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Teaching Turkish-Islamic Scholars in Mobile Augmented Reality Environment: Its Effect on Students' Scientific Attitudes

Pelin YILDIRIM [1] Gonca KEÇECİ [2]

Abstract

Science history showcases scientific thought's evolution and discoveries to students. Some topics include abstract concepts, making them challenging. Technology enhances teaching history of science, making it more effective and accessible. This study aims to examine the influence of teaching the lives of Turkish-Islamic scholars who have made significant contributions in various scientific disciplines such as astronomy, chemistry, and physics through TISAR-3D, a Mobile Augmented Reality (MAR) based learning environment, on secondary school students' scientific attitudes. A quasi-experimental method was employed in this study. This study was conducted in a public school in Elazığ, involving a total of 90 students in the 7th grade. Half of these students were assigned to the experimental group, while the other half formed the control group. The study was carried out for a duration of eight weeks on the experimental and control groups. The study lasted for eight weeks and consisted of an experiment group and a control group. The TISAR-3D application was used in the experiment group, while reading texts were used in the control group. The data obtained through the Scientific Attitude Scale were analyzed quantitatively using the SPSS 22 software package, and ANCOVA was applied. The study found that although the average scientific attitude scores of students in the experiment group, where the MAR application was used, were higher than the average scores of students in the control group, where reading texts were used, there was no statistically significant difference. Although primary textbooks are accessible to all students, insufficient coverage of Turkish-Islamic scholars and unfamiliarity with practical scholars may explain the lack of significant differences in scientific attitudes. Also, an eight-week study may not sufficiently alter students' scientific attitudes. By designing longer-term studies, a better understanding of how scientific attitudes develop and change over time can be achieved.

Keywords: Science History, Science Education, Mobile Augmented Reality, Turkish-Islamic Scholars, Secondary School Students, Scientific Attitude

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Mobil Artırılmış Gerçeklik Ortamında Türk-İslam Alimlerinin Öğretilmesi: Öğrencilerin Bilimsel Tutumlarına Etkisi

Pelin YILDIRIM [2] Gonca KEÇECİ [3]

Öz

Bilim tarihi, öğrencilere bilimsel düşüncenin gelişimini ve bilim insanlarının keşiflerini aktaran bir alandır. Ancak, bu konuların bazıları soyut kavramları içerebilir ve bu da öğrenciler için anlaşılması zor olabilir. Teknolojinin kullanımıyla birlikte, bilim tarihi öğretimi daha etkili, ilgi çekici ve kolay erişilebilir hale gelmektedir. Bu çalışma ile astronomi, kimya, fizik gibi birçok farklı fen disiplininde büyük başarılara imza atmış Türk-İslam âlimlerinin hayatının TISAR-3D adlı Mobil Artırılmış Gerçeklik (MAG) tabanlı öğrenme ortamında öğretilmesinin, ortaokul öğrencilerinin bilimsel tutumlarına etkisinin araştırılması amaçlanmıştır. Çalışmada yarı deneysel yöntem kullanılmıştır. Elazığ ilindeki bir devlet okulunda gerçekleştirilen bu çalışma, 7. sınıfta öğrenim gören toplam 90 öğrenci üzerinde yapılmıştır. Bu öğrencilerin yarısı deney grubunda yer alırken diğer yarısı kontrol grubunu oluşturmuştur. Deney grubu ve kontrol grubu üzerinde sekiz hafta süren bir çalışma gerçekleştirilmiştir. Deney grubunda TISAR-3D uygulaması, kontrol grubunda ise okuma metinleri kullanılmıştır. Bilimsel Tutum Ölçeği kullanılarak elde edilen veriler, SPSS 22 paket programı kullanılarak nicel olarak analiz edilmiş ve ANCOVA uygulanmıştır. Çalışmanın sonucunda, MAG uygulamasının kullanıldığı deney grubundaki öğrencilerin bilimsel tutum ortalama puanları, okuma metinlerinin kullanıldığı kontrol grubundaki öğrencilerin ortalama puanlarından daha yüksek olmasına rağmen, istatistiksel olarak anlamlı bir fark bulunmamıştır. Ülkemizde her öğrencinin ulaşabileceği birincil kaynak ders kitapları olmasına rağmen, ders kitaplarında Türk-İslam âlimlerine yeterince yer verilmemesi ve öğrencilerin daha önce uygulamada/okuma metinlerinde yer alan âlimleri tanımaması, grupların bilimsel tutum ortalamalarında istatistiksel olarak anlamlı fark olmamasının nedenlerinden olabilir. Bunun yanı sıra sekiz haftalık bir çalışma süresi, öğrencilerin bilimsel tutumlarını önemli ölçüde değiştirmek için yeterli olmayabilir. Daha uzun vadeli çalışmalar tasarlanarak, bilimsel tutumların zamanla nasıl geliştiği ve değiştiği daha iyi anlaşılabilir.

