International Technology and Education Journal
Vol. 6 No. 1; June 2022
ISSN: 2602-2885
URL: http://itejournal.com/

Atalay, N. (2022). Augmented reality experiences of preservice classroom teachers in science teaching. International Technology and Education Journal, 6(1), 28-42.

Augmented Reality Experiences of Preservice Classroom Teachers in Science Teaching*

Nurhan Atalay, nurratalay@gmail.com, Niğde Ömer Halisdemir University, Turkey, https://orcid.org/0000-0003-1002-3110

SUMMARY

Using technology in the learning and teaching process enables students to learn effectively and meaningfully. Augmented reality, one of the applications used in education, can meet students' needs in the learning process. Especially in science lessons, augmented reality enables students to understand the nature of science. It is important to have teachers who can reflect technology to learning environments effectively and efficiently. In line with this purpose, preservice classroom teachers were asked to create lesson plans for 3rd- and 4th-grade science topics and gains using the augmented reality application. The researcher prepared a structured interview form to collect preservice teachers' experiences in creating augmented reality products and determining their opinions on using this science teaching application. The interviews were analyzed using the descriptive analysis technique. As a result, preservice teachers stated that both science lessons and other lessons should include the augmented reality application; the application draws attention to the subject as it is fun, interesting, and intriguing, thus providing meaningful learning. Preservice teachers stated that they would benefit from augmented reality applications in their professional lives, augmented reality will be effective in science teaching. They realized the importance of using technology in science lessons with these applications.

Keywords: Augmented reality, classroom teacher, science teaching.

INTRODUCTION

In today's information age, individuals who produce information, question, and criticize the information they produce, are needed. Individuals are expected to use new and different learning programs and technologies to have questioning and critical thinking skills. Due to expectations and needs of societies arrangements were made in learning environments (Akkoyunlu & Kurbanoğlu, 2003). In this context, the updated primary school curricula aims to raise individuals with the characteristics of knowledge, skills, and behavior integrated with basic competencies. Digital competence, which is one of these competencies, is expressed as "the use of computers for accessing, evaluating, storing, producing, presenting and exchanging information, and basic skills such as participating in common networks and establishing communication through the Internet" (Ministry of National Education [MoNE], 2018). This new generation which spends most of its time on the internet and using other technologies, is referred to by different researchers as; the students of the new millennium (Pedro, 2006), Y-generation (McCrindle, 2006), internet generation (Oblinger & Oblinger, 2005), technological native (Monereo, 2004), and digital native (Prensky, 2001). Especially 21st century students and teachers, who are called 'digital natives' (Palfrey & Gasser, 2008), differ from previous generations with their distinctive features such as, "They want very fast access to information, prefer games instead of serious works, visual and graphic elements instead of long texts, have a parallel cognitive structure, they can perform multiple tasks simultaneously" (Bilgiç, Duman & Seferoğlu, 2011). In this context, the main problem to be focused on is how to benefit from technology in the learning and teaching process and effectively reflect this new generation's technology habits into the education process. One of the technologies that contribute to the learning process is augmented reality (AR).

Augmented reality (AR) is a technology that allows computer-generated virtual image information to be embedded directly in real life as real-time or indirectly in a real-world environment (Azuma, 1997; Zhou, Duh & Billinghurst, 2008). According to Peeck (1993), visual images in the classroom engage the student, focus their attention on the lesson, and simplify complex texts. AR applications have characteristic features such as presenting real and virtual elements together, simultaneous, interactive, and 3-D (Azuma, 1997). AR technology aims to create a blended environment by integrating the real and virtual environments (Billinghurst, Kato & Poupyrev, 2001). AR is different from virtual reality because people experience a computer-generated virtual environment in virtual reality. In AR, the environment is real, but it is enriched with the system's information and images. In other words, AR bridges the gap between real and virtual (Chang, Morreale & Medicherla, 2010). AR emerges as one of the technological developments that transform education and provides relevant contributions while presenting content to students. Likewise, there is a perception that information communication technologies improve the learning process and the technological skills of students and teachers (Holley & Howlett 2016). According to Azuma (1997), AR offers the opportunity to coexist in the same space using real and virtual elements and interact with

* This study was presented as an oral presentation of the conference 2nd International Congress of Pedagogical Research.

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them real-time. It enables us to obtain information by showing multimedia or texts about the objects or places in a simple and fast way (Billinghurst et al., 2001). As a result of their interaction with AR, students gain experience in different subjects at different educational stages (Huang et al., 2015). The use of AR in the classroom offers the option of turning anything virtual into an interactive lesson. Textbooks, memory cards, and other reading material used in education may contain embedded triggers or markers. The scanning of these triggers with the AR tool can reveal the information in various formats such as 3D or multimedia. In this way, students can participate in scientific processes interactively (Bender, 2017).

AR has been argued to provide increased content understanding, improvements in interaction and cooperation, better memory retention, and higher motivation than other media formats (Bucher & Grafe, 2018). Motivation must be taken seriously because it is directly linked to learning achievement. Therefore, AR applications that are interactively and visually richer than traditional media are more attractive and motivating than traditional tools (Duarte, Cardoso & Lamounier, 2005). AR can provide contextual and relevant learning experiences and explore the interconnected nature of knowledge in the real world (Johnson et al., 2010). Real learning requires experience (Luckin & Fraser, 2011). With the development of technology, different sensors, such as motion, monitor, touch, and sound, increase the power of the experiences that can be lived (Somyürek, 2014). The more relevant the senses (sound, sight, touch, emotions, etc.) are, the more powerful the learning experience is. In this context, AR appears to be an interesting technology for education (Luckin & Fraser, 2011). The fact that AR technology provides an opportunity to create learning experiences suitable for the constructivist approach and enables the effective use of the digital technologies that has led to the increased use of this technology in education (Somyürek, 2014). The use of technology is also very important for science because it enables learners to observe objects and events that cannot be witnessed due to size, distance, location, and speed (National Research Center [NRC], 1996). Students were discovered to be able to view body parts realistically in situ using the AR application, as opposed to previously used visualizations including images, movies, and models. The students claimed that, as a result of the AR application, they had a better grasp of lung function and physical dimensions. When teaching just with text or an inactive plastic model, these phenomena are typically exceedingly challenging to understand. Students also stressed how the procedure gives them the chance to select a unique, exploratory strategy in order to get a thorough understanding (Nielsen, Brandt & Swensen 2016). Studies show that augmented reality applications play a facilitating role in learning concepts by concretizing abstract concepts (Bujak et al., 2013; Sahin &Yilmaz, 2020; Shelton & Steven, 2004), and they can achieve more meaningful learning than they can physically see abstract concepts through 3D virtual objects (Sahin & Yilmaz, 2020). 2020). AR can help learners make spatial or temporal connections between information by integrating different representations, allowing them to interact with the learning content or call attention to pertinent information resources (Radu, 2014). This feature allows it to be an important learning tool in teaching abstract concepts to primary school students.

