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Determining the Educational Needs of Students Regarding the Use of Augmented Reality Applications in Museums

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Abstract: *In recent years, augmented reality (AR) applications, which have emerged as an indispensable technological element in many fields, have also begun to be used as an important learning tool in museum environments. It is seen that AR applications, which enable permanent learning especially by using technology, have positive effects on students. In this context, the aim of this research is to determine the educational needs of students regarding the use of augmented reality applications in museums. The research was conducted using the screening model from quantitative method designs. The study group consists of university students (n=99). In the spring semester of 2023-2024, students taking the museum education applications course and the Digital Literacies and Ethics course were determined from purposeful samples using the criterion sampling method. The quantitative data of the study were obtained with a 5-point Likert-type educational needs survey. Quantitative data were interpreted according to the mean score (MEAN) values in the distribution of the survey items. According to the research findings, students need training for the use of Smartify, Museum Alive, Layar, Wonderscope, ARLOOPA, ARKit, Vuforia Engine, ARCore applications. Based on these findings, in future studies, students will be asked to design augmented reality applications for museums by providing training on the relevant applications.*

Keywords: *museum; augmented reality technology, student needs; augmented reality applications.*

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1. Introduction

Augmented Reality (AR) technology has been defined in different ways by many researchers. Azuma (1997) stated that AR is a technology that combines the real world with the virtual dimension and ensures coordination between virtual objects. In the research prepared by Türker & Işık (2022), AR is mentioned as a technology that enriches real-world objects with the help of digital tools. Cai, Chiang & Wang (2013) define AR as the integration of 2D and 3D virtual data produced by a computer with the real world into the environment with graphics technology, computer vision techniques, or different perception technologies. As can be understood from the definitions, AR technology brings together objects in the virtual world and objects in the real world on an interactive digital platform. It can benefit from media tools such as video, animation, 3D models, sounds, graphics, and GPS locations on the digital platform (Lee, 2012). The benefits of using AR technology in related studies are stated as follows:

- Accessibility to AR technology can be easily achieved due to its adaptability to mobile devices (Sertalp, 2018).
- Developing applications with AR technology provides many benefits to the user. For example; It has important contributions such as being able to use three-dimensional models, benefiting from videos and animations, and being able to use virtual objects simultaneously in a real environment (Wang et al., 2013).
- It also has features such as effective learning, providing motivation, and increasing motivation (Azuma, 2001).

As can be understood, AR technology has significant effects on individuals. Creating AR environments that have these effects enriches individuals' learning skills. There are some stages in creating this technological environment. Following these stages is considered important in creating AR environments in a well-equipped manner.

1.1. Developing Augmented Reality Environments

There are some stages in developing AR environments. These stages are as follows (Abdüsselam & Karal, 2015; Zhou, Duh & Billinghurst, 2008):

- First, after selecting the digital object that can be transferred to the real environment, the hardware and software that will add reality to the object (e.g. video, audio, 3D model, etc.) are determined.
- The location of the digital object is associated with the tracking method.
- The digital object is visualized in the real environment with the help of hardware devices such as screens, glasses, projectors, etc.
- Control of digital objects is given to the user with an input and an output device.
- AR applications are designed to be interactive, helping the practitioner to take part by doing and experiencing.

As mentioned above, shaping the design according to the stages in the creation of AR environments is of great importance. It has been revealed in many studies that designed AR environments are also effective for individuals in education.

