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AUGMENTED REALITY APP IN PRE-SCHOOL EDUCATION: CHILDREN'S KNOWLEDGE ABOUT ANIMALS

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ABSTRACT

This study aims to determine the learning outcomes of children in educational settings by using an AR (Augmented Reality) app for animals in classroom activities. To achieve this, the study used sequential exploratory research design, applied in both quantitative and qualitative research. The participants in the study are 2 teachers and 37 children working in the kindergarten affiliated to the Ministry of National Education in the central district of Kilis Province in the 2019-2020 academic year. The augmented reality app was used in one group (n=18) of children, and not in the other group (n=19). The children were given an animal recognition test prepared by the researchers before the app was used and again afterward in an attempt to discover how the AR app affected learning. The study determined that while animal recognition increased in both the AR and non-AR groups, the children in the group where the AR app was used recognized more animals than the other group. As a result of the analyses made of the animal pictures drawn by the children who used the AR app, it was understood that the children had the opportunity to discover details about the animals. Additionally, the study conducted analyses of animal pictures drawn by the children who used the AR app, revealing that the app provided children with opportunities to discover and explore intricate details about the animals.

Keywords: preschool education, augmented reality, knowledge about animals, learning

INTRODUCTION

In recent years, developments in technology have become increasingly applied in education (Gözüm & Kandır, 2021). New technology applications are being used in preschool educational settings in line with these developments. There are many technological practices today that will attract children's attention, trigger their sense of curiosity, and develop enjoyable and permanent learning (Gözüm, 2022; Gözüm & Kandır, 2020). One such practice is the implementation of Augmented Reality (AR) technology, something we have encountered in many areas of our lives in recent years. Augmented Reality technology is an application that gives form to abstract concepts, appeals to multiple senses, makes learning more effective, and aims to improve educational settings (Lai & Hsu, 2011; Luckin & Fraser Hefu, 2011). In this

study, augmented reality technology, augmented reality in education, and augmented reality in pre-school education will be explained, respectively, because the integration of augmented reality apps into the educational environment in the places where preschool children receive an education is being investigated along with its effect on children's learning.

Augmented Reality Technology

Augmented Reality (AR) technology emerged in the 1970s with the development of the work that Ivan Sutherland and his students began on computer graphics at the Harvard and Utah universities in the 1960s. After the 1990s, it became widespread and reached the broader masses (Feiner, 2002). Augmented Reality applications let individuals observe situations that cannot be seen with the naked eye without breaking away from the real world; they make it possible to safely present situations that could be considered dangerous, and access information in more detail (Azuma, 1997). AR is a technological technique that transforms visual and auditory stimuli into information and lets sensory inputs created in a computer environment be used for various situations (Kipper & Rampolla, 2012). Azuma (1997) stated three features of AR that remove the limitations in different technological applications as follows: AR is the combination of the virtual and real world. AR virtual objects interact with reality simultaneously. AR lets virtual objects be arranged correctly in the real environment.

Some basic mechanisms need to be adjusted for AR technology to be implemented in the real environment. AR technology can be applied in a particular environment by adjusting the tracking, *display*, *registration*, and *calibration* mechanisms (Azuma et al., 2001). If we briefly explain the basic elements, *the tracking* mechanism is the process of calculating the 3D location and direction information as a result of defining the virtual object in the real environment (Ercan, 2010). The *display* is the optical or camera system used to watch virtual objects interact with real-world objects. The *registration* mechanism is the process of superimposing virtual objects onto real objects. The calibration mechanism is used for optimizing the image and adjusting the tracking, display and, registration mechanisms in the image's setting (Azuma, 1993; Englander, 2009; Rabbi & Ullah, 2013).

Using AR technology, virtual objects can be shown by superimposing them onto real objects using hardware screens, computer monitors, mobile device screens (smartphones and tablets), goggles, handheld displays, head-mounted displays, or projected displays (Bimber & Raskar, 2005). Today, as a result of the increase in the use of smartphones and tablets, AR technology can be used with these devices. The cameras in smartphones and tablets provide the hardware for technological tools as input devices. Browsers (Aurasma, Augment, Blippar, Junaio, Layar) and AR development media (Artoolkit, Vuforia, Wikitude Software Development Kit) make up the software components in the use of AR technology (İçten & Bal, 2017).

Depending on the technological infrastructure used, augmented reality systems can be given via two systems: location-based and image-based (Cheng & Tsai, 2013). Location-based AR systems such as GPS, WLAN, etc. detect the location of the user with the devices and places the data of virtual objects on top of real objects (Sırakaya & Seferoğlu, 2016). The use of location-based services with mobile devices is becoming widespread (Akbaş & Güngör 2017; Yilmaz & Batdı, 2021). Image-based AR systems are formed by adding virtual objects to the image taken by the camera at points determined by using objects defined in the

augmented reality environment as markers over pictures, graphics, logos, photographs, and motion and sound detection (Abdüsselam & Karal, 2012).

Augmented Reality technology is encountered in many fields such as a 3D representation of concepts in lessons such as physics, chemistry, mathematics, geometry, and biology, the visualization of surgical procedures, as well as engineering, military, sports, geography, and design (Somyürek, 2014).