As with most new technological introductions, a number of conditions must be satisfied. These prerequisites cover fundamental technological difficulties, such as hardware accessibility and availability, internet access, etc., but they also take into account students' and teachers' technological proficiency (Akcayır & Akcayır, 2017). Due to the fact that augmented reality is a relatively new technology, it is important to comprehend the advancements and practical effects of using it in educational settings, as well as how AR is used to create more student-centered learning scenarios (Chen, Liu, Cheng, & Huang, 2017). In this context, the teaching courses given to teacher candidates in the teaching dimension are of great importance in terms of gaining knowledge and experience about the methods and techniques used in the teaching process. In this research, prospective teachers are expected to plan their lessons with these technological applications and use them functionally in the process. In this study, the use of AR application in teaching primary school science lessons was examined. This research aimed to ensure that primary school teacher candidates plan the lesson process with AR application in line with the 3rd and 4th grade science course achievements. For this purpose, the following questions were addressed:

1. What are the problems that preservice classroom teachers encounter during the augmented reality application process?
2. What are the opinions of preservice classroom teachers about using augmented reality applications in the learning-teaching process?
3. What are the opinions of preservice classroom teachers about using augmented reality applications in the classroom teaching program?
4. How do preservice classroom teachers evaluate the advantages and disadvantages of the augmented reality application for the student and teacher?
5. How do preservice classroom teachers evaluate the advantages and disadvantages of the augmented reality application for the teacher?
6. What are the suggestions of preservice classroom teachers about augmented reality applications?

METHOD

This study, which aims to determine the opinions and experiences of pre-service teachers about the augmented reality creation experiences and the use of augmented reality in science teaching, is based on a basic qualitative research design. Merriam (2009) explains basic qualitative research as a philosophical derivation from structuralism, phenomenology, and symbolic interaction. It is also used by researchers interested in how people interpret their experiences, build their worlds, and what tendencies they show. According to Worthington (2010), it is also possible to explore experience, meaning, structuring, and process in a single study with basic qualitative research. Ultimately, the purpose of qualitative educational research is to improve our practice and provide an in-depth understanding of effective educational processes with basic qualitative research design.

Participants

The participants of this research are 41 third grade preservice teachers (10 male and 31 female) from a Faculty of Education in Central Anatolia. Participants were selected by criterion sampling, one of the purposeful sampling types used in the qualitative research method. Purposeful sampling allows the study of the situations that are thought to be rich in information (Patton, 2002). In this sampling method, either the criteria determined by the researchers or a predetermined list of criteria can be used to determine the participants (Yıldırım & Şimşek, 2005). Two main criteria were specified for this study: 1) voluntary participation in the research and 2) preservice classroom teachers attending the third grade (To be considered successful in the classroom teaching program from the science and technology laboratory course and other basic science courses).

Data Collection Tool

Research data were collected via a structured interview form. The interview questions were developed by the researcher based on the literature review and expert opinions. The written interviews were conducted with participants. The data were collected as writing from preservice teachers. For internal validity and reliability studies participants' written responses were edited by the researcher, and the participants were asked to confirm their responses (Lincoln & Guba, 1985).

Data Collection Process

The study was carried out with preservice classroom teachers during the 'Science and Technology Teaching I' course over three weeks. One week before the application, the researcher informed the participants about creating augmented reality and the Hp Reveal (Aurasma) program used in this process for three lesson hours. Then, the pre-service teachers used the augmented reality materials they prepared individually in their lesson plans. After three weeks of practice, the research applied the interview form to the students for one class hour.

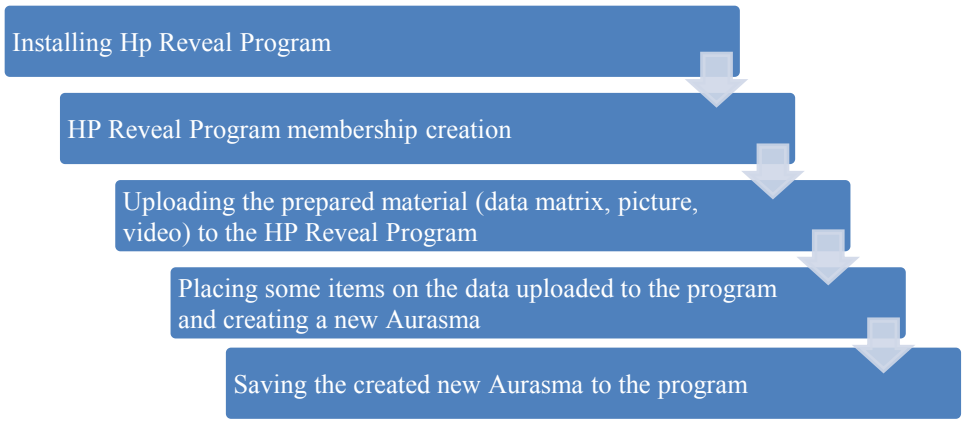

Figure 1. The Preparation process of an augmented reality application in Hp Reveal (Aurasma) program

Preservice teachers spent three weeks designing the augmented reality applications containing the 3rd and 4th grade science gains that they individually selected and incorporated into their lesson plans. As a result, these preservice teachers created 41 AR based lesson.


