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Opinions of Secondary School Students on the Use of Mobile Augmented Reality Technology in Science Teaching

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ABSTRACT Mobile augmented reality (MAR) draws attention in terms of providing a flexible learning process and environment. It is thought that learning environments can be more effective using MAR technology. The research aimed to determine the secondary school students' views on the use of MAR technology in science teaching. The research was conducted with 143 students studying in the sixth grade at two different secondary schools in Turkey. In the research, convergent parallel patterns from mixed-method patterns were used. For eight weeks, the research was carried out to cover the systems unit in our body, situated in the 6th-grade science course curriculum. During the process, the Anatomy 4D application was used in the experimental group during the procedure, and the science course curriculum was used in the control group. In this paper, a part of the mixed research, the qualitative data collected from the experimental group's semi-structured interview form and diaries were analyzed. Descriptive analysis was used to analyze the data. As a result of the research, although the students do not have a clear idea about AR and MAR technologies at the beginning of the application, it is observed that their thoughts change over time, and MAR applications are effective on the success of the course.

Keywords Mobile Augmented Reality, Science Teaching, Secondary School Students, Student Opinions.

1. INTRODUCTION

In recent years in which science is integrated with technology and increasingly dominates the world, it is necessary to educate individuals who can adapt to the needs of the age and developments in technology and choose what they need from the knowledge and skills. Today, human capital, the most valuable part of technologically advanced, developing, or underdeveloped countries, depends on education in general. In addition, the 21st-century skills that are expected to be from individuals are generally technology-centered. Questions on how to use the training in order to improve the quality of education lead the studies in the areas of education and training technology in recent years (Heinecke, Milman, Washington, & Blasi, 2001; Wang & Hannafin, 2005; Watson, 2001; Kozma & Anderson, 2002). Effective use of information technologies by individuals is accepted as an indicator of the advanced level of societies. Various policies and complete projects have been initiated to integrate information technologies such as Turkey, Italy, Germany, Japan, United States of America (USA) into educational environments (Keles, Oksüz & Bahcekapili, 2013). It has become imperative for various reasons like this to develop educational environments and teaching programs to enable technological tools. At this point, the concept of Mobile Augmented Reality (MAR) comes to the forefront in order to provide a flexible learning process and an effective learning environment for individuals called Z generations who are born between 1995 and 2010, growing with tablet computers, mobile phones (Ay, 2018).

The MAR concept, acknowledged in our day to be an indispensable part of daily life, thanks to technologies developed for especially mobile devices, can be defined as applications through mobile devices providing integration of virtual objects into real-world environments in Augmented Reality (AR) (Ifenthaler & Eseryel, 2013). Thus, MAR applications work on conveying the captured images of an object obtained through various information technologies due to processing it to the real world through mobile devices.

AR applications work with the principle of transmitting the image of the object obtained through various

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information technologies to the real environment. In AR applications, the reality is created due to the synchronic enrichment of the real-world image with the virtual data formatted and revealed in a computer environment. AR applications are grouped under two headings as image-based and location-based. It is primarily made understandable through virtual objects, locator pointer codes, and physical objects in image-based AR applications. Afterward, it is provided to convert the pointer image obtained by various mobile devices into 3D objects with the help of AR imaging programs (Icten & Güngör, 2017; Yilmaz, 2014). Image-based AR applications are also divided into two, in itself, pointer-based and non-pointer-based. In pointer-based AR applications, objects in the real environment can only be introduced, provided that pointers are introduced to the system. In non-pointer AR applications, existing objects in the environment are used instead of adding a pointer to the real environment. Location-based AR applications are based on the determination of the location through the features of mobile devices such as wireless networks and GPS, and the inclusion of virtual objects to the designated location, that is, to the real world (Somyürek, 2014).