Augmented Reality in Education

Augmented Reality in the education process is a useful technology in terms of providing permanent learning, visualizing abstract structures, and thus concretizing concepts and making difficult-to-understand subjects more understandable (Wu et al., 2013; Walczak et al., 2006). Augmented Reality is also a technology application that provides an enriched environment such as pictures, texts, sounds, 3D objects, animations, simulations (Azuma, 2004), actively involves children in the process, and provides permanent learning by doing (Chen et al., 2011; Dunleavy et al., 2009; Wojciechowski & Cellary, 2013;Talan et al., 2022; Wu et al., 2013; Yılmaz & Batdı, 2016). In addition, any practice to be done using augmented reality has a very important place in terms of being able to attract children's attention, make learning more enjoyable and meaningful, and that makes individuals more inquiring and questioning (Shelton & Hedley, 2002).

The use of AR technology in educational settings with 3D objects, drawings, and animations is becoming widespread. The Quiver (ColAR) app can show the marker papers painted by the user in 3D. The LearnAR app lets its users use AR technology in education in such fields as online chemistry, biology, and physics. The FETCH Lunch Rush app supports children's math skills with AR technology (İçten & Bal, 2017). As can be understood from the examples of the implementation of AR technology in education, tech firms are producing apps for education.

In this regard, research on the use of AR technology in education and its effects on learning will be briefly evaluated. A study was conducted with undergraduate students using the ARTool augmented reality app for the phenomena of seasons, world movements, and day and night. As a result of this study, it was found that AR provided benefits such as reducing student's miscomprehensions and simplifying complex subjects that students have problems understanding through the use of 3D learning. (Shelton & Hedley, 2002). Another study reported that students understood a subject that was explained using an augmented reality app better than a subject that was only shown visually (Serio, 2013). Results that benefit learning have been obtained using AR technology developed by Ibili and Şahin (2013) in geography, by Abdüsselam and Karal (2012) in physics, by Pérez-López and Contero (2013) in biology, by Di Serio, Ibáñez, and Kloos (2012) in the visual arts, by Poupyrev et al., (2001) in music, and by Zainuddin et al., (2010) in special education. Related studies show that AR technology is used at the primary, secondary, and higher education levels. The use of AR technology at the preschool education level and information in the literature regarding its effect on children's development and learning are given under the heading Augmented Reality in Preschool Education.

Augmented Reality in Preschool Education

With the increase in the use of technology in preschool education, children's interests with respect to technological applications have changed (Odabaşı, 2010). For this reason, various technology applications are being used in educational settings aimed at children's interests. As a result of the integration of information and communication technologies into preschool education programs, the use of augmented reality apps has also become widespread (Martinez et al., 2017). The inclusion of AR in preschool education enables children to be taught concepts in a fun, effective, and permanent way (Clements, 1999). According to Piaget, the use of concrete objects in the education of preschool children supports children's learning. (Gözüm, 2018). As a result of children seeing and perceiving learning objects concretely in education settings, the use of augmented reality technology could affect permanent learning through the subject being taught. Augmented reality applications provide an active learning environment by increasing the interaction of preschool children with objects. AR technology can be used in educational games by making preschool classrooms fun, as well as supporting children's motivation to learn, and improving their academic skills (Lin et al., 2013; Zulfikri & Masnan, 2023). By adding AR effects to the concretization of abstract situations, this study has the potential to significantly enhance the educational experience for preschoolers, promoting both effective learning and enjoyment in the process.

That AR technology can be applied using smartphones and tablets is very important for children in the preschool education period. Preschool children learn through trial and error with the touchscreens of tablets or smartphones without using the external components of computers loaded with software and hardware such as mouses and keyboards (Cohen et al., 2011, p.3; Olney et al., 2003; Papadakis & Kalogiannakis, 2017). With the instinct of playing with a new toy, children can learn to use technological applications by naturally interacting with the touchscreens of tablets and smartphones (Sharkins et al., 2015). According to Marsh (2015), 37% of children aged three to five in the UK have access to a tablet computer. This 37% access rate increased in 2019. With the increase in smartphone and tablet apps and their ease of use, AR technology gives preschool children regular access in home settings. This is important in terms of educating children using digital technologies (Madanipour & Cohrssen, 2020). Software and apps for AR technology are increasing in the 5-6-year-old range to support the development of children's imagination and concretize learning objects that cannot exist where they are. In AR technology used by children, 3D objects and flashcards have become the preferred choice to teach fruits, vegetables, animals, objects, professions, colors, numbers, and shapes (Yılmaz, 2016).

The use of technology in education is increasing as a result of the routine use of technological tools by children in the preschool period (Edwards, et al., 2018). To include technological applications in the educational environment according to the educational programs in the preschool period, teachers should consider that they use a game-based program. In addition, according to experts, teachers who integrate technological applications in preschool classrooms need to be self-confident. (Bay, 2022; Dağal et al., 2022; Madanipour & Cohrssen, 2020). In accordance with recent research conducted by Gözüm et al. (2023) in their study titled 'Developing the Teacher Self-Efficacy Scale in the Use of ICT at Home for Pre-school Distance Education During Covid-19,' it becomes evident that teachers' self-efficacy in the use of ICT is crucial. This study highlights the significance of teachers possessing a strong sense of self-efficacy when it comes to incorporating ICT tools, which is highly relevant to the effective implementation of augmented reality applications in educational contexts. Teachers with higher self-efficacy are better equipped to harness the potential of ICT

tools, ultimately enhancing the quality of education through augmented reality experiences. When it is considered that the development and academic achievements of children improve rapidly in the preschool period, it is vital that the effects of augmented reality apps on children be investigated (Campbell et al., 2001). In the study conducted by Oranç and Küntay (2019), the researchers asked an important question. *How does blurring the line between real and virtual affect children's learning?* To answer this question, it is thought that both the preparation of the educational setting and the effect of the augmented reality app on the learning of the child should be investigated. This study aims to determine the learning outcomes of children in educational settings by using an AR app for animals in classroom activities. To this end, the answer to the following research question is sought: How does a preschool teacher's use of augmented reality in activities in educational settings affect children's learning?