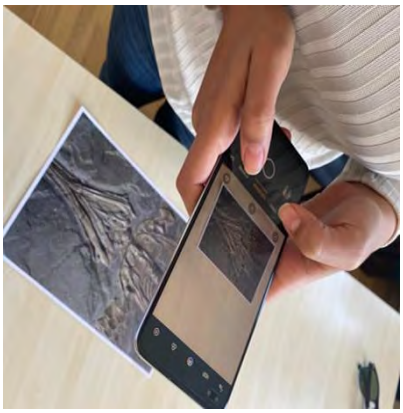

Figure 2. Application examples

Data Analysis

In qualitative research, data analysis includes the experiences lived and the organization of what is seen, read, and heard to understand those experiences (Glesne, 2012). In this research, the descriptive analysis technique was used in the analysis of data. In descriptive analysis, the data are summarized and interpreted according to previously determined themes. The data can be organized according to the themes revealed by the research questions or by considering the questions or dimensions used in the interview and observation processes (Yıldırım & Şimşek, 2005). In this study, the themes were created according to previously determined research questions. The researcher took some precautions to ensure the validity and reliability of the study. These measures are shown in the table below.

Table 1. Measures Taken to Ensure the Validity and Reliability of the Study

Validity	Internal Validity	Taking expert opinion Direct quotation Preliminary interview
	External Validity	Explanation of data collection tool and process Explanation of the data analysis process Description of the administration process on the participants Purposeful sampling
Reliability	Internal Reliability	Presentation of the findings without comment
	External Reliability	Checking the consistency between data Control List

The structured interview form used in the research was developed by taking the opinions of two experts working in this field to ensure the study's reliability and validity. The questions included in the interview form were explained to preservice teachers who were asked to consider their experiences during the application process. Then, preservice teachers were given time to fill in the interview form. Generally, preservice teachers spent one class hour to fill out the interview form. Data collected from the preservice teachers through the structured interview form were transferred to the computer environment; the data were then reviewed by the researcher repeatedly and analyzed in the context of the previously determined themes using descriptive analysis technique.

FINDINGS

Findings for the First Sub-Problem

Preservice teachers' problems are discussed under four themes: technical difficulties, individual inadequacies, time-consuming implementation, and problems of specifying the subject. In order to realize this purpose, the data collected were analyzed and given in figures below. The explanations of the figures are presented.

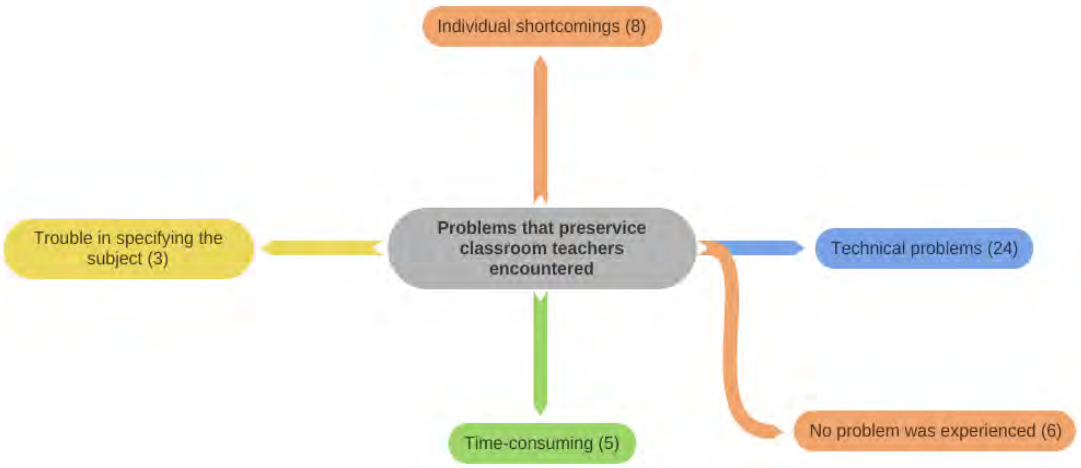

Figure 3. Problems that preservice classroom teachers encountered during the process of creating an augmented reality application

Regarding the opinions of preservice teachers who constituted the study group, 24 of them stated to having technical problems, 8 mentioned individual shortcomings, 5 found it time-consuming, 3 of them indicated that they had difficulties in specifying the subject, and 6 of them told that they did not have any problems.

Preservice classroom teachers have expressed their technical difficulties as follows: S2 *"One of the problems I encountered was that the program did not accept every photo.*", S22 "*Another problem I encountered was that my phone sometimes freezes and slows down while using the application."*

Preservice classroom teachers have expressed their individual shortcomings in the process as follows: S9 "*Even though they showed how to use the application in the lesson, it still troubled me. I had some difficulties finding sources such as pictures and videos of the subject*". S19 "*Since I have just begun learning in terms of technology, I had a problem in the technological sense, in uploading the QR code*."

Preservice classroom teachers stated their opinions as follows and emphasized that the creation process takes time, and they had problems in this context: S3 "*The creation process took some time*."; S25 "*It took me some time because I wanted to try different applications.*"

Some preservice classroom teachers stated that they had problems choosing the subject at the beginning of the process. S12 "*First of all, I was undecided about which subject to work on*."; S15 "*At the beginning, I had some trouble in adapting the application to the subject*."