With the development of technology, the MAR studies that have entered our lives are increasing daily. Cheng & Tsai (2013), in their research, have identified two major AR technology in science education, are named as image-based AR (Eursch, 2007; Kerawalla, Luckin, Seljeflot & Woolard, 2006) and location-based AR (Dunleavy, Dede, & Mitchell, 2009; Rosenbaum, Klopfer & Perry, 2007; Squire & Jan, 2007). When the use of MAR applications in the field of education is examined, it is understood that location-based mobile augmented reality applications are in the majority (Ardito & Lanzilotti, 2008; Papagiannakis et al., 2005; Efstathiou, Kyza & Georgiou, 2018; McMahon, Cihak & Wright, 2015; Turan, Meral & Sahin, 2018). There are also many pieces of research determining the effects of MAR; outdoor learning (Arvanitis et al., 2009), students' socio-scientific reasoning (Chang, Hsu, Wu, & Tsai, 2018), students' historical reasoning (Efstathiou et al., 2018), science interest and collaboration skills (Bressler & Bodzin, 2013).

The number of studies conducted to determine students' opinions about MAR technology in science teaching in Turkey is limited. However, these studies have been carried out in recent years. Considering the conducted studies, the objective of research carried out by Kücük (2015) was to determine the effects of MAR applications in anatomy education on academic successes and cognitive loads of medical students, and the students' views on these applications. As a result of the analysis of the data obtained through data collection tools, results have been obtained that MAR application embodies the subject, increases the interest in the lesson, provides a flexible learning environment, and will be helpful in individual studies. Another research conducted by Sentürk (2018) aimed to determine the effect of MAR applications in the process of science courses on the academic achievements, motivations, attitudes towards science, technology, and AR applications of secondary school students. According to the findings obtained from the research, it is concluded that AR technology facilitates learning, concretizes the subject, is fun, engaging, and realistic, and students are willing to use the AR application.

This research has been carried out based on the facts that the AR technology has been demonstrated to be among the promising educational technologies in the recent issues of Horizon Reports which have been orderly published since 2004; that it is thought to occupy an important place in education; that there are statements in the body of literature expressing that the studies directed towards the use of AR applications in education are in the infancy stage (Ifenthaler & Eseryel, 2013; Kücük, 2015; Sentürk, 2018; Sirakaya, 2015; Yilmaz, 2014; Zhang, Sung, Hou, & Chang, 2014) and that there is a need for studies to determine the effects for created of their use in science education.

1.1 Problem of Research

In the 21st century, it has been emphasized that science education has a vital role in reaching the target to be raised as individuals who can design content, use technology effectively and efficiently, have imagination, learning, and critical thinking skills (Ecevit & Kaptan, 2021). With the development of technology, the applications used in science education have increased. AR applications are one of them. However, the number of studies investigating the effect of using AR applications in science education on these goals is limited. Nevertheless, the results of the researches conducted with AR and MAR show that students' views of the use of these technologies are positive (Abd Majid, Mohammed, & Sulaiman, 2015; Bressler & Bodzin, 2013; Chang, Wu, & Hsu, 2013; Jamali, Shiratuddin, Wong, & Oskam, 2015).

On the other hand, different devices (smartphones, tablets, etc.) are needed for this application (Abd Majid, Mohammed & Sulaiman, 2015). Whether the lack of these tools because of different socio-economic statuses will influence opinions on this issue is a matter of research. Therefore, this research focuses on these problem situations.

1.2 Research Focus

This research will play an essential role in determining secondary school students' views on MAR in science education and the effects of MAR application. In addition, the research results will provide researchers and teachers with a perspective on the use of MAR technology, which is promising and will be a new generation of technologies that will significantly affect the quality of the education offered.

2. METHOD

In this research, which is based on a mixed-method, parallel pattern converging from mixed-method patterns was used (Creswell & Plano Clark, 2015). Convergent parallel patterns are patterns in which the quantitative and qualitative data are collected concurrently and analyzed independently following the research context. Then, combine two sets of data to produce meaningful results. In this research which carried out in line with the convergent parallel pattern, on the one hand, the diaries reflecting the positive/negative emotions and thoughts, observations, suggestions of the application, which were expressed at the end of each course by the students, were analyzed using qualitative analytical methods. On the other hand, data on students' academic achievements and attitudes were collected and analyzed by quantitative methods. For eight weeks, the research was carried out to cover the systems unit in our body, situated in the 6th-grade science course curriculum. During the process, the Anatomy 4D application was used in the experimental group during the procedure, and the science course curriculum was used in the control group. Since the AR application was not carried out with the students in the control group, the students' opinions were not included in qualitative data analysis. In this paper, a part of the mixed research, the qualitative data collected from the experimental group's semi-structured interview form and diaries were analyzed.