Methodology

This study used the sequential exploratory mixed research method. Quantitative data were collected first followed by qualitative data to determine the learning outcomes (knowledge levels) of children by using an AR app for animals in classroom activities. The questionnaire method, one of the quantitative research methods, was used to determine the effect of the AR app on children's learning (Cohen et al., 2000). The qualitative data for the effect of the AR app on children's learning in the study consisted of the pictures made by the children before and after the app and the interviews about the pictures formed the qualitative data. Both the quantitative and qualitative research findings were brought together and interpreted jointly.

It is important to note that ethical research principles were strictly adhered to in our study. This research is grounded in studies that, like Petousi and Sifaki's (2020), have examined the dimensions of harm resulting from research misconduct. Throughout the research process, ethical guidelines and standards were rigorously followed, and data collection and analysis were conducted fairly and accurately. As a result, we are confident that the study's findings were obtained on a reliable and ethical basis.

Working Group

The study's population consisted of two different classes in the age group 60-72 months in a kindergarten in the central district of Kilis Province in the 2019-2020 academic year. Two classes consisting of a total of 2 schoolteachers and 37 pupils were chosen at random for the study; the first class of 18 children was the group that used the AR app and the other class of 19 children was the group that did not use the AR app. It is crucial to note that there was not an intervention in the group that did not use the AR app, which makes a significant aspect of this study. Of the children in the AR group, 10 were boys and 8 were girls. Of the children in the group that did not use the AR app, 11 were boys and 8 were girls. The mean age of the children in the group where the AR app was used was 68.4 months. The mean age of the children in the group where the AR app was not used was 68.2 months. While 10 of the children in the group in which the AR app was used began attending the preschool education institution 1 year ago, 8 of them were there for the first time. Similarly, 10 of the children in the group in which the AR app was not used began attending the preschool education institution 1 year ago and the other 9 were there for the first time.

Data Collection Tool

Personal Information Form

A form consisting of questions about the age and gender of the children and whether they were continuing at the pre-school education institution was prepared by the researchers and used in the study. The personal information form was completed using the files containing the children's personal information with the consent of the children's parents and school administration.

Qualitative Data Collection Tools

Document analysis and interviews were used to collect qualitative data in the study. Based on the document analysis technique in the study, the documents for the pictures made by the children before and after the AR app were collected. An attempt was made to understand the content of the pictures made by the children by asking their opinions about them.

Collecting qualitative data through methods like document analysis and interviews is fundamental in educational research, particularly when investigating young children's experiences. Below is a more academic summary emphasizing the importance of qualitative data collection with a focus on drawing, substantiated by pertinent academic literature:

Child-Centered Research: Qualitative data collection techniques such as drawing and interviews are indispensable for researchers aiming to adopt a child-centered approach. In the realm of early childhood education research, it is imperative to comprehend the cognitive processes, perceptions, and experiences of young children from their own vantage point. This perspective furnishes invaluable insights that quantitative methodologies alone may fail to capture (Clark, 2011; Roberts & Riley, 2014; Merriman & Guerin, 2006).

Uncovering Complexity: Young children's comprehension of abstract concepts and their ability to articulate their thoughts can be intricate and multifaceted. Qualitative approaches, exemplified by drawing and interviews, facilitate a profound exploration of this intricacy. Drawing, in particular, affords children a visual means to convey their thoughts and knowledge, offering a non-verbal avenue for expression (Clark, 2011; Roberts & Riley, 2014; Merriman & Guerin, 2006).

Naturalistic Data Gathering: Qualitative data collection methods, including drawing, engender a naturalistic and familiar milieu for children. Drawing is a commonplace activity for children, frequently employed as a mode of communication. This sense of familiarity fosters a comfortable environment in which children are more inclined to express themselves openly and candidly (Clark, 2011; Roberts & Riley, 2014; Merriman & Guerin, 2006).

Richness of Insights: Drawing is instrumental in unveiling facets of children's knowledge, perceptions, and emotions that might remain concealed when relying solely on verbal communication. It furnishes a visual representation of their cognitive processes, granting researchers access to intricate and nuanced data (Clark, 2011; Roberts & Riley, 2014; Merriman & Guerin, 2006).

Literary Endorsement: Drawing finds validation in research pertaining to early childhood education and development. It aligns with Vygotsky's socio-cultural theory, wherein drawing is regarded as a form of symbolic play that mirrors a child's cognitive advancement and comprehension of the world. Furthermore, the Reggio Emilia approach, a prominent framework in early childhood education, underscores the significance of visual languages, including drawing, in a child's learning and self-expressio (Clark, 2011; Roberts & Riley, 2014; Merriman & Guerin, 2006).