Anahtar Kelimeler: Bilim Tarihi, Fen Eğitimi, Mobil Artırılmış Gerçeklik, Türk-İslam Alimleri, Ortaokul Öğrencileri, Bilimsel Tutum

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Introduction

In today's era, education activities without the inclusion of technology cannot meet the needs of individuals or societies (Karasar, 2004). Technology maintains a prominent presence in every aspect of our lives. Education must adapt to these advancements and be intertwined with technology. Particularly, new generation technologies such as Augmented Reality (AR) have the potential to transform education.

AR holds a significant position in the field of education as an innovative and promising area of research and application. AR overlays virtual information onto the real world, introducing new and interactive methods of learning (Billinghurst, Clark & Lee, 2015). It is categorized as a form of mixed reality, where virtual objects are seamlessly integrated into the real environment, creating an immersive learning experience (Milgram, Takemura, Utsumi & Kishino, 1995; Pan, López, Li & Liu, 2021). According to the Horizon reports AR technology is predicted to have a significant impact on education in the future (Cai, Wang & Chiang, 2014). A report from 2012 also emphasizes the potential impact of integrating AR into education within the next 4-5 years. Likewise, some experts assert that AR holds the potential for transformative effects in education (Kiryakova, Angelova & Yordanova, 2018).

AR has gained significant interest and research attention in the field of education in recent years. This technology provides numerous benefits in education. It enables students to visualize and comprehend abstract or complex concepts through visual and concrete representations (Radu, 2014; Yildirim, 2018; Johnson, Levine, Smith & Stone, 2010; Kececi, Yildirim & Kirbağ Zengin, 2021a; Wu, Lee, Chang & Liang, 2013). AR offers an interactive learning experience, encouraging active student engagement, and providing personalized learning opportunities tailored to individual needs (Ibáñez, Di-Serio, Villarán-Molina & Delgado-Kloos, 2016; Yusoff & Dahlan, 2013). Furthermore, AR enhances motivation and stimulates interest, enabling students to learn more effectively (Akkus, 2021; Chang & Hwang, 2018; Erbas & Demirer, 2019; Georgiou & Kyza, 2018; Hung, Chen & Huang, 2017). AR also plays a crucial role in distance education by offering virtual classroom experiences, overcoming geographical limitations, and increasing accessibility to education (Erbas & Demirer, 2014). With all these benefits, AR is emerging as a transformative tool in education, shaping the future of learning. This study aims to examine the influence of teaching the lives of Turkish-Islamic scholars in a Mobile Augmented Reality (MAR) learning environment called TISAR-3D on secondary school students' scientific attitudes.