2.1 Participants

In this research-based mixed method, the convergent parallel design, one of the mixed-method designs, was used. In the research, two schools were selected among 30 secondary schools classified as low and high socio-economic levels in Elazig to determine the effectiveness of students' socio-economic levels on various variables. Year-end averages of the branches were taken into account in determining the experimental and control groups. The experimental and control groups of the research were randomly selected among twelve classes that did not differ according to the year-end averages. In Turkey, the 8-year compulsory education period has been increased to 12 years since the 2012-2013 academic year. 4+4+4 the education system, which is formulated in the form and consists of 3 levels, is organized as a first-tier 4-year primary school, a second-tier four-year secondary school, a third-tier 4-year high school. The research was carried out with 143 students studying in the 6th grade of Barbaros Hayrettin Paşa Secondary School and Bahçelievler Secondary School in Elazig province in the 2017-2018 academic year. Barbaros Hayrettin Paşa Secondary School was coded as primary school, and Bahçelievler Secondary School was the second school in the research. The research was carried out with two experimental and two control groups, one experiment, and one control group in each school. In the research, the experimental and control group in Barbaros Hayrettin Paşa Secondary School was named as experiment-1 and control-1 group, and the experimental and control group in Bahçelievler Secondary School was named as experiment-2 and control-2 group.

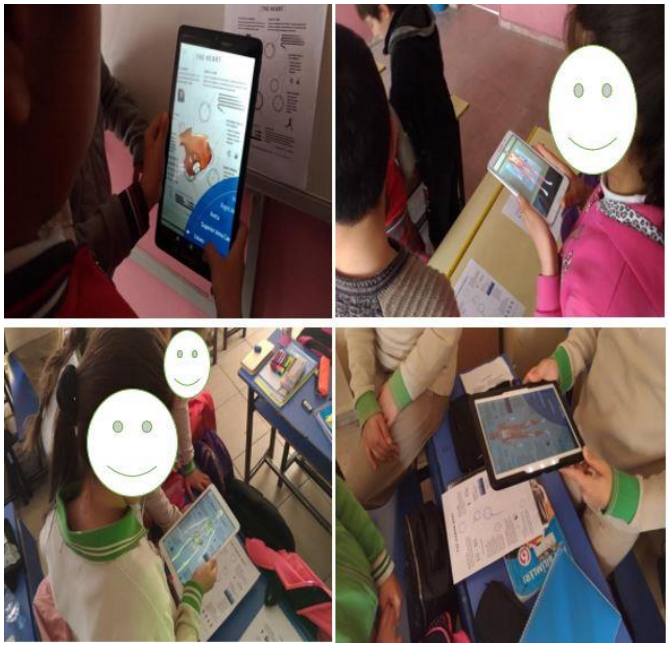

Figure 1 Sample photos of MAR application in experimental groups

The photos of the Anatomy 4D application used in the teaching of the lesson in the experimental groups are shown in Figure 1.

2.2 Demographic Characteristics of Students

The student information form was used to determine the demographic characteristics of the students who formed the research group. When we look at the distribution of students by schools and gender, the first group in the experiment-1 group 23 (13 girls, 10 boys), the control-1 group consisted of 23 (13 girls, 10 boys) students. In the second school, the experiment-2 group consisted of 48 (23 girls, 25 boys), and the control-2 group consisted of 49 (27 girls, 22 boys) students.

2.3 Working Process

The research was carried out with 143 students attending the 6th grade of Barbaros Hayrettin Pasa Secondary School and Bahcelievler Secondary School in Elazig province in the 2017-2018 academic year. In this research, a total of 2 experiments and 2 control groups, one experimental and one control group in each school, were carried out. The year-end averages of the branches for the previous year were considered in determining the experimental and control groups. In this research, a semi-structured interview form was applied to the students in the experimental groups, and the students in the experimental groups kept diaries. The research included eight weeks for the systems unit in our body, one of the units in the curriculum of the 6th-grade science course. During the process, the Anatomy 4D application, a MAR application, was used in support and movement system, respiratory

system, circulatory system in the experimental groups, and the control groups were subjected to the existing textbook the course.