Qualitative data collection, specifically drawing and interviews, holds paramount importance in studies investigating the learning experiences of young children. These methods offer a child-centric perspective, facilitate the exploration of cognitive intricacies, create a conducive and familiar research environment, yield multifaceted insights, and garner support from academic literature in the realm of early childhood education. Drawing, in particular, emerges as a potent instrument for unraveling children's knowledge and their visual means of expressing it.

Quantitative Data Collection Tools

The questionnaire, consisting of animal pictures, was used to collect qualitative data in the study by asking whether or not the children recognized the animals. The choice of animals as the subject of investigation aligns with a child-centric approach. Animals are a topic that naturally captures the interest and curiosity of young children. They are a part of a child's early learning experiences, making them a relevant and engaging subject for this study. The form asked eight knowledge questions. By way of example of the items in the data collection tool, good-quality, high-resolution photographs of a horse, frog, lion, raccoon, bee, monkey, cow, and elephant were shown to the children, who were asked what they were called. Expert opinion was sought when creating the animal questionnaire. A preschool teacher, a biology teacher, and three experts in science and pre-school education gave their opinions on the appropriateness of the questionnaire for the children's ages and the content validity of the animal recognition information. The animal pictures in the expert interview form were categorized as *"appropriate," "not appropriate,"* and *"must be changed"* and the experts' opinions were obtained by them giving an open-ended "explanation" to express their opinions separately. Cramer V coefficient was calculated for the relationship between expert opinions. According to Field (2009), Cramer's V coefficient is used to determine the strength of the relationship between two categorical variables, where one of the variables consists of at least two categories. As a result of the experts' opinions in this study, the Cramer V value of the animal pictures in the questionnaire going by the ages of the children was determined to be .86 while the Cramer V value according to their opinions on the scope of animal recognition knowledge was calculated to be .78. According to Cohen (1988), the expert interview form values were found to be in good agreement not only with the children's ages but also with the experts' opinions on the scope of animal recognition knowledge.

Data Collection

Quantitative Data Collection

Quantitative data were collected by the researchers by interviewing the children one-on-one with a questionnaire. The answers given by the children were recorded on the answer form.

Quantitative data were collected twice, before and after the AR app was used. When the quantitative data collection tool was administered by the researchers, the children were asked to name the animal and their answers were noted down.

Qualitative Data Collection

Qualitative data consists of the pictures made by the children and verbatim quotes of their comments when they compared their pictures. The researchers collected the data by recording the pictures made by the children and the comments noted on the pictures. When the researchers collected the qualitative data, the children were made to sit apart from each other so that they could not interact with and influence each other. When children put their thoughts and feelings into words when dealing with something, Patton (2014) calls this process the "thinking out loud protocol." In this study, children drew pictures before and after using the app. The pictures drawn by the children before and after using the app were brought together and the children's thoughts were recorded verbatim when comparing the pictures.

Data Analysis

Quantitative Data Analysis

In analyzing the quantitative data, the correct and incorrect answers given by the children to the pictures were defined as frequency and percentage. Correct answers were coded as 1 and incorrect answers as 0.

Qualitative Data Analysis

In analyzing the qualitative data, the differences between the animal pictures drawn by the children before and after using the AR app were examined. In analyzing the content of the pictures, the pictures were described using the content analysis technique. The children's explanations about the pictures were combined with the explanations underneath the pictures by taking verbatim quotes. Mc Millan (2000) emphasized that the validity and reliability results for the analysis of qualitative data should be believable and real. Accordingly, the pictures drawn by the children that constitute the study's documentation and verbatim quotes of their expressed thoughts revealing what they know about the animals were included in the findings. In addition, Mc Millan (2000) advocated member checking of the data as a way to increase reliability in qualitative research. In this context, reliability was increased by comparing the children's pre- and post-app pictures, examining the documentation, and noting the children's comments as a result of checking their pictures in line with the member checking technique. In this study, the children were asked to create drawings related to various animals, including a horse, frog, lion, raccoon, bee, monkey, cow, and elephant, both before and after using the augmented reality (AR) application. The purpose of these drawings was to assess the impact of AR on the children's ability to recognize and depict animals in greater detail.

Process

The study was conducted in two kindergartens where activities were carried out for children aged 60-72 months attending the official independent kindergarten affiliated to the Ministry of National Education. The educational institutions where the research was conducted were informed about the application and the necessary official permissions were obtained. Consent forms were collected from the families of the children in the classes where the study was to be conducted. After the necessary data collection phase was completed, a meeting was held with the teachers. In the meeting held with the teachers, the children were asked to plan activities involving animals such as horses, frogs, lions, raccoons, bees, monkeys, cows, and elephants for 3 weeks. Two kindergarten teachers prepared activities in science, mathematics, language, drama, game, and art activities in the program according to the gains and indicators in the 2013 Ministry of National Education Preschool Education program. In the planned activities, gain-indicator, the method used, the concept, the material, the duration of the activity, and the content of the learning process are the same. The only difference in the activities is that one used 2D pictures of the animals and the other used the AR app when the animals' names were mentioned and after the activity when the animals were shown. The researchers prepared an educational setting for activities using the AR app in one of the classes, which they randomly selected, and without the AR app in the other. The teachers of the classroom where the AR app was going to be used were given training by the researchers on the AR app devices and their use, and after the pilot application was made on AR cards of professions, AR cards of animals were used in practice. Below is a sample photo of the activities prepared by the researchers in the educational setting.