1.2. Use of Augmented Reality Applications in Education

AR applications used in education, as in many other areas, have significant effects on individuals. AR applications are considered among the most prominent technologies of the 21st century and one of the most fundamental components of the Industry 4.0 program (Son, 2024). When the literature is examined at this point, it is understood that AR applications have significant benefits for students. These benefits mentioned in the studies are listed below:

It has positive effects on students;

- Concretizing abstract knowledge, developing psychomotor skills, providing motivation,
- Developing questioning and authentic skills, increasing metacognitive learning capacities,
- Developing mental skills such as comprehension and imagination,

- Gaining problem-solving skills, including them in interactive learning processes,
- Increasing their interest in lessons (Abdüsselam & Karal, 2015; Chiang & others, 2014; Dembe, 2024; Dunleavy, Dede & Mitchell, 2009; Dunleavy, 2014; Sakr & Abdullah, 2024; Villagran-Vizcarra et al., 2023)

The above-mentioned features of AR applications are effective in increasing students' motivation for lessons and their active learning.

1.3. Use of Augmented Reality Applications in Museums

It is seen that AR technology, which is quite effective for students in education, is also applied in other areas. At this point, it is stated in the relevant studies that AR applications are especially used to make museums more accessible. There are many advantages to using AR technology in museums. For example; AR applications allow intuition and manipulation of the works so that visitors to the museum can interact with the works one-on-one (Chang et al., 2014; Miller & Dousay, 2015). In addition, thanks to these applications, the integration of digital content related to the works with the visual perception of the visitors can be achieved (Chang, Wu & Hsu, 2013). Individuals can access detailed content about the works exhibited in the museum and can gain permanent learning by watching the animations of these works (Sucaklı & Güzel, 2020). Thus, the visitor's interest in the works in the museum can also increase. As can be understood, the use of AR applications in museums has positive effects on individuals. In addition, AR applications make important contributions to students' ability to reinforce theoretical knowledge about the courses through museum activities.

Thanks to AR technology, students can actively learn art and history by doing and experiencing (Germak, Salvo & Abbate, 2021). In addition, AR applications help students better interpret and make sense of the works in the museum. Abstract concepts can be more easily concretized by students thanks to AR technology (Lin, Lo & Yueh, 2022). In light of the information given above, it can be thought that using AR applications in museum environments is effective both in ensuring the learning of student and adult groups in the museum and in making positive contributions to museum education. At this point, it is an important issue to focus on that students' skills in using AR applications are developed within the scope of museum education (Karakaş & Özerbaş, 2020). When the literature is examined, it is understood that no needs determination study has been conducted regarding the use of AR applications by students in the museum environment before, and the studies have mostly been prepared for AR applications and examples in museums, the importance of AR applications in the context of courses, and the opinions of students on AR applications (Coşkun, 2021; Koçoğlu, Akkuş & Özhan, 2018; Karakaş & Özerbaş, 2020; Sucaklı & Güzel, 2020). In this context, it is believed that the deficiency in the literature in this direction can be eliminated by determining the needs of students regarding the use of AR in museums and developing a model proposal for this in future studies.

1.4. Related Studies

When the relevant studies are examined, it is seen that there are some studies prepared on the use of AR in museums. In the research of Akkoç and Coşkun (2019), it was aimed to investigate the needs of individuals visiting the museum regarding the use of AR technology. In the research, data was collected from 12 museum visitors who visited the Anadolu University Republican History Museum using a semi-structured interview form within the scope of the qualitative research method. The findings obtained revealed that the visitors had positive opinions about the use of augmented reality technology in this area. In the research prepared by Lin, Lo, & Yueh (2022), the effects of an AR-based learner-controlled design on visitors' museum learning were investigated. The experimental model was used in the research and applied to 48 university students. The results obtained revealed that visitors were willing to use AR technology in the museum environment and showed a stable performance in acquiring information. Practical suggestions were also presented in the research regarding the inclusion of learner control in AR-based interactive exhibitions. Yumak