During the process, the researcher has made the Anatomy 4D application available on the smartboard through a computer program. Afterward, students who had tablet computers among the experimental groups were asked to download the Anatomy 4D application to their computers and bring their tablet computers throughout the process.

In the first week of the research, experiments and control groups were determined. Students in experimental groups were divided into groups with at least one tablet computer in each group, were informed about MAR technology and Anatomy 4D application, and pre-tests were applied. In order to permit each student in the experimental groups to actively use the Anatomy 4D application both in the classroom and outside the classroom environment during the research period, two worksheets were developed with AR technology were given.

In the 2nd week of the application, the Anatomy 4D application was activated on smartboard and tablet computers, and the subject of support and movement system was processed. Throughout the process, on the one hand, the places of the bones in our body were shown actively. On the other hand, the visual was enriched with theoretical knowledge, and simultaneously, learning was performed. Furthermore, from time to time, groups were given time to use the application from their tablet computers, and their active participation in the process was ensured.

In the 3rd week of the application, after the Anatomy 4D application was activated on both the smartboard and the tablet computers, questions were asked about the bone and joint types in order to repeat what was done in the previous course, and the students were asked to show the locations of various bones and joints through the application. Subsequently, the transition to the muscular system and the muscles' location through the application are shown actively.

In the 4th week, the application of Anatomy 4D was activated on smartboard and tablet computers, and the respiratory system subject was processed. Throughout the process, the primary organs of the respiratory system were shown in 3D, and theoretical information was given about the organs. In addition, the students were asked to learn about the respiratory system organs and give feedback from time to time.

In the 5th week, the application of Anatomy 4D was activated on the smartboard and tablet computers, and the respiratory system subject was processed. Throughout the process, the primary organs of the respiratory system were demonstrated in 3D, and theoretical information was given about the organs. From time to time, the students were asked to give information about the respiratory system organs and give feedback. Subsequently, a short introduction was made to the circulatory system's topic, and the students' readiness levels were observed.

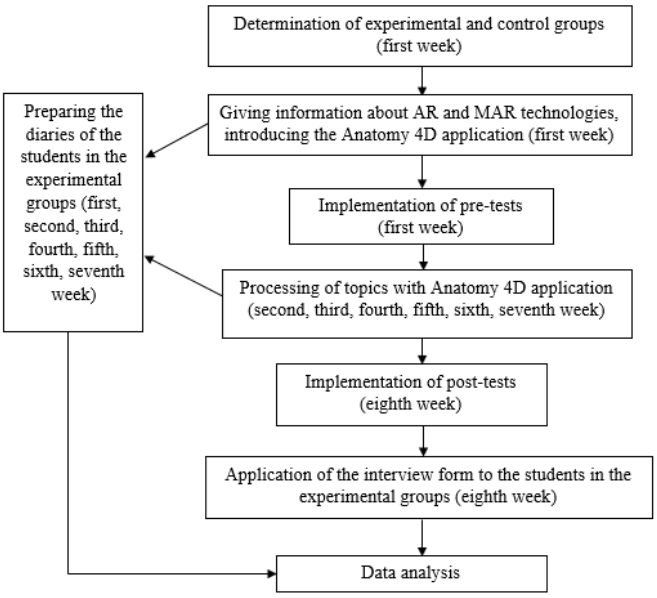

Figure 2 Flow chart regarding the steps followed during the research

At the 6th and 7th weeks of the application, the circulatory system's last subject has been processed. In addition to the "human body" worksheet developed with the AR technology used in the processing of support and movement system and respiratory system issues, the "heart" worksheet was also used in order to make learning about the structure of the heart, to concretize the abstract concepts that are difficult to understand.