FINDINGS

According to the data collected in the study, the findings are grouped under two headings. First of all, the findings obtained as a result of quantitative data analysis are given under the heading of quantitative findings, and the findings obtained as a result of qualitative data analysis are included under the heading of qualitative findings.

Quantitative Findings

In this section, the frequency and percentage values of the data obtained to compare the difference based on learning information about animals between the groups that did and did not use the AR app are given in Table 1 and Table 2.

Table 1
The results of children's animal knowledge when the AR app was used.

	Before									After									
	#1	#2	#3	#4	#5	#6	#7	#8		#1	#2	#3	#4	#5	#6	#7	#8		
ID	Horse	Frog	Lion	Raccoon	Bee	Monkey	Cow	Elephant	Total	Horse	Frog	Lion	Raccoon	Bee	Monkey	Cow	Elephant	Total	Status
C1	1	0	0	0	0	1	1	1	4	1	1	1	0	1	1	1	1	7	↑
C2	1	0	0	0	0	1	0	1	3	1	0	0	0	1	1	1	1	5	↑
C3	1	1	1	0	1	1	1	1	7	1	1	1	0	1	1	1	1	7	●
C4	1	0	1	0	1	0	1	0	4	1	0	1	1	1	1	0	0	5	↑
C5	1	1	0	0	1	1	0	0	4	1	1	1	0	1	1	1	1	7	↑
C6	1	0	0	0	0	1	0	0	2	1	0	1	0	1	1	1	0	5	↑
C7	1	1	1	0	1	0	1	0	5	1	1	1	0	1	1	1	1	7	↑
C8	1	0	1	0	1	1	0	1	5	1	1	1	0	1	1	1	1	7	↑
C9	1	0	1	0	1	1	1	1	6	1	0	1	1	1	1	1	1	7	↑
C10	0	1	0	0	1	0	1	0	3	0	1	0	0	1	1	1	0	3	●
C11	1	0	1	1	0	1	1	1	6	1	1	1	1	0	1	1	1	8	↑
C12	0	0	1	0	1	1	0	1	4	1	0	1	0	1	1	1	1	6	↑
C13	1	1	1	0	1	0	0	1	5	1	1	1	0	1	1	1	1	7	↑
C14	1	0	1	0	0	0	1	1	4	1	1	1	0	0	1	1	1	6	↑
C15	1	0	1	0	0	1	0	1	4	1	1	1	1	1	1	1	1	8	↑
C16	0	0	0	0	0	0	1	0	1	1	1	1	0	1	1	1	1	7	↑
C17	0	0	0	0	0	0	1	0	1	1	1	1	0	1	1	1	1	7	↑
C18	1	0	1	0	1	1	1	1	6	1	0	1	0	1	1	1	1	6	●
Total	14	5	11	1	10	11	11	11	74	17	12	16	4	16	18	17	15	115	↑

According to Table 1, while 4 out of 18 children did not recognize the horse before the AR app, only 1 child could not recognize the horse after the AR app. Before the AR app, 13 children did not recognize the frog, and after the AR app, 6 children did not recognize the frog. Before the AR app, 7 children could not recognize the lion, and after the app, only 2 children could not recognize the lion. Before the AR app, only 1 child could recognize the raccoon, while 4 children recognized the raccoon after the app. While 10 children were able to recognize the bee before the AR app, only 2 children could not recognize the bee after the app. Before the AR app, 11 children recognized monkeys, cows, and elephants. After the AR app, all children recognized the monkey, 17 children recognized the cow, and 15 children recognized the elephant. This shows that the number of recognitions for each animal increased. After the app was used, the least known animal was the raccoon, while the best-known animal was the monkey.

Table 2
The results of children's animal knowledge without the AR app.

	Before									After									
	#1	#2	#3	#4	#5	#6	#7	#8		#1	#2	#3	#4	#5	#6	#7	#8		
ID	Horse	Frog	Lion	Raccoon	Bee	Monkey	Cow	Elephant	Total	Horse	Frog	Lion	Raccoon	Bee	Monkey	Cow	Elephant	Total	Status
C1	1	0	1	0	0	0	1	1	4	1	1	1	0	1	0	1	0	5	↑
C2	1	0	0	1	0	0	1	0	3	1	0	1	0	1	0	1	1	5	↑
C3	1	1	1	0	1	0	0	0	4	1	1	1	0	1	0	0	0	4	●
C4	1	1	1	0	0	1	0	1	5	1	1	1	0	0	1	0	1	5	●
C5	1	0	0	0	1	1	1	0	4	1	0	0	0	1	1	1	0	4	●
C6	1	1	1	0	1	1	0	1	6	1	1	1	0	1	1	0	1	6	●
C7	1	0	1	0	1	1	1	1	6	1	0	1	0	1	1	1	1	6	●
C8	0	0	0	0	1	0	1	0	2	1	0	1	0	1	1	0	0	4	↑
C9	1	0	1	0	1	1	0	0	4	1	0	1	0	1	1	1	1	6	↑
C10	0	0	0	0	1	1	1	1	4	0	0	1	0	1	1	1	0	4	●
C11	1	1	0	0	1	0	0	1	4	1	1	0	0	1	1	1	1	6	↑
C12	0	1	1	0	1	1	1	0	5	0	1	1	0	1	1	1	0	5	●
C13	1	0	0	0	1	1	1	0	4	1	1	1	0	1	1	0	1	6	↑
C14	1	0	1	0	0	1	1	0	4	1	1	1	0	1	1	1	1	7	↑
C15	0	0	0	0	1	0	1	1	3	1	1	0	0	1	1	1	1	6	↑
C16	0	0	1	0	0	0	0	0	1	1	0	1	0	0	1	0	0	3	↑
C17	0	1	0	0	0	0	0	1	2	1	0	1	0	0	1	1	1	5	↑
C18	1	0	1	0	1	1	1	1	6	1	0	1	0	1	1	0	0	4	↑
C19	1	1	1	0	0	1	1	0	5	1	1	1	0	1	1	1	0	6	↑
Total	13	7	11	1	12	11	12	9	76	17	10	16	0	16	16	12	10	97	↑