Findings for the Second Sub-Problem

Preservice teachers expressed their opinions on using AR applications in the learning-teaching process under eight themes: it provides meaningful and permanent learning, attracts interest and attention, ensures participation in the lesson, makes the lesson fun, improves imagination and creativity, materializes abstract concepts, increases attitude and motivation towards the lesson, and saves cost and time. Figure 4 shows that preservice classroom teachers' opinions on the use of augmented reality application in the learning-teaching process

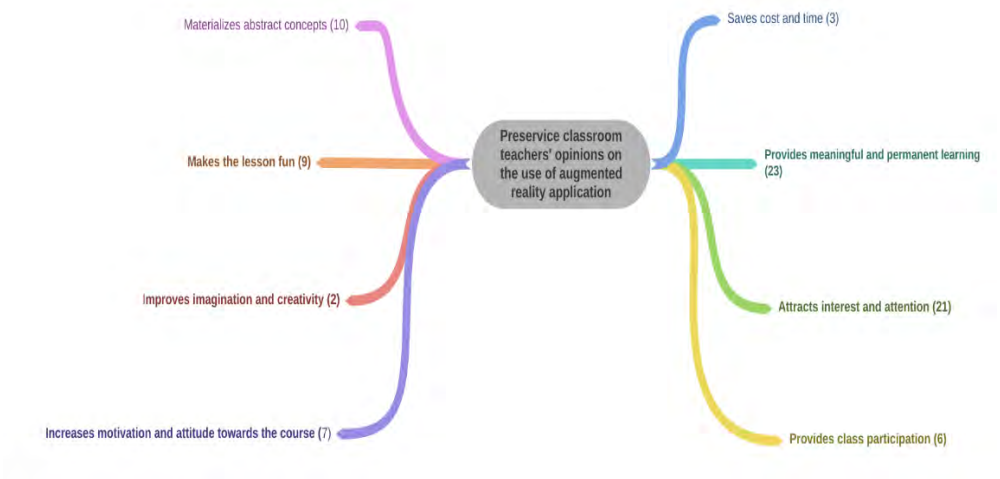

Figure 4. Preservice classroom teachers' opinions on the use of augmented reality application in the learning-teaching process

Regarding the opinions of preservice teachers in the study, 23 participants? stated that the application would provide meaningful and permanent learning, 21 participants? had opinions about attracting interest and attention, 6 participants? about ensuring participation in the lesson, 9 participants? about making the lesson fun, 2 about improving imagination and creativity, 10 about materializing abstract concepts, 7 about increasing the attitude and motivation towards the course and 3 about saving money and time.

Preservice classroom teachers stated that using the application would provide students with meaningful learning, and this learning would be permanent. S8 "*The importance of the plurality of sense organs on the permanence in the learning-teaching process is obvious.*" and, S12 "*Especially when certain subjects are given to children in 3-D, they are formed more clearly in their minds and learning becomes easier and more permanent*."

Preservice classroom teachers said that the process would increase students' interest and attention. S1 "*I think that the 3-D use of visual objects will increase students' participation in the lesson as it will attract their attention*." And, S19 "*This application is an efficient application in terms of attracting the attention of the new generation students.*"

Preservice classroom teachers pointed out that the application would contribute to students' participation in the lesson. S38 *"With augmented reality application, the student can better participate in the lesson.*" And, S33 "*I think it increases the participation in the lesson because it is a remarkable application*."

Preservice classroom teachers mentioned their opinions as follows: S10 *"Its use, especially in exploration and deepening stages, helps concretize the lesson and help to understand difficult subjects and abstract concepts more easily*." And, S18 "*Augmented reality applications are effective in explaining the subjects more concretely and in understanding the events in the learning-teaching process*."

Preservice classroom teachers stated that AR applications do not require time and money. S29 "*It is a cost-effective and efficient application to show the materials that are difficult to bring to the classroom.*" And, S34 "*The application is both costless and easy to design. It does not take much time*."

Findings for the Third Sub-Problem

Preservice teachers expressed their opinions on using AR application in classroom teaching program under the following seven headings: it has a facilitating effect on teaching, concretizes the subjects, can be used in all courses, provides technological competence, makes lessons fun and different, is appropriate for the level of students, and provides attention and curiosity. Among these preservice teachers, there were 9 opinions about the facilitating effect of the application on teaching, 14 about concretizing the subjects, 5 indicating that it can be used in all courses, 3 about providing technological competence, 4 pointing that it makes the lessons fun and different, 16 about the suitability of the students' level, and 14 mentioning that it provides attention and curiosity. Figure 5 shows that preservice classroom teachers' opinions on the use of augmented reality application in the classroom teaching program

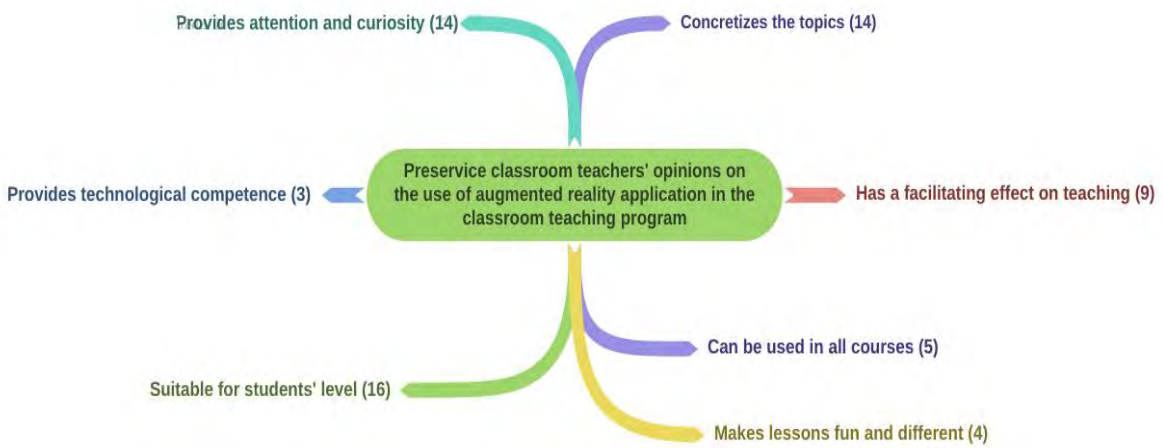

Figure 5. Preservice classroom teachers' opinions on the use of augmented reality application in the classroom teaching program

Preservice classroom teachers stated their opinions regarding the facilitating effect of using augmented reality application in the classroom teaching program as follows: S1 "*I think that the use of this application in the classroom teaching program will be beneficial primarily for classroom teachers, as it will facilitate the instruction of the lessons to be taught*." And, S28 "*Since the audience addressed by classroom teachers is children between the ages of 7-11 and they are in the concrete operational period, and it will make it very easy for them to understand the subjects*."