In the last week of the application, the research was terminated by applying a semi-structured interview form to the experimental groups. The steps followed during the research and the schematic structure for this process are given in Figure 2

3. DATA COLLECTION TOOLS

In this research, semi-structured interview forms and diaries kept by the students in the experimental groups were used as data collection tools. In research, a semi-structured interview form consisting of 6 questions was used to determine the students' opinions in the experimental groups on the practice used and the effects of this application on various variables. The semi-structured interview form was applied to 65 students in the experimental groups, and the students were given 40 minutes to answer the questions in the interview form. In addition, within the scope of the research, the students in the experimental groups were asked to keep the diaries during which they could reflect their positive/negative

Table 1 Frequency and percentage distribution of students' answers to their thoughts about MAR technology

Answers	f	%
3D image	16	24.62
An application that introduces our body, Anatomy 4D	12	18.46
Enrichment of our environment with simultaneous addition of digital objects such as sound, image, animation, hologram	11	16.92
Using applications such as Aurasma, Layer, Alive, 2D, and 3D visuals depending on some criteria for various purposes	6	9.23
Use of mobile devices in applications that enable us to organize and direct our daily lives	5	7.69
A view of a new perception environment as direct or indirect 3D	4	6.15
I don't know	3	4.62
Various applications such as Aurasma, Layer, Alive	2	3.08
Virtual Reality	1	1.54
Transfer what we see in real life to a virtual environment	1	1.54
Integration of AR technology into mobile devices	1	1.54
Demolition of the wall between the real world and the virtual world	1	1.54
An application to help students understand the subject better	1	1.54
I know, but I can't explain	1	1.54

feelings and thoughts, observations, and suggestions about the application.

3.1 Data Analysis

Descriptive analysis was used to analyze the data obtained from the semi-structured interview form conducted for the students in the experimental groups. The data obtained in this process were coded using the concepts that are likely to play a crucial role in answering the research questions developed, and then these codes were categorized under broader themes. In this way, the basis for linking the themes was prepared, and the variables in the data set were compared. In addition to this, direct quotations from the data sources were included, and the students' opinions were put forward effectively and contributed to the validity of the research. Interpretations to be made concerning the relevance of these themes and their predictions and predictions will make the analysis more important (Cepni, 2014).

During the research period, descriptive analysis was used to analyze the data obtained by the students in the experimental groups. In the descriptive analysis, a framework has been formed from the research's conceptual framework to determine which themes will be organized and presented the data obtained through the students' diaries. The data obtained following the frame created has been read and arranged. The edited data has been made understandable by supporting it with direct quotations in the necessary parts of the research. Finally, some conclusions have been made by interpreting the findings that have been made clear (Cepni, 2014). The students' diaries in the experimental groups were collected under the themes of 'feelings and thoughts about AR technology and Anatomy 4D application, problems encountered during the research period'.

4. RESULTS

With this research, secondary school students' opinions on the use of MAR technology in science teaching were determined. Results are presented in two subtitles, "semi-structured interview form results" and "students' diary results".

4.1 Results from Semi-Structured Interview

It is aimed to reach the concepts and themes that can clearly explain the data so that the readers can clearly understand the data obtained through the semi-structured interview form consisting of 6 questions. Accordingly, an inductive logic based on coding was preferred (Yildirim & Simsek, 2006). In this process, data resembling each other were categorized under certain concepts and themes, and sensitivity was shown to reflect the answers given by the students without deviating their meanings.

A semi-structured interview form was applied to 65 students (35 girls, 30 boys) in the experimental groups. In the research, student names were presented by coding. The answers to the questions in the form, frequencies related to the answers to the questions, the percentage of these frequencies, and some students' answers are given below.

The first question, 'Can you explain what Mobile Augmented Reality (MAR) technology is?'. The frequencies related to the answers given by the students to this question and the percentages related to these frequencies are shown in Table 1.