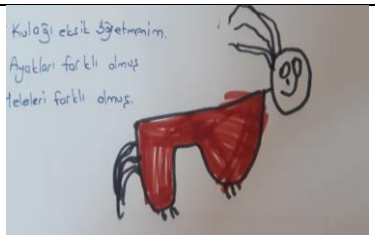
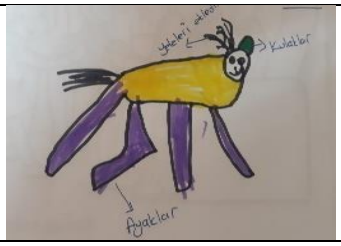
According to Table 2, 13 children in the group where the AR app was not used recognized horses before the activity, and 17 children recognized horses afterward. Before the activity, 7 children recognized the frog, and afterward, 10 children recognized the frog. Before the activity, 11 children recognized the lion, and after the activity, 16 children recognized the lion. Before the activity, 1 child recognized the raccoon, but after the activity, no child could recognize the raccoon. Before the activity, 7 children could not recognize the bee, but only 3 children could not recognize the bee afterward. Before the activities, 11 children recognized the monkey, and afterward, 16 children recognized the monkey. While no change was observed in the number of cows recognized before and after the activities, 9 elephants were recognized before the activities, and 10 elephants were recognized afterward. The number of cows recognized before and after the activities did not change. While the best-known animal before and after the application was the horse, the least known animal in both cases was the raccoon.

On comparing Table 1 and Table 2, it can be seen that the total number of animals recognized after the activities by children who did not receive the AR app was 97, this number being 115 for children who did receive the AR app. Although no change was observed in 6 children after the activities in groups in which the AR app was not used, the fact that no change was observed in only 3 children when the AR app was used shows the effectiveness of AR apps.

Qualitative Findings

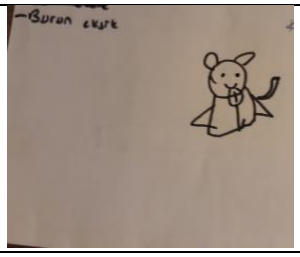
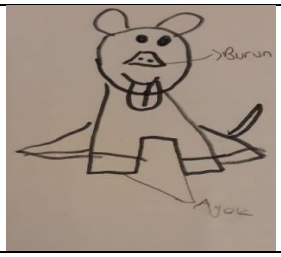
In this section, the pictures for the qualitative data collected in the educational setting where the AR app was used and verbatim quotes of the answers given by the children to the questions asked about the pictures are analyzed and interpreted.

Table 3
Children's horse pictures and comments before and after the AR app.

Before	After
	
T: What are the differences in the horse pictures you made? C1: The horse's mane in the picture ("*hair,"*) its ears ("*pointy ears*"), and its feet and nails are different. T: How is the horse's hair different? C1: *"There is more of it."* T: How are the horse's ears different? C1: "*Its ears are long and pointed."* T: How are the horse's feet different? C1: The horse's feet are "*longer"* and "*it has short nails."*	

According to Table 3, it was determined that the children expressed the details of the horse's mane, feet, and ears in their drawings and comments following the use of the AR app. According to the quantitative findings, 14 of the children recognized the horse before the activity while 17 of them recognized the horse afterward. Learning details about the horse made the animal more recognizable.

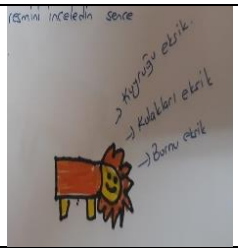
Table 4
Children's frog pictures and opinions before and after the AR app.

Before	After
	
T: What are the differences in your frog pictures? C3: The frog's "*nose"* and *"feet"* are different. T: How is the frog's nose different? C3: *"It is thin and inward."* T: How are the frog's feet different? C3: "*His toes are stuck together."*	

T: Did you see the frog's ears?
C3: I did not.
T: Why did you draw ears on the frog?
C3: *"....so it can hear..."*

According to Table 4, it was determined that the children expressed the details of the frog's nose and feet in their drawings and comments as a result of the AR app. According to the quantitative findings, 5 of the children recognized the frog before the activity using the app, while 12 of them recognized the frog afterward. Learning details about the frog made the animal more recognizable.