and Güneröz (2023) conducted a study on the use and acquisition of new technologies in museum education using a general screening model. This study addresses how technologies such as augmented and virtual reality and metaverse are utilized in museum environments. In addition, sample world museums and applications that utilize these technologies are introduced. As a result of the study, the importance of integrating these technologies into museum environments and the necessity of developing learning activities are pointed out. In the study prepared by Shen et al. (2024), the benefits of AR technology in museum areas were evaluated through the views of the participants. The research data were collected with a questionnaire. The data obtained from the research revealed that AR technology has significant contributions to the recovery of attention, reduction of stress factors, and elimination of anxiety in the museum environment. On the other hand, Xu and Pan (2024) examine the effects of AR use in museums. In this context, it was investigated how virtual text and artificial intelligence affect visitor engagement, knowledge acquisition, emotional response, and social interaction. Text analysis, thematic qualitative data analysis, and agent-based modelling were used in the study. The results show that the use of virtual texts in line with the AR application in museums and the variety of accessibility increase visitor motivation and social interaction. Translated with DeepL.com (free version) The examinations conducted in the literature have shown that the use of AR in museums is addressed from different dimensions. In the studies, information on the use of AR in museums is provided, and sample museums that use the application are mentioned. In addition, it has been observed that there are studies in which AR applications in museums are characterized according to visitor opinions. As a result of the scans conducted, no research has been found in the literature that determines the educational needs of students regarding the use of AR in museums within the scope of museum learning. At this point, it is seen as an important necessity to investigate this study topic to eliminate this deficiency in the literature.

2. The Aim of The Research

This research aims to determine the educational needs of university students regarding the use of augmented reality applications in museums. The following questions were sought in the research:

Students;

1. What are the educational needs regarding the use of augmented reality (AR) applications in museums?
2. How is their knowledge of AR Applications in Museums?
3. How is their use of AR applications in museums?

3. Method

Under the method heading of the research, information regarding the research model, study group, data collection, and data analysis process is mentioned.

3.1. Research Design

This research was conducted using the quantitative research method. In quantitative research, numerical data are used to reveal the relationships between events, and evaluations are usually made with statistical analyses. In the collection of large amounts of data, scanning methods can be used from quantitative methods (Buyukozturk et al., 2022). In this context, data were collected in this research using the scanning model from quantitative research methods.

3.2. Participants

The sample group of the study consists of university students (n=99). The students took the museum education practices course and the Digital Literacies and Ethics course in the 2023-2024 spring semester. 65.7% (n=65) of the students who participated in the study were female and 34.4% (n=34) were male. The students are studying in the departments of English Translation and Interpretation, English Language and Literature, English Language Teaching, and Classroom Teaching (Table 1). The sample of the study was determined using the "criterion sampling" method, which is one of the purposeful sampling methods. In the criterion sampling method, a criterion can be selected by the researcher (Grix, 2010; Marshall & Rossman, 2014). In this study, the knowledge of the students within the scope of the courses on Museums and Augmented Reality Technologies was determined as a criterion of the research. Within the scope of this criterion, all of the students who participated in the study carried out applications within the scope of the courses they took on museums and augmented reality. A study group was created within this scope.

3.3. Data Collection & Instrument

The research was started by conducting a literature review on "Educational Needs of Students on Augmented Reality Applications in Museums". In this context, in the first stage of the research; national and international indexes were scanned and publications in this field were examined. After determining that there was a deficiency in the literature in the relevant field, the problem status of the research was determined. In the second stage of the research, a data collection tool was designed to obtain quantitative data in order to determine the educational needs of students on the subject. In this direction, a Likert 5-type educational needs survey was developed by the researchers to collect quantitative data. Information on the development of the data collection tool used in the collection of research data is provided in detail in the following section.