Table 1 describes what Mobile Augmented Reality (MAR) technology is. It is observed that respond in the form that 24.62% of students respond to the question as 3D image, 18.46% of an application that introduces our body, Anatomy 4D and 7.69% of as the use of mobile devices in applications that enable us to organize and direct our daily lives. These results show that most students are familiar with MAR technology and are based on the Anatomy 4D application used during the research while

Table 2 Frequency and percentage distribution of students' response to the success of MAR application use in the course

Answers	f	%
Facilitate learning and understanding	22	33.85
Provide clear and detailed learning	20	30.77
To embody abstract concepts	20	30.77
Making learning permanent	9	13.85
Allowing of applied learning	7	10.77
Making the lesson fun	6	9.23
Making sense of reality	5	7.69
Provide an increase in the success in the course	3	4.62
Love the lesson, interested in the lesson	3	4.62
Ensuring adaptation to the course	1	1.54
Allowing technology-based training	1	1.54

defining this technology. Some of the students' answers to the relevant question are given below:

Emir: 'Enrichment of the environment in which we are in real-time with objects such as sound, image, animation, hologram.'

Side: 'Like virtual reality, it's like seeing in 3D and showing detail.'

Mert: 'Mobile technologies can enable us to organize and direct our daily lives with mobile applications we use during the day. One of the applications used in mobile devices is augmented reality technology.'

2nd question 'Have you used Augmented Reality (AR) or Mobile Augmented Reality (MAR) technologies and used applications for these areas? Can you explain?'. Sixty-three students answered yes, and two students answered no to this question. These results show that almost all students are aware of the AR and MAR technologies and have started to benefit from the work done. Some of the students' answers to the relevant question are given below:

Ali: 'Yes, I used it. I wore 3D glasses in some games and when I went cinema.'

Melis: 'No, I didn't use it. For the first time, I met with AR and MAR.'

Sevgi: 'No, I did not use it, but after I started to use it in the Science course, I started to use it. It helped me a lot. Because in our writings we can study Anatomy 4D for working on those issues.'

3rd question 'Do you think the use of Mobile Augmented Reality (MAR) application during the course contributes to the lesson's success? Can you explain?'. Fifty-nine students answered yes to this question, two students at medium level, and four answered no. The frequencies related to the answers given by the students to this question and the percentages related to these frequencies are shown in Table 2.

When Table 2 is examined, it is seen that 33.85% of the students responded to this question as facilitating understanding and learning, 30.77% providing precise and detailed learning, and 9.23% making the lesson fun. These results show that the use of the MAR application plays an active role in the development of the students' academic achievement levels and contributes to the learning of the current subject by having fun. The answer given by one of the students to the relevant question is given below:

Table 3 Frequency and percentage distribution of students' response to the contribution of MAR application used to the attitude towards the course

Answers	f	%
Changing the attitude towards science in a positive direction	37	56.92
Changing the attitude towards technology in a positive direction	13	20.00
Provide the increase in knowledge accumulation	11	16.92
Facilitate understanding	9	13.85
Making the lesson fun	7	10.77
Provide participation in the course	3	4.62
Making learning permanent	2	3.08
Making sense of reality	1	1.54
Provide clear and detailed learning	1	1.54

Furkan: 'Yes, it is remaining in my mind. I think it is helping to classes, and I think the science course more tasteful and memorable with visual.'

Sertan: 'Yes, I think. Because with the application of Anatomy 4D, we see parts of our bodies as if they were really in front of us. That's why I think it's contributing.'

Sila: 'According to me yes. Because I used to love science less, I was less interested. Now I love it more, and I'm interested.'

4th question is 'Did the use of Mobile Augmented Reality (MAR) application affect the attitude of the course. Can you explain?'. Thirty-eight students answered yes, two students at medium level, and 25 students answered no to this question. The frequencies related to the answers given by the students to this question and the percentages related to these frequencies are shown in Table 3.

When Table 3 is examined, it is seen that 56.92% of the students responded as changing the attitude towards science positively, 20% changing the attitude towards technology positively, and 16.92% providing an increase in knowledge. The answer given by one of the students to the relevant question is given below:

Omer: 'Thanks to the mobile augmented reality application, I made more contributions to the Science course. I liked it more than before.'

Tarik: 'Yes, it's okay. I'm not much of a student who loves science. However, when using MAR, I realized that science is more fun and important lesson.'