History of science is a discipline that examines the development process of scientific knowledge, the emergence of theories, situations where society can contribute to science, the struggles of scientists, the tools they use, the general recognition of scientific activities, and the societal responses to scientific outcomes (Matthews, 1994; Topdemir & Unat, 2014). Including the history of science in education is crucial for offering students a comprehensive understanding of the evolution of scientific breakthroughs. Insufficient availability of learning resources regarding the history of science has a detrimental impact on the teaching process (Henke & Höttecke, 2015). Traditional methods of teaching can lead to student boredom and difficulty in understanding the subject (Duman, 2023; Utkugun & Yildirim, 2023). Therefore, the use of technological applications is important for making the teaching process more effective. However, existing technological applications are not sufficient for teaching the history of science.

Animation and simulations can provide individuals with educational and interactive experiences (Krajšek & Vilhar, 2010; Piliouras, Siakas & Seroglou, 2011), but combining real-world experiences with AR technology can provide a superior learning experience. AR technology enables students to interact with the real world in a virtual environment, making the history of science more engaging and interactive (Ates & Garzón, 2023; Yildirim, 2018). With this technology, students can explore historical events and scientists in a more immersive and realistic way.

Importance of Research

The term "nature of science" encompasses what science is, how it operates, its scientific culture, society's responses to scientific activities, within the context of science education (Clough, 2006). Properly understanding the nature of science can help students progress in their science education and achieve scientific literacy (Matthews, 1994; National Research Council [NRC], 1996). Effectively conveying knowledge and scientific processes to students, as done by scientists, is important in helping students perceive science as a human endeavor, increasing their interest in science lessons, enhancing their learning of scientific content, and improving their collective decision-making skills (Matthews, 1994; McComas, Clough & Almazroa, 1998).

Science history is a field that serves as a bridge between science and the humanities, being a component of the nature of science. Science history has several educational values, including deepening students' understanding of the nature of science, increasing their interest and motivation, aiding in their comprehension and construction of scientific knowledge, developing their critical thinking skills, enriching and humanizing the content of textbooks, providing teaching material support for teachers, and serving as an inspiration for the design of relevant instructional connections (Matthews, 1994). The use of science history has long been recommended as a tool, particularly for enhancing students' understanding of science.

In today's rapidly advancing societies, it is important for educational institutions, including schools, to keep up with technological developments and provide educational environments designed to equip students with the skills of today and the future (Gungordu, 2018). In this context, technologies like AR are being used as significant tools in the field of education. Furthermore, AR aids societies in responding to changes in information technologies and contributes to the development of new technologies. Therefore, the use of new technologies like AR in education plays an effective role in enabling students to receive a better education and prepare them for future job and life skills. On the other hand, the examination of scientists in a MAR-based learning environment can increase students' interest in science history and help them develop a deeper understanding of science. A MAR-based learning environment can make abstract concepts more tangible for students by offering interactive and visual learning experiences (Johnson et al., 2010; Kececi et al., 2021a; Wu et al., 2013) and help them grasp previously difficult-to-understand topics more easily (Coskun, 2018; Kececi, Yildirim and Kirbag Zengin, 2021b). In this manner, the integration of new technologies in education contributes to students receiving a better education and prepares them for the challenges they will face in the future.

Despite the existence of new technologies and resources, it is emphasized that science textbooks play a significant role in shaping students' beliefs and attitudes towards science (DiGiuseppe, 2013; Ramnarain & Chanetsa, 2016). However, science textbooks often face a challenge with the lack of sufficient content related to the historical, provisional, and human dimensions of science, limiting students' understanding of science and scientists (Chi, Wang & Qian, 2023; Idin & Yalaki, 2016). This situation may lead to deficiencies in shaping students' beliefs and attitudes towards science. Particularly, the inadequacy of content related to the history of science can restrict students' understanding of science and scientists. It is unclear whether these deficiencies negatively affect students' scientific attitudes and how they influence their interest in the natural sciences. In this context, a problem situation emerges for effective education strategies and content development to enhance scientific attitudes and increase students' interest in the natural sciences. In this regard, this study aims to examine the impact of teaching the significant contributions of Turkish-Islamic scholars in various science fields such as astronomy, chemistry, and physics through a MAR-based learning environment called TISAR-3D on the scientific attitudes of secondary school students. This research will not only focus on effectively conveying the contributions of scientists to students but also investigate how a MAR-based learning environment can contribute to students' attitudes towards science, thus playing a crucial role in increasing students' interest in the natural sciences and strengthening positive attitudes towards science.