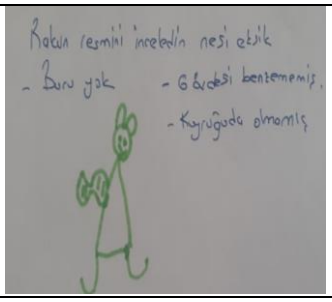
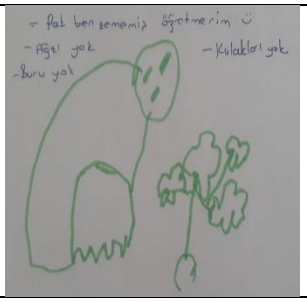
Table 5
Children's lion pictures and opinions before and after the AR app.

Before	After
	

T: What are the differences in the lion pictures you made?
C4: The lion in the picture has a different *"tail,"* "*ears,"* and *"nose."*
T: How is the lion's nose different?
C4: *"He had a big black nose..."*
T: How did you notice the lion's ears?
C4: "*I saw them in its hair."*
T: Did you see the lion's tail?
C4: *"I saw it, it was thin and had hair on the tip."*

According to Table 5, it was determined that the children expressed the details of the lion's tail, ears, and nose in their drawings and comments as a result of the AR app. According to the quantitative findings, 11 of the children recognized the lion before the activity, while 16 of them recognized the lion afterward. Learning details about the lion made the animal more recognizable.

Table 6
Children's raccoon pictures and comments before and after the AR app.

Before	After
	

T: What are the differences in the raccoon pictures you made?

C11: The raccoon in the picture has no *"mouth,"* "*nose,"* or *"ears."*
T: Does a raccoon have a mouth?
C11: *"Yes, it has a small mouth…"*
T: How did you notice the raccoon's nose?
C11: "*Its nose is pointed and black."*
T: Did you see the raccoon's ears?
C11: *"Yes, its ears are small and pointed."*

According to Table 6, it was determined that the children expressed the details of the raccoon's mouth, nose, and ears in their drawings and comments as a result of the AR app. According to the quantitative findings, 1 child recognized the raccoon before the activity, while 4 of them recognized the raccoon afterward. It is understood that not many children were able to learn about the raccoon.

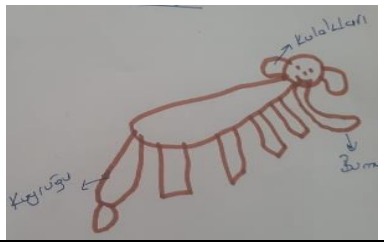
Table 7
Children's bee pictures and comments before and after the AR app.

Before	After
	

T: What are the differences in the bee pictures you made?
C13: The bee in the picture has different *"feet,"* "*body,"* and *"colors."*
T: How are the bee's feet different?
C13: *"The front legs are short, the back legs are long…"*
T: How is the body of the bee different?
C13: "*It has a fat belly behind its head."*
T: How are the colors of the bee different?
C13: *"Some places are yellow, some are orange."*

According to Table 7, it was determined that the children expressed the details of the feet, body, and colors of the bee in their drawings and comments as a result of the AR app. According to the quantitative findings, while 10 of the children recognized the bee before the activity, 16 children recognized the bee afterward. Learning details about the bee made the animal more recognizable.

Table 8
Children's monkey pictures and comments before and after the AR app.

Before	After
	
T: What are the differences in the monkey pictures you made? C8: The monkey in the picture has different *"hands and feet,"* "*tail"* and *"fur."* T: How are the monkey's hands and feet different? C8: *"His fingers are short, his legs are long, but his hands are also feet…"* T: How is the monkey's tail different? C8: "*…not straight, the end is curly."* T: How is the monkey's fur different? C8: *"Its fur is short and missing in some places."*	

According to Table 8, it was determined that the children expressed the details of the monkey's hands, feet, tail, and fur in their drawings and comments as a result of the AR app. According to the quantitative findings, 11 of the children recognized the monkey before the activity, while 18 children recognized the monkey afterward. Learning details about the monkey made the animal more recognizable.

Table 9
Children's cow pictures and comments before and after the AR app.

Before	After
	
T: What are the differences in the cow pictures you made? C14: The cow in the picture has different "*horns,"* and "*udders."* T: How are the cow's horns different? C14: *"It has horns on top of its head…"* T: How are cow's udders different? C14: "*They are at the back, not at the front"*	

According to Table 9, it was determined that the children expressed the details of the cow's horns and udders in their drawings and comments as a result of the AR app. According to the quantitative findings, 11 of the children recognized the cow before the activity, while 17 children recognized the cow afterward. Learning details about the cow made the animal more recognizable.

Table 10
Children's elephant pictures and comments before and after the AR app.

Before	After
	
T: What are the differences in the elephant pictures you made? C18: The elephant in the picture has different *"feet,"* "*tail," "trunk," and "ears."* T: How are the elephant's feet different? C18: *"It has nails on its feet and they are big…"* T: How is the elephant's tail different? C18: *"its tail is long and has hair on the tip…"* T: How is the elephant trunk different? C18: *"its trunk is long and thick…"* T: How are the elephant's ears different? C18: *"The elephant's ears are very big."*	

According to Table 10, it was determined that the children expressed the details of the elephant's feet, trunk, tail, and ears in their drawings and comments as a result of the AR app. According to the quantitative findings, 11 of the children recognized the elephant before the activity, while 15 children recognized the elephant afterward. Learning details about the elephant made the animal more recognizable.