Preservice classroom teachers expressed that using the AR application in the classroom teaching program will concretize the subjects. S33 "*I think it concretizes the instruction of complex subjects that are not understood*." And, S36 "*I think it would be beneficial to use it as the age group to which we will provide the gains is low, and this application will concretize the intangible assets*."

Preservice classroom teachers stated that AR can be used in all lessons. S3 *"I think it is very suitable to apply in all courses of classroom teaching department, especially in science.*" And, S22 "*It can be used in every lesson in classroom teaching*."

Preservice classroom teachers suggested that AR applications would provide technological competence. S4 "*We have to use technology in our lessons, and therefore we must learn every application that is necessary.*" And, S40 "*It will be useful for classroom teachers to learn about such technological applications for their students in the future*."

Preservice classroom teachers expressed their opinions that using the AR application in the classroom teaching program will make the lessons fun and different. S6 *"It can be very different and fun for primary school level children. Regarding their age, such animations can be very interesting for children at this level.*" And, S28 "*Augmented reality applications both attract attention and allow learning by having fun."*

Preservice classroom teachers emphasized that the application was suitable for the students' level. S21 *"I think it is appropriate for the ages and grades of primary school students."* And, S31 "*Since we address the age group of 1-4th grades, I think this application is a program that is very suitable for their level, by giving the knowledge as a game.*"

Preservice classroom teachers stated that the application is remarkable and intriguing S16 "*The class and age group we are going to address are small, so it attracts their attention very quickly*." And, S19 "*Augmented reality is an application that can attract the attention and curiosity of everyone, old and young."*

Findings for the Fourth Sub-Problem

Preservice teachers stated their opinions on the advantages of AR application for students under seven themes, namely: permanent and meaningful learning, providing attention and motivation towards the lesson, ensuring participation in the lesson, enriching the learning environment, arousing interest and curiosity, making the lesson fun, and facilitating learning. These preservice teachers made 20 comments about that the practice contributes to students' permanent and meaningful learning, 16 opinions about providing attention and motivation towards the lesson, 7 about ensuring participation in the lesson, 7 about enriching the learning environment, 12 about arousing interest and curiosity, 11 about making the lesson fun and 7 about facilitating learning

Regarding the disadvantages of AR application for students, preservice teachers mentioned the following opinions; its frequent use will make the course ordinary, distract attention, and there may be problems due to lack of technological means. Preservice teachers expressed 11 opinions that its frequent use will make the course ordinary, 6 about distracting attention, and 9 about possible problems arising from the lack of technological means. 16 preservice teachers stated that the application had no disadvantage for the students. Figure 6 shows that preservice classroom teachers' evaluation of the advantages and disadvantages of augmented reality application for students

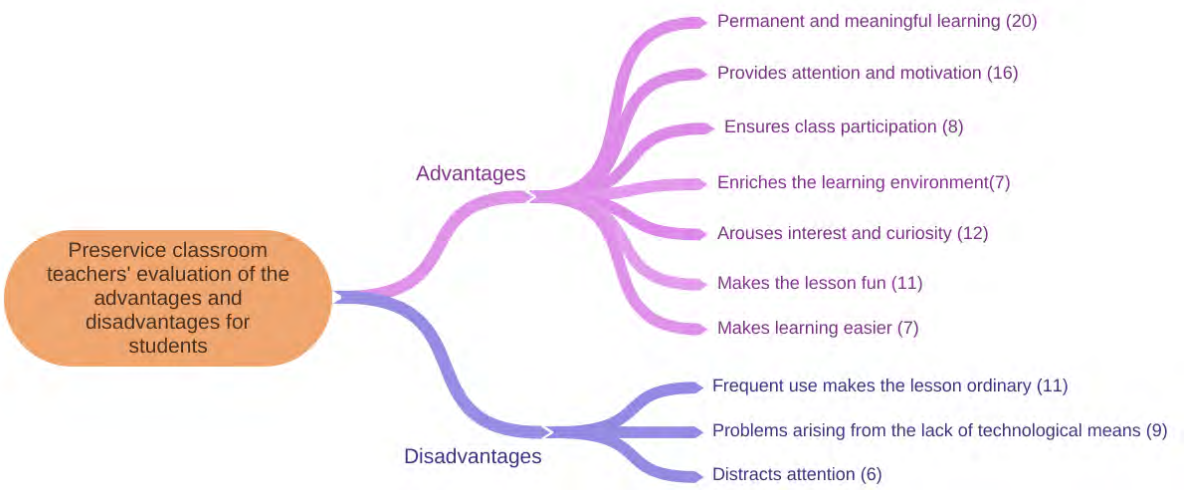

Figure 6. Preservice classroom teachers' evaluation of the advantages and disadvantages of augmented reality application for students

Preservice classroom teachers stated that the AR application would contribute to permanent and meaningful learning. S18 "*From the student's point of view, those with visual intelligence remember and do not forget what they learned more easily with the augmented reality application*." And, S20 *"It ensures that information is permanent*."

Preservice classroom teachers suggested that using AR applications would provide attention and motivation towards school or lessons. S24 "*It is a useful application in terms of attracting students' attention and focusing them on the subject*." And, S25 "*Increases students' interest, motivation, and attention towards school and lessons.*"

Preservice classroom teachers underlined that it was an effective application in students' participation in the class. S16 "*The student does not get bored in the lesson and follows the lesson attentively. It ensured active participation*."