Method

In the researcher's doctoral thesis, the "Turkish-Islamic Scholars Knowledge Test" was utilized as a quantitative data collection tool to assess the current levels of knowledge among secondary school students regarding Turkish-Islamic scholars. Additionally, the "Scientific Attitude Scale" was employed to determine the scientific attitudes of the same students. ANCOVA was applied to statistically control the variables associated with the dependent variable. The Turkish Islamic Scholars Knowledge Test_ POST (TISKT_POST) and Scientific Attitude Scale_POST (SAS_POST) variables were defined as dependent variables, while the method, The Turkish Islamic Scholars Knowledge Test_ PRE (TISKT_PRE), and Scientific Attitude Scale_POST (SAS_PRE) variables were defined as independent variables. This study includes data related to the attitude variable and incorporates variables associated with the Turkish-Islamic Scholars Knowledge Test to assist researchers in gaining a clearer understanding of the impact of students' scientific attitudes. The inclusion of these variables in the ANCOVA analysis aims to provide researchers with the opportunity to assess how much the effects on students' scientific attitudes are influenced by the variability originating from their initial knowledge levels.

The study employed a quasi-experimental method, where the pre-existing classroom sections were assigned as the experimental and control groups in an unbiased manner. This choice was made based on the assumption that potential errors or variables that could threaten internal validity would have the same effect on both groups and could be controlled.

In educational research, controlling all variables is generally challenging. It is known that in schools affiliated with the Ministry of National Education, classroom assignments are predetermined, and students are placed using a different method than random assignment to experiment and control groups. Therefore, in educational research, the quasi-experimental method is considered a more preferred approach due to its practical applicability and minimal disruption to school routines (Cepni, 2010).

Participants

The study was conducted during the first semester of the 2022-2023 academic year. It involved a total of 90 students, with 41 of them being girls and 49 being boys. These students were studying in the 7th grade of a public school located in the city center of Elazığ. Purposive sampling design was used in the sample selection in the study. Purposive sampling involves selecting units or individuals who possess similar characteristics to the parameters of the population in order to form the sample. In this method, the sample group can be divided into subgroups (e.g., girls and boys), and the selected sample units from each subgroup should possess an important characteristic that can represent the entire group (Cepni, 2014). The study was carried out in the selected school due to its central location and the presence of students from different socioeconomic backgrounds. The study employed both an experiment and a control group. Detailed information regarding the study group and the procedure can be found in Table 1.

Table 1. Sample and Conducted Studies

Groups	Pre-test	Total Eight Weeks for the 2022-2023 Academic Year	Post-test
Experiment group (45 participants)	Scientific Attitude Scale	TISAR-3D application developed for scholars and supported by MAR technology	Scientific Attitude Scale
Control group (45 participants)	Scientific Attitude Scale	Reading texts prepared for scholars	Scientific Attitude Scale

Research Process

In this process, the experiment group used the TISAR-3D application developed for scholars and supported by MAR technology. In the control group, reading texts prepared for scholars were used during the instructional process. The conducted study spanned a total of eight weeks, with two weeks allocated for pre-test and post-test applications.

TISAR-3D is an AR-based educational app for multiple platforms. The application includes audio and text-based educational content about the physical descriptions and inventions of five Turkish-Islamic scholars: el-Cezeri, Ibnu'l-Heysem, Abdurrahman el-Hazini, Ibnu'n-Nefis, and Ebu Bekir er-Razi. The application also features 3D visuals and provides language support in Turkish and English.