Survey to Determine Training Needs on the Use of Augmented Reality Applications in Museums

In the study, a needs assessment survey was developed by the researchers in order to determine the educational needs of students regarding the use of augmented reality applications in museums. In the first stage, a literature review was conducted on the subject. In the review, no research and data collection tool was found that determined the educational needs of students regarding the use of AR applications in museums. Based on this deficiency, an item pool was created by examining the relevant articles and theses on the research. A draft survey was developed. The prepared draft survey was examined by museum education experts (n=2), information technology experts (n=4), and programme development experts (n=4), and some items were removed from the draft accordingly. Thus, the scope validity of the study was also ensured. After the necessary corrections were made in the last stage, the final form of the needs assessment survey was created. The needs analysis survey was designed in two parts. The first part included three questions containing demographic information about the students participating in the study. The questions were limited to "gender", "knowledge about augmented reality applications in museums" and "augmented reality application status in museums". The second section includes 31 items that question students' educational needs regarding the use of augmented reality applications in museums. The survey was prepared in a 5-point Likert type. While evaluating the items, they were scored from 1 to 5 as "Strongly Agree", "Agree", "Neutral", "Disagree" and "Strongly Disagree". When the reliability analysis of the survey is made, it is seen that the Cronbach's Alpha value of 31 survey items is .976. In line with this value, it is seen that the survey is reliable.

3.4. Data Analysis

In the analysis of research data; quantitative data were interpreted according to the mean score (MEAN) values in the distribution of survey items. In the analysis of research data, the descriptive analysis model was used to provide summary information about different phenomena and events that researchers wanted to investigate (Buyukozturk et al., 2022). In this study, the

educational needs of university students regarding the use of augmented reality applications in museums were analyzed using the descriptive analysis method.

4. Findings and Discussion

4.1. Educational needs of students regarding the use of augmented reality (AR) applications in museums

In line with the first sub-objective of the research, the educational needs of the students regarding augmented reality applications in museums were determined. The educational needs of the students are presented in Table 1.

Table 1. Educational needs of students regarding the use of AR applications in museums

Questionnaire Statements	Mean	Std. Deviation
I need training on visual systems (glass systems, mobile device types, etc.) that will bring the real world and the virtual world together.	3.71	.91
I need to have knowledge of Unity 3D, the software used in the creation of reality applications.	3.67	.84
I need training on integrating 3D models or animations into museum works.	3.76	.85
I need training in creating 3D story animations for museum artifacts	3.77	.86
I need training in designing museum artifacts using simulation methods	3.68	.85
I need training on determining tracking methods that can relate the location between the digital artifact and the user	3.76	.80
I need training in determining the software and hardware suitable for museum artifacts	3.78	.86
I need training on choosing which devices to use to visualize digital artifacts	3.74	.91
I need training in learning the layering technique to give a sense of depth to digital artifacts	3.80	.84
I need training on which tools or applications I can use to create an interactive environment between the museum artifact and the user	3.79	.93
I need training on reading the directional signs in the museum to the application on my mobile device	3.67	.95
I need training on adding audio narrations to digital artifacts	3.76	.92
I need training on providing viewers with additional visuals and information about the artifacts by placing internet links on digital artifacts	3.75	.94
I need training on combining new and old images of museum artifacts with a two-stage transformation calculation technique	3.81	.88
I need training on how to access information about digital artifacts using a smartphone I need training on learning with the help of QR codes	3.81	.98
I need training in visual recognition and information technology in museums	3.70	.95
I need training on augmented reality applications that provide analysis tools for technical details and colors of artifacts in museums	3.82	.89
I need training on using augmented reality technology to create time traveler experiences in museums	3.85	.89
I need training in creating interactive games for museum collections with augmented-reality applications	3.79	.85
I need training on using design applications to create augmented reality guidebooks	3.87	.83
I need training on privacy policies regarding data collection of augmented reality applications used in museums	3.75	.89
I need training on location determination and tracking applications used in augmented reality applications used in museums	3.74	.84
I need training on using Smartify application that offers visitors the opportunity to access more information from augmented applications used in museums	3.85	.76
I need training on using Museum Alive application that animates the artifacts exhibited	3.74	.90

in the museum		
I need training on using location-based Layar augmented reality application	3.65	.89
Stories in museums designed for children I need training to use Wonderscope application	3.87	.87
I need training to use ARLOOPA application that allows augmented reality visualization of works in museums	3.77	.89
I need training to use ARKit application to create augmented reality application	3.72	.89
I need training to integrate sound effects in museums	3.67	.92
I need training to use Vuforia Engine application to create augmented reality application	3.72	.86
I need training to use ARCore application to create augmented reality application	3.77	.85