DISCUSSION

The features of the augmented reality app can help the development of children's theoretical and practical abilities. In related studies, it has been determined that augmented reality apps simplify learning by concretizing the learning process and positively affect the academic achievement of learners (Abdüsselam & Karal, 2012; Özarslan, 2013; Shelton & Hedley, 2002; Sırakaya, 2015). When the differences between the group that used the AR app and the group that did not were examined, it was seen that the children learned the details about the animals' organs more meaningfully.

When studies on AR technology in the preschool period are examined, they are seen to cover AR apps in mathematics education for children (Lee & Lee, 2008; Zhu & Wang, 2017), Chinese word memorization and vocalization in language education for children (Chen et al., 2007), teaching English as a foreign language (Hsieh & Lee, 2008), and in teaching Turkish (Yılmaz, 2016). AR technology has been used in teaching children about nature (Cascales et al., 2013; Fajarianto et al., 2018; Rasalingam Muniandy & Rasalingam, 2014). Augmented reality apps have been used in drama, which is effective in socializing children and teaching them social roles in preschool education (Han et al., 2015). It has been determined that

augmented reality apps are effective in improving children's spatial skills (Gecu-Parmaksız & Delialioğlu, 2018). Augmented reality apps have also been used in storybook activities for children (Yılmaz & Göktaş, 2017). This study is similar to the results of related studies in which AR apps affected children's learning in early childhood.

In this study, animals (horse, cow, bee) that children encounter easily in daily life were examined in the AR app's support of children's learning. Although raccoons, monkeys, and elephants may not be observed much in daily life, it has been determined that there are deficiencies in the pre-learning of animals that children can easily observe in daily life. In this regard, AR enables the formation of an experiential setting by supporting the development of children's imagination and concretizing objects that are difficult to implement in daily life and that children have limited access to in the real world (Si-Mohammed et al. 2018). Based on this, the use of AR technology in education and preschool education is supported and it is thought that it should be adapted to activities.

The findings of this study emphasize that AR technology can play a vital role in supporting the development of children's knowledge and skills by providing immersive learning experiences. These experiences help bridge the gap between the abstract and the concrete, making learning more engaging and effective. As such, the integration of AR technology in educational and preschool settings is strongly encouraged, and its adaptation into various activities is considered beneficial for enhancing children's learning outcomes.

While the number of children acquiring knowledge about animals increased in kindergartens without AR, the noteworthy surge in AR-based practices suggests that technology enhances children's learning experiences and captures their attention more effectively. This observation aligns with the findings from the children's drawings, which indicate that AR engages children more intensively and allows them to perceive finer details in their learning experiences. As suggested by Wasko (2013), when teachers embrace a positive outlook regarding AR-supported education and recognize the advantages of AR technology in educational settings, the creation of AR-based learning environments using AR hardware and software resources becomes a significant avenue for enhancing learning outcomes. AR applications contribute to sustaining learners' interest and attention, making the learning process more engaging and dynamic.

In this context, in this study, children in classes with AR apps have more interest and attention than children in classes that do not have AR apps. When the preliminary knowledge of bees, cows, frogs, and horses (animals that children can easily encounter in their daily lives) is examined, it is seen that more is known about them in classes that have AR apps. The reason for this may be the idea that children already know about these animals so it is enough to simply look at a picture and move on rather than making a detailed examination. However, in the classroom where AR apps are used are, the gathering of children's attention and interest offered by technology presents an opportunity for them to observe in detail even those animals they think they know. Accordingly, it has been seen that AR apps increase children's achievement compared with classes that do not use AR apps due to their providing permanent learning, attracting children's attention, being fun, making children feel like they are actually there, and being lively, etc. (Yılmaz & Batdı, 2016). As for the answer to the research question *How does blurring the line between real and virtual affect children's learning?* it can be argued that AR apps that are integrated into children's activities in a balanced way positively affect their learning. However, it is argued that teachers need to receive good training to integrate AR

practices into kindergartens. Although teachers were given AR app training in this study, difficulties were encountered in terms of the timing of activities and the use of AR app tools.

CONCLUSION

The study showed that children's animal recognition knowledge increased after the activities in both the class where the AR app was used (f=115) and the class where it was not used (f=97). However, it is understood that in the classrooms where the AR app was used, children not only increased their animal recognition knowledge but also had different knowledge about the details of the animals. It is thought that observing the animal from different angles thanks to the AR app is important for children to gain detailed information about animals. When the children were observing the animals from different angles, the use of technology in recognizing the animal in their activities increased the children's capacity to observe. In light of the research conducted in the field, it becomes evident that there is a pressing need for the development of mobile applications specifically designed for children. These applications, as highlighted by Papadakis and Kalogiannakis (2020), have the potential to offer valuable educational content and engaging experiences, particularly in the context of augmented reality applications. Therefore, it is crucial to prioritize the development of mobile applications tailored to the unique needs and learning preferences of young learners. By doing so, we can harness the full educational potential of technology to provide enriching and effective learning experiences for children. The study by Gözüm, Papadakis, and Kalogiannakis (2022) emphasizes the importance of underscores the need to equip preschool teachers with STEM pedagogical content knowledge for effective STEM implementation in augmented reality experiences. Therefore, it is recommended that teacher training programs prioritize STEM expertise development, enabling educators to effectively use augmented reality for STEM education, ultimately enhancing the quality of education for young learners.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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