Data Collection Tools

In the study, the Scientific Attitude Scale, originally developed by Moore and Foy and adapted into Turkish by Demirbas and Yagbasan (2007), was utilized to assess the levels of scientific attitude among secondary school students. The scale comprises 6 subscales and 40 items. The translation of the scale into Turkish was presented to experts for their opinions regarding language, content, and scope. To assess the validity and reliability of the scale, it was tested on 300 students in grades 6, 7, and 8 in elementary schools, and analyses were conducted. The results indicated a Cronbach's Alpha reliability coefficient of 0.76 and a Spearman-Brown split-half test correlation of 0.84 for the scale. The content of the items, subscales, and scoring ranges are detailed in Table 2.

Table 2. Scientific Attitude Scale, Content of Subscales, and Item Ranges

Scale	Number of Items	Subscale Content	Item Numbers	Scoring Range
1. AB*	3+3=6	Structure of scientific laws and theories	(4, 16, 34); (11, 15, 35)	6-30
2. AB	3+3=6	Structure of science and approach to events in natural sciences	(10, 19, 33); (2, 7, 26)	6-30
3. AB	3+3=6	Exhibiting scientific behavior	(17, 18, 25); (3, 5, 32)	6-30
4. AB	3+3=6	Structure and purpose of natural sciences	(20, 21, 28); (9, 24, 31)	6-30
5. AB	3+3=6	Role and importance of natural sciences in society	(12, 23, 29); (6, 8, 38)	6-30
6. AB	5+5=10	Desire to conduct scientific studies	(1, 27, 30, 36, 40); (13, 14, 22, 37, 39)	10-50
Positive sentences	20			20-100
Negative sentences	20			20-100
Total	**40**	**-**	**-**	**40-200**

* A: Positive Items in Subscales, B: Negative Items in Subscales

Analysis of Data

The data were analyzed using the SPSS 22 statistical program. Each response was assigned a numerical value to ensure accurate data processing, and special variables necessary for analysis were created. Quantitative data were summarized using measures of central tendency and dispersion, and descriptive analyses were conducted on these values. The findings were used to draw inferences about the distributions of variables and the relationships between them.

In the study, the normal distribution of quantitative variables was assessed by considering specific criteria. The criteria used for this evaluation are as follows (Cevahir, 2020):

- The mode, median, and mean values being close to each other,
- The histogram distribution resembling a bell-shaped curve,
- The skewness and kurtosis coefficients being within the range of -1 to +1,
- The points in a normal Q-Q plot being along or close to a 45-degree line.

In the study, Buyukozturk (2017) stated that the Shapiro-Wilk and Kolmogorov-Smirnov tests can be used to assess the normality of the data set. In this study, the Shapiro-Wilk test was used because the sample size was less than 50. Based on the test results, it was accepted that the data showed a normal distribution, and the analysis was continued (Can, 2016). The obtained p-value from the Shapiro-Wilk test, being greater than 0.05, indicates that the scores did not significantly deviate from a normal distribution at the 0.05 significance level, thus confirming the normality (Buyukozturk, 2017; Can, 2016). Additionally, skewness and kurtosis coefficients are used as a method to determine whether the groups have a normal distribution (Buyukozturk, 2015; Tabachnick & Fidell, 2007). While it is stated that skewness and kurtosis coefficients between -1 and +1 are evidence that the distribution does not significantly differ from the normal distribution (Buyukozturk, 2015; Huck, 2012), some sources suggest that these values should be between -2 and +2 (George & Mallery, 2003). The skewness and kurtosis coefficients obtained in the study were calculated within the range of -1 to +1. These values indicate that normality is achieved.

In the study, ANCOVA was applied to statistically control the variables associated with the dependent variable. ANCOVA provides greater statistical power and reduces error variance compared to a simple ANOVA, and it has the advantage of controlling pre-existing differences between groups to reduce bias in the study. As ANCOVA combines regression analysis and ANOVA approaches, it should meet the assumptions of both approaches. The assumptions of ANCOVA, as stated by Buyukozturk (2017), are as follows:

- Equality of regression coefficients within groups,
- Linearity between the dependent variable (Y) and the covariate (X),
- Normal distribution of scores for the dependent variable in the population and equality of variances,
- Absence of correlation between the means of the compared samples.