Buse: 'Yes, it's okay. Because beforehand, I understood this application very simple. However, in every science

Table 4 Frequency and percentage distribution of students' responses to advantages of using MAR application in the course

Answers	f	%
Facilitate learning and understanding	29	44.62
Provide clear and detailed learning	16	24.62
To embody abstract concepts	9	13.85
Contributing to making an observation	7	10.77
Provide the increase in knowledge accumulation	6	9.23
Making the lesson fun	6	9.23
Making learning permanent	4	6.15
Love the lesson, interested in the lesson	3	4.62
Providing a learning environment by living by doing	1	1.54
Provide the participants to the course	1	1.54
Provide the adapt to the course	1	1.54

course at the moment, I want to open this application. I thought science class was boring before. However, now I like science more than other courses.'

When the students' answers about to whether MAR application contributes to scientific process skills are examined, it was determined that 50 students responded in the form of no, and 15 students in the form of yes.

When the students' answers about the contribution of MAR application to scientific process skills are examined; It was determined that 13 students responded in terms of observation, seven students as classification, and seven students as the definition. The answer given by one of the students to the relevant question is given below:

Omer: 'Observation: We were able to examine the systems in our body with augmented reality.'

Ali: 'Observation: I didn't normally know the inside of the human body, but I saw both the human body and the muscles with this practice.'

Ayse: 'Defining: We can better tell what we have learned.'

Students all have the advantage when the students' answers about the advantages and disadvantages of using the MAR application in the course processing are examined. Among the 65 students, nine students have the disadvantage. One student was identified to respond in the form of an no idea.

The students 'What are the advantages and disadvantages of using Mobile Augmented Reality (MAR) in the course?' the frequencies of the answers they gave to the question and the percentage ratios depending on these frequencies are shown in Table 4 and Table 5.

When Table 4 is examined, it is seen that 44.62% of the students responded to this question as facilitating learning and understanding, 24.62% providing precise and detailed learning, and 13.85% embodying abstract concepts.

Table 5 Frequency and percentage distribution of students' responses to the disadvantages of using MAR application in the course

Answers	f	%
Application isn't suitable to be used in each tablet	2	3.08
Causes eye fatigue	2	3.08
Internet is slow	1	1.54
Use of for other purposes outside the class hours of tablets	1	1.54
The content of the MAR application is in English	1	1.54
The slowing down of the functioning of the course	1	1.54
Limited activities in MAR applications	1	1.54

When Table 5 is examined, it is seen that two students each responded as the application was not suitable for use on every tablet, causing eye fatigue. The answer given by one of the students to the relevant question is given below:

Arda: 'Helping us to understand the important topics in the course better.

Disadvantage = This application only works on certain tablets. It doesn't work in some.'

Ayşe: 'The lesson began to be more fun and different. We have seen everything more in detail. So I think no disadvantage.'

Duygu: 'Disadvantages = My eyes were tired, the internet was slow, people were playing the game from the tablet, the application does not work in IOS.

Advantages = I began to get to know the organs well, my participation in the classes was excellent, it added a lot to me.'

4.2 Results from Students' Diaries

The descriptive analysis technique was used to analyze qualitative research data obtained through the students' diaries in the experimental groups during the research period. After reading the logs several times, codes were formed according to the concepts obtained from the data. After the codes were compiled and analyzed, common aspects between the codes were found and categorized. The students' diaries were collected under the themes of 'feelings and thoughts about AR technology and Anatomy 4D application, problems encountered during the research period'.

Results Related to the Theme of the Students' Feelings and Thoughts Related to AR Technology and Anatomy 4D Application

When the diaries of the students in the experimental groups were examined, sentences that reflect the new hearings of the students' AR and MAR concepts were frequently encountered. As time progressed, it was observed that the students had mastered both these concepts and the application used. In their diaries, the

students expressed that the teacher played a decisive role in their love for the lesson and learned the lesson by having fun.

During the application, the students have been enabled to actively use the practice to play an active role in the course. Thus, an educational approach that takes the students to the center has been adopted. In addition, each student was given application-specific research papers to personalize their learning process independently of time and place by using their mobile devices.

Below are direct quotations from some students:

'The first day was wonderful. I liked the teacher, the lesson and the subject. I think the Anatomy 4D application is nice. The application, our muscle system, in short, telling all the organs in our body. If we come to the useful videos that we watch in the course, they are standing in front of us with the most ornamented form, and since all of these privileges are for our class, we have handled the lesson proudly.'