When the research findings are examined, it is seen that the students responded to all items at the level of “I agree”. In this direction, the students stated that they need training on visualization systems (glasses systems, mobile device types, etc.) that will bring the real world and the virtual world together. In addition, the students stated that they have a lack of knowledge of Unity 3D software used in the creation of reality applications and creating 3D story animations for the works in the museum. They also need training on the integration of 3D models or animations into the works in the museum and the design of the works in the museum with the simulation method. As can be understood, the students lack knowledge of the technical use of AR in the museum. At this point, when the literature was examined, it was found that most of the target audiences lacked knowledge about the technical use of AR technology in museums in parallel with the findings obtained from the research (San, ZhiYuan & Leong, 2022). In addition, the students need information on determining the monitoring methods that can associate the position between the digital work and the user and on determining the software and hardware suitable for the works in the museum. In addition, the students do not know which devices should be used in visualising digital work. They also do not have information on the layering technique that gives a sense of depth to digital works and which tools or applications can be used in creating an interactive environment between the work in the museum and the user. The findings reveal that students have serious deficiencies in designing a learning environment where museum environments and AR applications are used together. Similar findings were found in other studies conducted in this field. For example, Moorhouse, Tom Dieck & Jung, (2019) stated that students have significant knowledge gaps in integrating AR applications in museums and designing new environments. This finding supports the findings obtained from the research. In addition to these, students need training in reading directional signs in the museum to the application on their mobile devices, adding audio narrations to digital works, placing internet connections on digital works so that viewers can access additional visuals and information about the works, combining new and old images of works in the museum with the two-stage transformation calculation technique, and learning information about digital works with the help of QR codes using smartphones. As can be seen, students need information on using digital technologies. Similar findings are also supported in the research conducted by Yan (2024). In Yan (2024), the advantages of digital technology in the museum environment were revealed and it was emphasized that it is useful to make use of these technologies for students to gain permanent learning experiences related to museum education. Again, there are training needs in museums regarding visual recognition and information acquisition technology, in augmented reality applications that provide analysis tools regarding technical details and colors of works in museums, in using augmented reality technology to create time traveler experiences in museums, and in creating interactive games for museum collections together with augmented reality applications.

Finally, students stated that they need training on using design applications to create augmented reality guidebooks, Privacy policies regarding data collection of augmented reality applications used in museums, Location detection, and tracking applications used in augmented

reality applications used in museums, Smartify applications that provide visitors with access to more information from augmented reality applications used in museums, Museum Alive application that brings the works exhibited in museums to life, Layar augmented reality application used based on location, Wonderscope application that presents stories in museums designed for children, ARLOOPA application that enables augmented reality to bring works to life in museums, ARKit application for creating augmented reality applications, Integrating sound effects in museums, Vuforia Engine application for creating augmented reality applications, ARCore application for creating augmented reality applications. It is understood from all the data obtained that students need training in all stages of AR use in museums. At this point, it is believed that planning an education aimed at these needs in future research could be effective in meeting these needs. Wang & Zhu (2022) examined in their study how Mobile Augmented Reality technology used in museums increases the variety of exhibitions and provides visitors with a richer experience by addressing the dimensions of content, guidance, and interaction. Fenu & Pittarello (2018) examined in their study the effect of an AR application accessible to cultural heritage experts on the development process. In addition, the relationship between AR technology and storytelling was examined, as well as the effects of AR technology use on the elderly in literary museums. Chen & Lai (2021) aimed to determine the educational effect of augmented reality (AR) in museums, thus developing a prototype by revealing the positive relationships between research, visitor acceptance, learning motivation, and learning effectiveness. Hassan & Ramkissoon (2017) suggested in their study that AR can support cultural tourism. Siang et al., (2019) show that the decrease in the number of tourists has caused museums to turn to digital technologies, thus factors such as content suitability and social impact of the augmented reality (AR) mobile application can be used positively. Barekyan & Peter (2023) emphasize in their research that augmented reality technology is very important in the use of museums as an educational environment, therefore individuals must learn how to use digital technology. Research findings and related studies show that AR technology is indispensable for museums. Therefore, individuals need to learn the environments and applications where they can create digital virtual museums using these technologies.