The following steps were taken to determine whether the necessary assumptions for using ANCOVA in the study were met prior to the analysis:

In ANCOVA analysis;

- To determine if there is multicollinearity among the covariates, Pearson correlation analysis was conducted. The correlation between the pretest scores of the variables under investigation was found to be lower than 0.8 (r=0.008) among the covariates. This result indicates that ANCOVA meets the assumption of no multicollinearity and provides evidence that this prerequisite is fulfilled.
- The assumption of equal variances for all dependent variables was examined using the Levene Test. According to the results of the Levene Test, the p-values for TISKT_POST and SAS_POST were calculated as p=.087>0.05 and p=.326>0.05, respectively. These results indicate that the variances of all dependent variables are homogeneous.
- To examine whether the assumption of equality of within-group regression slopes is met, separate ANOVA analyses were conducted for each dependent variable, TISKT_POST and SAS_POST. In order for ANCOVA to meet this assumption, the p-value should be greater than 0.05, indicating non-significance. It was found that the common effect of the common variables and the group variable on the TISKT_POST dependent variable (F(1,88)=50.41; p=.000) was statistically significant, while for the SAS_POST dependent variable (F(1,88)=2.15; p=.145), it was found to be statistically insignificant. Based on these results, it can be concluded that the assumption of equality of regression slopes

is met for the dependent variable TISKT_POST, except for the TISKT_POST dependent variable.

- The partial eta-squared (effect size) coefficient, which takes values between .00 and 1.00, has been used to calculate the strength of the relationship between the dependent variable and the independent variable.
- The effect size of the independent variable on the dependent variable was determined using the partial eta-squared (η2) coefficient. A value of .01 represents a small effect size, .06 represents a medium effect size, and .14 represents a large effect size (Buyukozturk, 2017).
- According to the standards specified by Cohen, Cohen, West and Aiken (2013), the observed power value (1-β) should be at least .80 in studies. In this study, this threshold was also adopted as the accepted power value. Additionally, if the observed power value is above .90, it is considered as a large power (Stevens, 2009).
- The assumption of independence was satisfied as the researcher's observations were conducted, and precautions were taken to ensure that the groups did not experience exam and grade anxiety. Additionally, the researcher offered feedback to the students at each stage of the process.

Findings

This section of the study includes the findings obtained from the Scientific Attitude Scale. This section is presented under two main headings: "Descriptive Statistics" and "Inferential Statistics".

Descriptive Statistics Findings

The study analyzed the average distribution of pre-test (SAS_PRE) and post-test (SAS_POST) scores obtained from the Scientific Attitude Scale among the participants. Table 3 presents a comparison of mean test scores across groups, the number of students in each group, standard deviations of the groups, skewness and kurtosis values, as well as the minimum and maximum values, and Shapiro-Wilk values.

Table 3. Descriptive Statistics of Secondary School Students' Scientific Attitude Scale Pre-Test and Post-Test Scores

Tests	Groups	Number of People (N)	Mean	Std. Deviation	Skewness	Kurtosis	Range	Min	Max
SAS_PRE	Experiment	45	139.91	10.54	.43	-.36	42	121	163
	Control	45	138.75	14.01	.03	-.99	49	113	162
SAS_POST	Experiment	45	145.13	13.36	.41	-.28	57	122	179
	Control	45	141.22	11.84	.02	-.03	53	113	166

Upon examining Table 3, it is evident that there is a mean difference ($Mean_{dif}$=1.16) between the pre-application experiment group's mean SAS_PRE score (Mean=139.91) and the control group's mean SAS_PRE score (Mean =138.75). After the application, it is seen that there is a difference of $Mean_{dif}$=3.91 between the mean SAS_POST score of the experiment group (Mean=145.13) and the mean score of SAS_POST of the control group (Mean=141,22).