Preservice classroom teachers suggested that augmented learning practices would enrich the learning environment in different ways. S28 "*Learning will be easier because they are visuals and address different sensory organs*." And, S33 "*Using technology in the lesson in this way makes the learning better and the lesson more colorful.*"

Preservice classroom teachers stated that the application would arouse interest and curiosity in the students. S4 "*This is an advantage if the student is new to this application. It makes him wonder, and he/she begins to explore more and more*." And, S6 "*Students become curious about the lessons*."

Preservice classroom teachers underlined that the application would make the lessons fun. S13 "*Students learn by having fun*." And, S25 "*It decreases the boredom of lessons and provides an enjoyable class environment*."

Preservice classroom teachers commented that it is an application that facilitates learning. S14 "*They learn more easily*." And, S15 "*They can understand abstract concepts more easily*."

As one of the disadvantages, preservice classroom teachers stated that the application could become ordinary if used frequently or for different reasons. S13 "*It may be boring when used too much."* And, S14 "*If every subject is instructed in this way, there may be boredom*."

Preservice classroom teachers stated that the application may have a distracting effect. S3 "*Frequent use is boring for the student, and it loses its purpose. Thus, the student gets distracted*." And, S35 *"The student's interest may concentrate on augmented reality, and they may have difficulty in listening to the subject*

Preservice classroom teachers suggested that the technological limitation of the application may be a disadvantage. S9 "*Since this application is an application run with technology, it cannot be used in places lacking technology, and under unsuitable conditions*." And, S14 "*Technological opportunity of every student may not be sufficient for this*."

Findings for the Fifth Sub-Problem

Preservice teachers stated their opinions on the advantages of augmented reality application for teachers under five headings: providing effective teaching, facilitating teaching, time-saving, providing a positive attitude to the teacher, and being cost-effective. Preservice teachers stated 21 opinions about providing effective teaching, 29 about facilitating teaching, 9 about saving time, 4 about providing a positive attitude to the teacher, and 3 about being cost-effective.

Preservice teachers' opinions on the disadvantages of AR application for teachers included the time spent for preparation and implementation, not being suitable for every subject, being challenging to prepare, causing problems in classroom management, technical difficulties, and problems arising from the inability to use technology. Preservice teachers stated 7 opinions about taking time to prepare and implement, 5 about not being suitable for every subject, 10 about being difficult to prepare, 8 about causing problems in classroom management, 13 about experiencing technical difficulties, and 6 about the problems arising from the inability to use technology. Figure 7 shows that preservice classroom teachers' evaluation of the advantages and disadvantages of augmented reality application for teachers

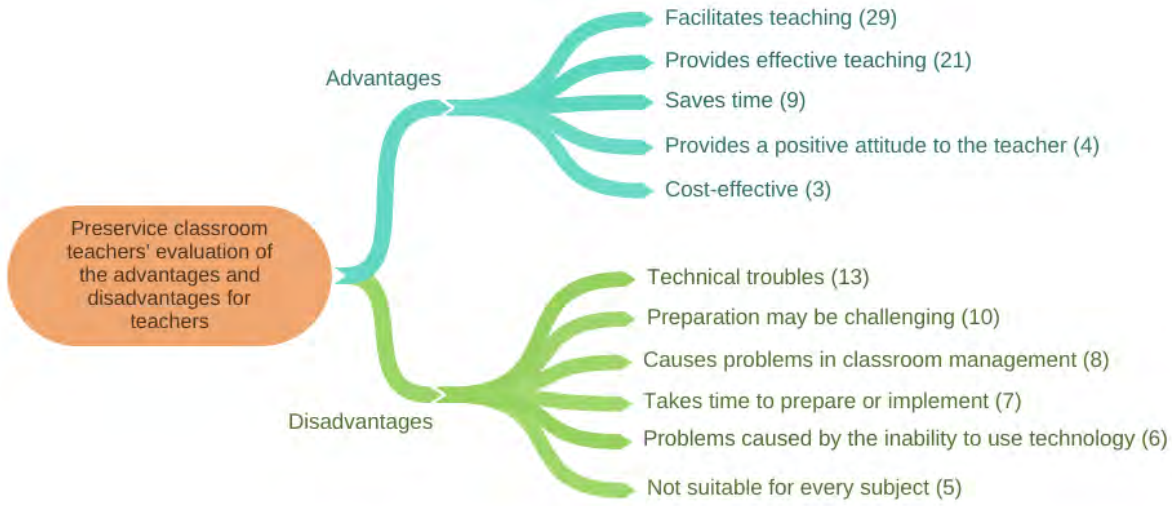

Figure 7. Preservice classroom teachers' evaluation of the advantages and disadvantages of augmented reality application for teachers

Preservice classroom teachers expressed that the application provides effective teaching. S23 *"Teachers can teach the lesson more effectively."* And, S38 *"The teacher instructs the lesson better with the active participation of the students."* Preservice classroom teachers suggested that implementing AR may save time. S18 *"Saving time for the teacher, more concrete instruction*." And, S29 "*It is very useful as it is not a very time-consuming application*."

Preservice classroom teachers have stated that the practice would positively affect the teacher's attitude towards the profession. S37 "*It rescues the teacher from being a classical teacher*." And, S39 "*It rescues the teacher from the boredom of the profession.*"

Preservice classroom teachers emphasized the cost-effectiveness of the application. S17 *"Once done, it can be used over and over for a long time.*" And, S13 *"The most important advantage is that it is more economical compared to other materials."*

Preservice classroom teachers stated the disadvantages of the application in terms of keeping classroom management. S31 "*It is as important to keep the order in the classroom without disorder as much as preparing the application*." And, S35 "*It takes a certain time in the lesson to show augmented reality to the students. After showing, it would be difficult to return to the topic and get the students to listen, which would be a disadvantage for the teacher*. "

Preservice classroom teachers stated the disadvantages of the application in terms of technical difficulties. S18 "*I can say that reaching an application environment in the classroom is technologically difficult*." And, S32 "*It creates a disadvantage for teachers in places with technology shortages*."

