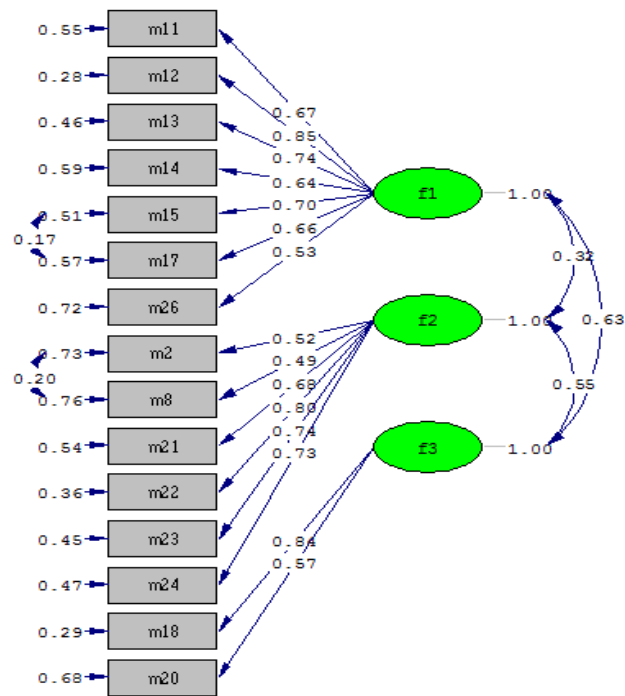
As a result of the EFA, a structure with 3 factors and 15 items has been established. With the aim of providing aid to this structure, Confirmatory Factor Analysis (CFA) has been applied with Lisrell software. As a result of the analysis done, $\chi^2=141.74$ ($df=.85$, $p<.05$) value has been obtained related to the structure of 3 factor scale, which consisted of 15 items. In terms of the results obtained, it is expected Chi-Square value to be insignificant, however, this value is very sensitive to the sample size and it sometimes can be found as significant for bigger sample groups. In that sense, a calculation obtained by dividing the alternatively calculated Chi-Square rate by degree of freedom has been suggested (Kline, 2011). In this study, this rate has been found as ($\chi^2/df =1.66$). This rate's being 2 or under shows that it is a good model, and its being 5 or under, on the other hand, shows that the model has an acceptable fitness level (Simsek, 2007). Therefore, the value obtained here is an important evidence for the model to be an/a acceptable/good one. In addition to this, Root Mean Square Error of Approximation (RMSEA), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), and Standardized Root Mean Square Residual (SRMSR) fitness indices have also been calculated. When the correction indices suggested by Lisrell software investigated, correlation has been allowed between errors via expert opinion since the suggested error correlations took place under the same factor, and the model has been re-established. The value ranges of the indicated indices were based on Hair, Anderson, Tatham and Black (1998), Kline (2011), Raykov and Marcoulides (2006) and have been presented with the first pre and post-modification values in the model in Table 2.

Table 2. Results of CFA for Pre-Modification and Post-Modification (Final) Models of ARAAS.

Fitness Statistics	Perfect	Acceptable	Pre-modification	Post-modification	Fitness
χ^2/df	≤ 2	2-5	1.92	1.67	Perfect
RMSEA	$\leq .05$	$\leq .08$	.07	.06	Acceptable
GFI	$\geq .95$	$\geq .90$	.88	.90	Acceptable
AGFI	$\geq .95$	$\geq .85$	.84	.86	Acceptable
CFI	$\geq .97$	$\geq .95$	.95	.96	Acceptable
SRMR	$\leq .05$	$\leq .1$	.06	.06	Acceptable
NFI	$\geq .95$	$\geq .90$	.91	.92	Acceptable
NNFI	$\geq .97$	$\geq .95$	.94	.96	Acceptable

As it is seen in Table 2, the model prepared is at an acceptable level. The standardized factor loads' values have been changing between .85 and .49 in terms of the last model. In addition, no insignificant structure has been met between t-values. In the study, as a result of the analyses to develop ARAAS, a structure comprised of 3 factors and 15 items have been obtained. The Path diagram gained from CFA has been presented in Figure 3.

The obtained data related to the validity and reliability has shown that ARAAS can be used safely to measure secondary school students' attitudes towards AR applications.



Chi-Square=141.74, df=85, P-value=0.00011, RMSEA=0.063

Figure 3. Path Diagram for ARAAS

Discussion, Conclusion and Suggestions

In this study, it is aimed to develop an attitude scale that will help determining the attitudes of secondary school students towards the use of AR applications in education. With this aim, in the first step, a scale consisting of 26 items in Likert type has been prepared via qualitative methods. The validity and reliability analyses of the scale have been done on 167 participants. After necessary steps have been applied in EFA, a structure with 3 factors and 15 items have been established. In the direction of expert opinions and literature, the first factor has been named as “the use satisfaction”, the second factor has been named as “the use anxiety”, and the third factor has been named as “the use willingness”. In the first factor, there are 7 positive statements that will reveal students' satisfaction levels towards AR applications. In the second factor, there are 6 negative statements that will show students' anxiety towards the use of AR applications. Finally, in the third factor, there are 2 positive statements that will bring out students' aims to use AR applications in the future. Although the factor's being formed by two items can be evaluated as a limitation for the research, factor's reliability is relatively high. The internal consistency analysis (Cronbach's alpha), which was applied to the factors obtained and the whole scale, has shown that the scale is reliable (The whole scale $\alpha=0.835$, the 1st factor $\alpha=0.862$, the 2nd factor $\alpha=0.828$, the 3rd factor $\alpha=0.644$). With the aim of providing aid to this structure, Confirmatory Factor Analysis (CFA) has been performed. The structure established through EFA has been tested via CFA. The results have shown that the developed structure is acceptable (see Table 2).

As it has been stated in the literature, in education, AR applications provide important gains to students in the learning process (Billinghurst et al., 2001; Farias & Dantas, 2011; Kaufmann & Papp, 2006; Kerawalla et al., 2006; Oh & Woo, 2008; Wu et al., 2013). Students' attitudes towards AR applications emerge as an important factor in those applications' establishing positive effects in the learning process. In the literature, there is limited number of studies to reveal students' attitudes towards AR applications (Balog & Pribeanu, 2010; Wojciechowski & Cellary, 2013). In addition, it is seen that there are not any data collection tools of which validity and reliability studies have been done that will show secondary school students' attitudes. Accordingly ARAAS has been developed in this research. Scale is formed by three factors as "the use satisfaction", "the use anxiety" and "the use aim". 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. If they have troubles and hesitations with using them, the use anxiety emerges and their behaviors towards the new technologies negative. The use aim unveils individuals' desire whether to use mentioned new technologies in future or not. In accordance with the literature, the three factor structure revealed in the scale is meaningful while conceiving attitude of individuals (Venkatesh, Morris, Davis ve Davis, 2003).

The attitude scale, which was developed in terms of the results gained from this study, is a valid and reliable measurement tool that will be used in the secondary school level. However, collecting data only from 5th grade students under education in secondary school can be perceived as a limitation in this research. Besides, it was not possible to collect data from different sample groups for confirmatory analysis as the research involved a teaching design period. Also, performing confirmatory factor analysis with using data collected for explanatory factor analysis is another limitation of the research. This scale can be used for determining students' attitudes in the integration period of AG technology. Though the scale was developed as a result of use of AG applications, it can be a useful tool for other lessons. In the future studies, the data collected through this attitude scale can be correlated with different variables in the learning process. In addition, attitude scale development studies towards different educational levels can be realized.

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