Inferential Statistics Findings

In the study, ANCOVA was employed to statistically account for variables related to the dependent variable. In this phase of the study, the ANCOVA analysis was conducted to examine the significance of the difference between the post-test scores of the experimental and control groups, while controlling for the pre-test scores.

Table 4 presents the mean and adjusted mean values for the post-test scores of the students in both the experimental and control groups on the Scientific Attitude Scale.

Table 4. Arithmetic Mean and Adjusted Mean Values for SAS_POST Scores of Experiment and Control Groups

Variable	Group	N	Mean	Adjusted Mean
SAS_POST	Experiment	45	145.13	144.81
	Control	45	141.22	141.53

Table 4 provides the arithmetic mean and adjusted mean values for SAS_POST scores of the experimental and control groups. The arithmetic mean of SAS_POST scores for the experimental group is Mean=145.13, and the adjusted mean is Mean=144.81. The arithmetic mean of SAS_POST scores for the control group is Mean=141.22, and the adjusted mean is Mean=141.53. These values reflect the overall trend of SAS_POST scores in the experimental and control groups.

The ANCOVA results, indicating the statistical significance of the observed differences in mean scores among the groups, are presented in Table 5.

Table 5. ANCOVA Results on SAS_POST Scores of Experiment and Control Groups

Source of Variance	Sum of Squares	df	Mean Squares	F	p	η2	Observed Difficulty
Corrected model	4375.969	2	2187.985	19.037	.000	.304	1.000
Still	3119.306	1	3119.306	27.140	.000	.238	.999
TISKT_PRE	4031.792	1	4031.792	35.079	.000	.287	1.000
Group	241.601	1	241.601	2.102	.151	.024	.300
Mistake	9999.186	87	114.933				
Total	1859364.000	90					
Adjusted total	14375.156	89					

Upon examining Table 5, it is observed that there is no statistically significant difference between the experimental and control groups in terms of their scores on the Scientific Attitude Scale post-test. The use of the MAR application in teaching does not have a statistically significant effect on the SAS_POST scores ($F(1,87) = 2.102$; $p = .151 > .01$). The obtained result indicates that the group variable has a small effect on the post-test scores (partial $\eta 2 = .024$).

Conclusion

This study investigated the impact of teaching the lives of Turkish-Islamic scholars who have achieved great success in various scientific disciplines such as astronomy, chemistry, physics, through the TISAR-3D, a MAR-based learning environment, on the scientific attitudes of secondary school students.

The descriptive statistics regarding the scores obtained from the application of the Scientific Attitude Scale to both the experimental and control groups before and after the application are provided in Table 3. It can be observed that the pre-intervention mean scores of the Scientific Attitude Scale for the experiment group, where the MAR application was used in teaching, (Mean=139.91) and the control group (Mean=138.75) were similar to each other.

ANCOVA analysis was performed on the pre-test and post-test total scores of the experimental and control groups in order to assess the impact of the MAR application utilized during the instructional process on the scientific attitudes of the students. The ANCOVA results are presented in Tables 4 and 5. Upon examining the data in these tables, it is observed that there is no statistically significant difference in the students' scientific attitude levels between the experimental group, where the MAR application is used in teaching, and the control group, where reading texts focused on scientists are used. This result can be interpreted as the MAR application utilized in the teaching process does not yield a significant difference in the development of students' scientific attitude compared to reading texts. In this context, in studies conducted by Mutlu (2012), Baran (2013), and Emren (2018), the scientific attitude scale was utilized to analyze students' scientific attitudes; however, according to the results of these studies, no significant difference was determined in the average scores of scientific attitudes between the groups.