'We had so much fun in science today. Hodja was very good, kind, and sometimes made us laugh. The course was great. It was very spectacular to see the human body and organs in 3 dimensions.'

'What the teacher told things us was wonderful, we had so much fun. The functioning of the lesson with the tablet was very nice. I hope it applies to other classes...'

Results on the Theme of Problems Students Live Through the Process

When the students' diaries were examined, some of the students stated that the tablets used were not fixed and, therefore, the image could not be clarified fluently. However, over time, students have found a solution to eliminating this problem, which they use by fixing their working papers and tablets with the help of various objects. In addition, the students in the experimental-1 group sometimes stated that the course of the lesson slowed down, and the reason for this was the noise caused by the classmates' conversations. During the process, the utmost care has been taken to ensure classroom management to minimize the impact of this problem.

Below are direct quotations from some students:

'Today, we learned the structure of the bones in the course. Our body is a great miracle. In this course, I also learned topics I never knew. It was great to see our body in 4D, but the internet connection was distressed. It was just boring. As usual, this course is great.'

'There is noise in the same way in the class. So, it's not from my teacher, but the students were because of that noise...'

5. DISCUSSION

The data obtained from the semi-structured interview form and the diaries that the students had kept during the research period showed that a large proportion of students heard AR and MAR concepts for the first time, they did not use AR and MAR technologies before, and they did not use applications for these areas. In addition, it is seen that a significant number of students associate MAR technology with the application used during the process and associate MAR technology with the application of Anatomy 4D. Although the students do not have a clear idea about both the application to be used during the research process and the AR and MAR technologies, it is observed that their thoughts change over time, and MAR practices are effective on the success of the course. In the results obtained, various factors play an essential role. The MAR application used in the course gives a sense of reality, allowing practical learning, understanding, facilitating learning, and providing precise and detailed learning. When the related literature is examined, it is seen that the number of studies that determine the views of MAR technology in the course of the course is quite limited. Sirakaya (2015), in his research, investigated students' views on AR material. As a result of the research, the AR reached the opinion that the learning material embodied the abstract issues, made the subjects more comprehensible, made the lesson more exciting and fun, increased communication, and became more effective at the course. Fleck & Simon (2013) investigated the effect of AR technology on students' achievements and conceptual misconceptions. He found that the use of AR technology embodies abstract concepts by presenting a rich learning environment and thus facilitates understanding. The results of the studies carried out by Sirakaya (2015) and Fleck & Simon (2013), which include the students 'views on MAR application, are consistent with the student's views on the use of MAR technology in the course.

All of the students in the experimental groups stated that the use of the MAR application was advantageous in the course of the course. In contrast, a small part stated some disadvantages of using the MAR application in the course. The students stated that the use of MAR application has several advantages: understanding facilitating learning, providing precise and detailed learning, concreting abstract concepts, increasing knowledge, making the lesson fun, and making learning permanent. In addition to this, some students stated that the MAR application used in the course is not suitable for every tablet. The internet is slow, and the tablets are used for different purposes other than course hours.

Furthermore, the content of the MAR application is in English. Within the scope of the research, Sentürk (2018), Di Serio, Ibáñez & Kloos (2013) have concluded that the AR technologies used in the course processing have disadvantages arising from technical reasons. The results obtained from the researchers ' studies support the results of this research on the disadvantages of using the MAR application in the course.

6. CONCLUSION

This experimental research was carried out with middle school students to determine their views on MAR technology used in science teaching. As a result of the research, students stated that MAR has several advantages, such as facilitating learning and providing precise and detailed learning. From this point of view, researchers can provide technology-based education by integrating technological tools into educational environments. However, the research is limited to a small group of students and one MAR application available. In order to expand the field of this limitation, the application needs to be integrated into activities that address different learning areas. There is a need for people in the software field in the development of such applications. At this point, richer learning environments can be created by collaborating with science educators.

Different socio-economic levels of students and the difference in access to technology resulting from this did not affect their views. It has been found that students find solutions to eliminate the technological problems they face during the research. This can outweigh the desire to use it, even if it is difficult to access the technology.

NOTES

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