Preservice classroom teachers suggested that teachers may experience negativities due to the lack of technical knowledge. S14 "*The teacher may be insufficient in using technology*." And, S40 "*The disadvantages are that the user has little knowledge about the application, and the problems arising from the inadequacy of the technological devices in the classroom*."

Findings for the Sixth Sub-Problem

Preservice teachers expressed their suggestions on the AR application under three headings: usage, effectiveness, and limitations of the application.

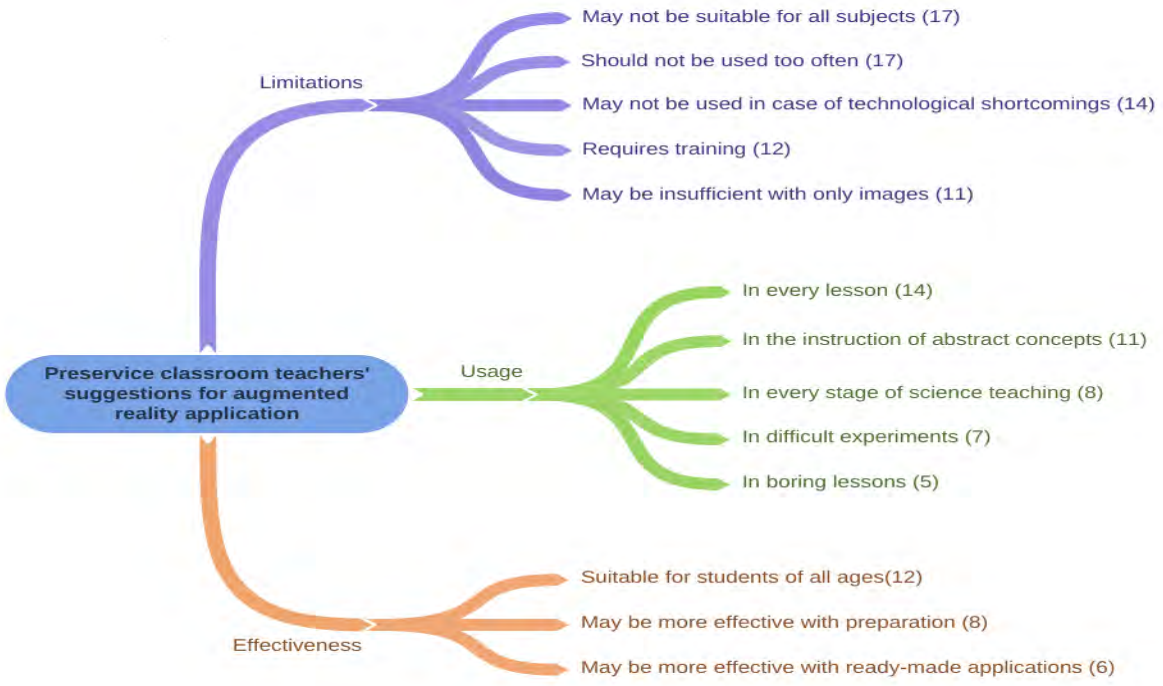

Figure 8. Preservice classroom teachers' suggestions for augmented reality application

Preservice classroom teachers had suggestions about the *usage* of the application in the teaching process under five headings: *"In every stage of science teaching, in the instruction of abstract concepts; in boring lessons, in every lesson, and for difficult experiments."* Preservice classroom teachers emphasized that the application can be used at every stage of science teaching. S4 *"It can be used in every lesson and especially in all stages of the science lesson*." And, S25 "*Augmented reality application is very important for the Science course. It can even be used at every stage of the lesson*." Preservice classroom teachers stated that the application could be used in the teaching of abstract concepts. S1 "*This application can be used while teaching abstract concepts.*" And, S26 "*This application can be employed in almost every subject, and it can be used especially for abstract concepts in lessons*." Preservice classroom teachers suggested that it would be beneficial to use the application, especially in lessons and content where students are bored. S1 "*It can be preferred, especially in lessons where children are bored and have difficulty in understanding*." And, S12 "*It can be used when the lesson is boring.*" Preservice classroom teachers mentioned that the application could be used effectively in every course. S28 *"Although it is frequently used in science lessons, I think it can be used effectively in other lessons as well.*" And, S35 "*It is an*

application that the teacher can use in most lessons and topics." Preservice classroom teachers emphasized that the application could be used in situations that are not suitable for experimenting. S12 *"Suitable for difficult experiments in the classroom."*

Preservice teachers stated their suggestions on the *effectiveness* of the application under three headings. They have said that the application was suitable and usable for all age levels. S11 "*It attracts the attention and attention of primary school children, and can also be used for senior students."* Preservice classroom teachers pointed out that the application required preparation before the lesson, and it would be more effective with preparation. S2 "*First of all, the gain should be specified, and after creating the AR in your mind, it will be good to do research and prepare an appropriate material before the lesson.*" Preservice classroom teachers emphasized that using ready-made applications in the process would be more effective. S8 *"Augmented reality applications that are already made for education can be more fun and effective for children, rather than the applications we made."*

Preservice teachers discussed the *limitations* of the application under five headings. They have stated that the application should not be used too often. S6 "*The application should not be used constantly in every lesson. If used continuously, this application will not be of any benefit to the students, and it will cause boredom*." And, S9 "*I think it is difficult to apply everywhere because it is an application that requires technology*." Preservice teachers also stated that the use of the application requires training. S24 *"Before using the augmented reality application, it is necessary to get detailed information. It is not possible to do without knowing the application.*" Preservice teachers emphasized that the application may not be suitable for every subject. S9 "*It is a good application, but it should not be used for every gain; some gains may use this application, but not every gain will have the same effect."* Preservice teachers also stated some other limitations. S32 "*This application should not solely consist of images; I recommend using animation and videos more*."