Discussion

When students experienced a learning experience supported by the MAR application, their scientific attitudes were observed to be higher compared to the control group. However, despite this observed difference, the lack of statistical significance in the analysis suggests that based on the available data, the MAR application does not have a definitive impact on improving scientific attitudes. Studies examining students' scientific attitudes reflect that historical materials related to science used in the teaching process are effective in fostering positive attitudes towards science (Baran, 2013; Emren, 2018), and this study supports the result that the average scores of scientific attitude in the experiment group were higher than those in the control group. Furthermore, studies indicate that the coverage of Islamic scholars who made significant contributions to the history of science in textbooks is insufficient (Ozgur & Aktan, 2015; Yildirim & Kececi, 2022). Despite primary source textbooks being accessible to every student in our country, the insufficient representation of Turkish-Islamic scholars in textbooks and students' lack of familiarity with the scholars mentioned in the application/reading texts may be among the reasons for the lack of statistically significant differences in the average scientific attitude scores between the groups. By including Turkish-Islamic scholars, their lives, success stories, and inventions in textbooks, students can be encouraged to take an interest in this field, ignite scientific curiosity, and increase their desire for research.

One of the fundamental goals of the education system is to enhance individuals' scientific behaviors and attitudes (Buyukozturk, 1999). Scientific attitudes encompass various characteristics, including openness to different ideas, approaching events with skepticism, fearlessness of failure, patience, and attentiveness (Carin & Bass, 2001). These attitudes also influence the skills individuals need to possess. For instance, factors such as scientific thinking, perspectives on science, the ability to comprehend the formation process of scientific knowledge, and attitudes toward the characteristics of a scientist are crucial elements shaping an individual's scientific attitude (Duran, 2008). In this context, regardless of the educational level, it is important for individuals to set high goals and enhance their scientific thinking skills. This involves gaining knowledge about the contributions of science to society and the ability to solve everyday problems using scientific methods. However, if one of the elements supporting students in acquiring these characteristics, namely new generation technologies and information tools, is not adequately utilized in educational environments, it may become challenging to cultivate individuals with these attributes. Therefore, the lack of a statistically significant difference in scientific attitude averages between groups can be associated with the limited use of technology in education. The frequent utilization of new generation technologies and information tools in educational environments can facilitate the cultivation of individuals with these characteristics and support students in developing a positive attitude towards science.

Suggestions

Scientific attitude is a long-term goal and may not be increased in a single lesson or application. A study conducted over a longer period can provide more accurate results. Therefore, researchers should set long-term goals to enhance students' scientific attitude and develop appropriate strategies to achieve these goals.

Peer-Review	Double anonymized - Two External
Ethical Statement	* This study includes a part of the doctoral thesis entitled "Teaching the Lives of Turkish-Islamic Scholars who have Contributed to Science in the Field of Science in a Mobile Augmented Reality Based Learning Environment". It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.
Plagiarism Checks	Yes - Ithenticate
Conflicts of Interest	The author(s) has no conflict of interest to declare.
Complaints	itobiad@itobiad.com
Grant Support	This research has been supported by the Scientific Research Projects Unit of Firat University (project number EF.21.08).
Author Contributions	Design of Study: 1. Author (%50), 2. Author (%50) Data Acquisition: 1. Author (%50), 2. Author (%50) Data Analysis: 1. Author (%50), 2. Author (%50) Writing up: 1. Author (%50), 2. Author (%50) Submission and Revision: 1. Author (%50), 2. Author (%50)

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Etik Beyan	* Bu çalışma, "Fen Alanında Bilime Yön Vermiş Türk-İslam Alimlerinin Hayatının Mobil Artırılmış Gerçeklik Temelli Öğrenme Ortamında Öğretimi" başlıklı doktora tezinin bir bölümünü içermektedir. Bu çalışmanın hazırlanma sürecinde bilimsel ve etik ilkelere uyulduğu ve yararlanılan tüm çalışmaların kaynakçada belirtildiği beyan olunur.
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