4.2. Students' knowledge of AR applications in museums

In line with the second sub-objective of the research, it was examined whether the students knew AR applications in museums. As can be seen from Figure 1.

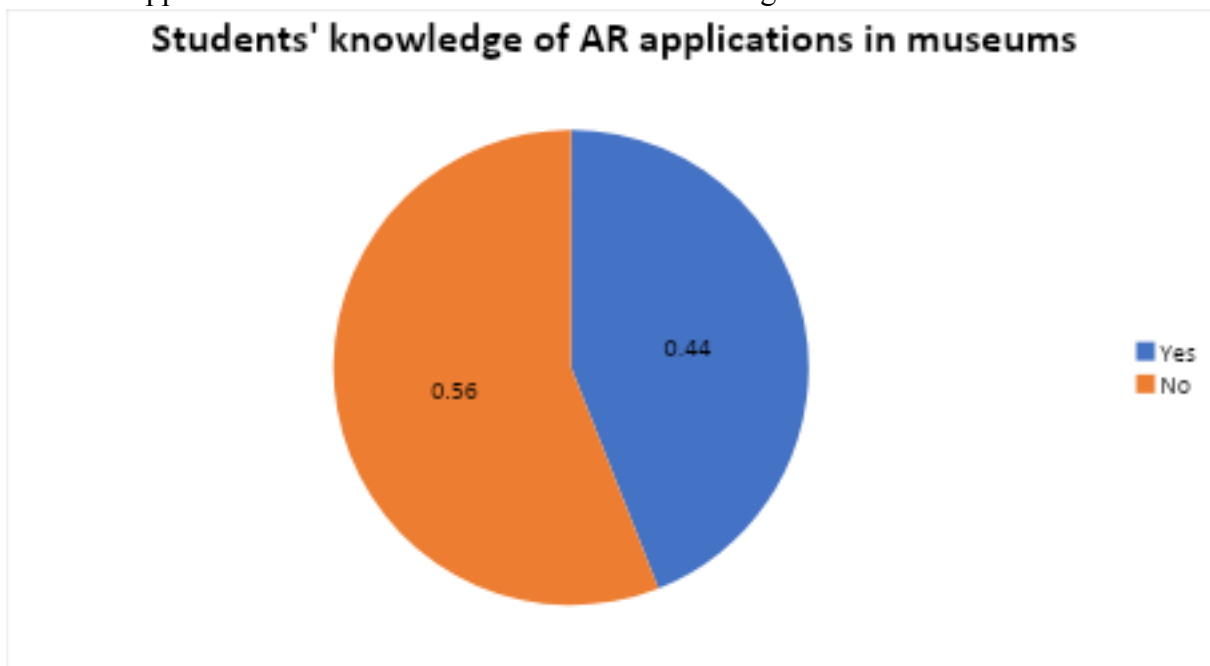


Figure 1. Students' knowledge of AR applications in museums

The findings show that the majority of the students participating in the study did not have any prior knowledge about AR applications and development and they needed training in this regard. It is believed that designing AR-supported interactive educational environments based on students' individual needs will make significant contributions to their achievement levels (Al-Ansi et al., 2023). At this point, it is thought that students' learning experiences will improve and their motivation levels will increase in AR-supported interactive museum environments.