CONCLUSION AND DISCUSSION

Today, the technology seen in every field with the changing conditions and the developing world has also taken place in education. Considering the readiness and cognitive development of students at all levels of education, different applications are put into practice in the process. It is more and more important that classroom teachers, who teach especially in primary school age, should be equipped with these skills and receive training in this direction. Augmented reality is one of these applications. In this study aiming at, pre-service classroom teachers had three weeks of experience through AR. As a result of the individual and group experiences, the opinions of the prospective teachers, their experiences and their perspectives on the use of technology in education have changed. Within the scope of the research, some of the participants of the AR creation process stated that they did not encounter any problems, while the problems experienced by some pre-service teachers were reflected in their views.

Some of them stated that they experienced technical problems and problems caused by individual inadequacy. In contrast, some preservice teachers stated that it took much time to prepare the application and had difficulties specifying the subject. Similarly, in their study, Mundy et al. (2019) revealed that teachers and administrators perceive themselves at an intermediate or advanced level regarding AR application. The results obtained in the application creating process are similar in many studies. In this study, the participating preservice teachers stated that using AR applications in the learning-teaching process could provide meaningful and permanent learning, attract interest and attention, and provide participation in the lesson. Similarly, studies show that using AR applications in the teaching process affects students' interests, desires and attention, motivation, satisfaction, understanding, and remembering knowledge (Saltan & Arslan, 2017). Akkiren (2019) revealed that AR teaching processes attracted students' attention, their level of understanding of the subject increased, and 4-dimensional studies provided permanent learning. Göçmen (2019) stated that the augmented reality application makes learning easier and lessons more interesting.

Preservice teachers stated that using the application in the classroom teaching program had a facilitating effect, concretizes the subjects, could be used in all lessons, provided technological competence, made the lessons fun and different, and attracted attention and curiosity when appropriate for the students' level. Similarly, in Altıntaş's study (2018), preservice teachers stated that the AR application was interesting, concretizing, and enhanced reality. The advantages of using AR application in the process have been determined as follows: it contributes to students' permanent and meaningful learning, attracts attention and motivation towards the lesson, ensures participation in the lesson, attracts interest and curiosity, makes the lesson fun and facilitates learning. The disadvantages were mentioned as the frequent use of the application will make the course ordinary, distract attention, and there may be problems due to lack of technological means. Like the research results, it was found that AR personalize the learning. It was student-centered, constructive, participatory, collaborative, interactive, cognitively rich, creative, challenging, problem-solving-oriented, content-related, authentic, meaningful, attractive, entertaining, and motivating effects (Dunleavy, Dede & Mitchell, 2009; Kerawalla et al., 2006). Research has emphasized that AR can eliminate students' misconceptions, and their conceptual understanding improves (Enyedy et al., 2012; Chang, Wu & Hsu, 2013; Shelton & Hedley, 2002). The finding that AR applications can increase the attitude and

motivation towards the course coincides with many studies in the literature (Delello, 2014; Di Serio et al., 2013; Vate-U-Lan, 2012). The result that the application aroused interest, enthusiasm, and curiosity and increased motivation for the course coincides with the result that students are eager excited about AR content, obtained in the research of Mundy et al. (2019).

Many studies revealed that the application attracts students' attention and increases their interest in the lesson (Delello, 2014; Perez-Lopez & Contero, 2013) makes the lesson fun (Rambli, Matcha & Sulaiman, 2013; Sırakaya, 2015); and increases students' motivation and attitudes towards the lesson (Delello, 2014; Di Serio et al., 2013; Ersoy et al., 2016; Küçük, Yılmaz & Göktaş, 2014; Perez-Lopez & Contero, 2013). In the research, students stated that they enjoyed the games and applications designed with augmented reality and thought of themselves as assistant researchers (Klopfer & Sheldon, 2010; Noonoo, 2012).

Preservice teachers stated the advantages of using augmented reality applications as follows: providing effective instruction for the teacher, facilitating teaching, saving time, providing a positive attitude to the teacher, and being cost-effective. The disadvantages of the application are: it takes time to prepare and implement it, it is not suitable for every subject, it is difficult to prepare, it causes problems in classroom management, technical difficulties, and problems arising from the inability to use technology. AR applications can be used as an important tool in teaching abstract concepts to primary and secondary school students (Sırakaya, 2018). Augmented reality will allow instructing abstract concepts by concretizing them (Abdüsselam & Karal, 2012; Shelton & Steven, 2004; Wojciechowski & Cellary, 2013). It easily teaches complex subjects that are difficult to teach (Kaufmann, 2003). It allows the instruction of the events and situations that are impossible to show in the classroom environment (Shelton & Hedley, 2002; Yuen, Yaoyuneyong & Johnson, 2011). In many studies, it has been concluded that Augmented Reality applications also increase success (Abdüsselam & Karal, 2012; Chiang et al., 2014; Dunleavy, Dede & Mitchell, 2009; Ersoy, Duman & Öncü, 2016; Kırıkkaya & Şentürk, 2018; Küçük et al., 2014; Sırakaya, 2015). The limitations of the application are: it should not be used frequently, it may not be used in case of technological shortcomings, it requires training, it is not suitable for every subject, and it may be inadequate with only visuals. According to Sırakaya (2018), AR's characteristic features provide significant advantages for educational environments. However, since the hardware and software tools were not at the desired level in the first years of augmented reality technology, it was necessary to wait for its educational use. However, advances in technology have removed these obstacles. As a result of the findings and results obtained from this research, studies on augmented reality applications should be increased. Training and lectures should be given to preservice teachers to improve them in technological applications. Preservice teachers should acquire skills to prepare lesson plans supported by technology and enrich learning and teaching processes.

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