4.3. Whether students have used AR applications in the museum before

In line with the third sub-objective of the research, students' use of AR applications in museums was examined.

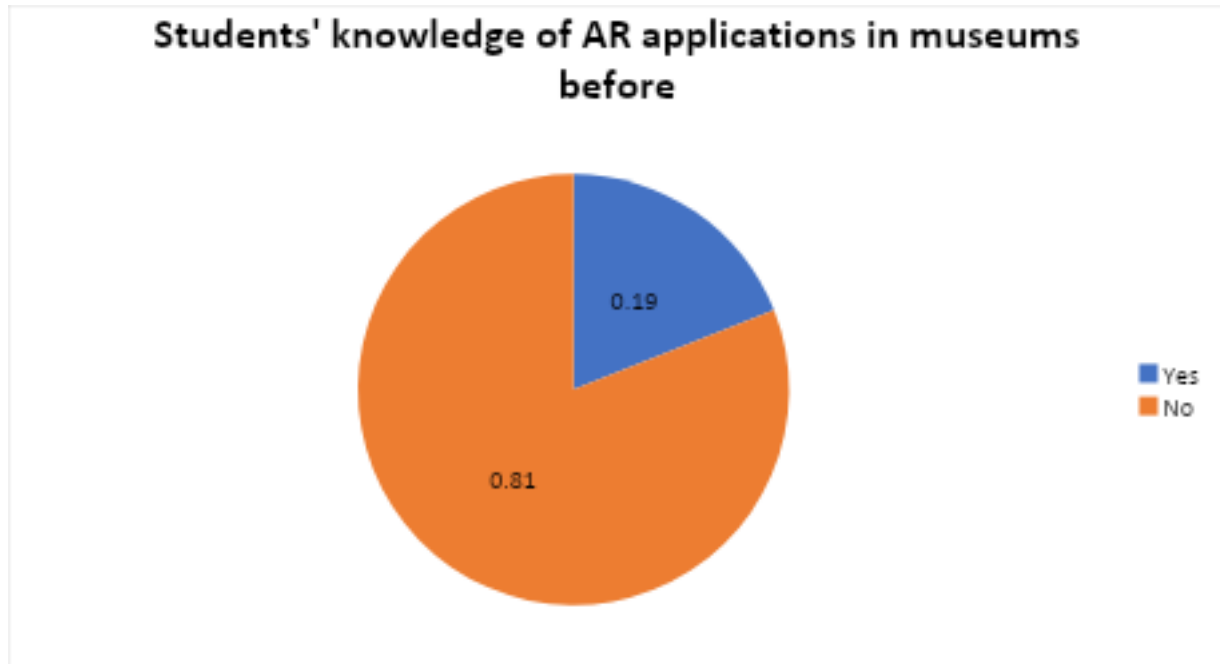


Figure 2. Whether students have used AR applications in the museum before

The findings show that the students participating in the study have not used AR applications before and they need training in this direction. When the research is analyzed, it is revealed that both students and teachers have training needs regarding the use of AR technologies in environments. (Son, 2024)

5. 5. Conclusion and Future Studies

According to the research findings, students want to learn how to use the software used in creating augmented reality applications. For this reason, they have stated their training needs in the use of the relevant software. Unity 3D is the software they mainly want to learn, but there are also training needs related to creating story animations, designing works in museums using the simulation method, tracking methods that can associate the position between the digital work and the user, determining the software and hardware suitable for the works in the museum, learning the layering technique to give a sense of depth to digital works, adding audio narrations to digital works, using augmented reality technology to create time traveler experiences in museums, creating interactive games, and using design applications. In order to implement all the augmented reality applications mentioned, they need training for the use of Smartify, Museum Alive, Layar, Wonderscope, ARLOOPA, ARKit, Vuforia Engine, and ARCore applications. Based on these findings, in future studies, training will be provided for the relevant applications and students will be asked to design augmented reality applications for museums with the relevant applications.

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