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Enriching a Traditional Learning Activity in Preschool through Augmented Reality: Children's and Teachers' Views

Sophia Rapti [1], Theodosios Sapounidis [1,*] and Sokratis Tselegkaridis [2]

[1] School of Philosophy and Education, Department of Education, Aristotle University of Thessaloniki (AUTH), 54124 Thessaloniki, Greece; raptsofi@edlit.auth.gr
[2] Department of Information and Electronic Engineering, International Hellenic University (IHU), 57400 Sindos, Greece; stselegkaridis@ihu.gr
* Correspondence: teo@edlit.auth.gr

Abstract: Nowadays, Augmented Reality flourishes in educational settings. Yet, little is known about teachers' and children's views of Augmented Reality applications in Preschool. This paper explores 71 preschoolers' opinions of Augmented Reality teaching integrated into a traditional learning activity. Additionally, five educators' views of Augmented Reality applications in Preschool are captured. Mixed methods with questionnaires and semi-structured interviews were used. The questionnaires record children's preferences regarding their favorite learning activity between traditional and the Augmented Reality one. Additionally, they explore the activity preschoolers would like to repeat and found most enjoyable: playful. Regarding quantitative data analysis, independent/paired samples *t*-tests and chi-square test along with bootstrapping with 1000 samples were used. As for the qualitative data collection, educators' semi-structured interviews focused on three axes: (a) children's motivation and engagement in Augmented Reality activities, (b) Augmented Reality's potential to promote skills, and (c) Augmented Reality as a teaching tool in preschool. The emerging results are: Preschoolers prefer more Augmented Reality activities than traditional ones. There are no statistically significant gender differences in preferences for Augmented Reality activities. Educators regard Augmented Reality technology as an innovative, beneficial teaching approach in preschool. However, they express concern regarding the promotion of collaboration among preschoolers via Augmented Reality.

Keywords: augmented reality; augmented technology; preschool education

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1. Introduction

Nowadays, the technological growth and the constant changes in every aspect of our lives lead governments and educators to seek for new, interesting teaching tools and practices so as to effectively prepare future citizens. Augmented Reality (AR) arises as one of the most innovative tools utilizing a range of technologies. Moreover, it is regarded as a concept, a system or a set of devices able to present information virtually and three-dimensionally (3D), enabling the users to interact with it in real time [1].

Several definitions have been provided to AR technology: (a) a system combining the virtual and real world by 3D display of items [2], (b) a set of technologies "augmenting" the learning process and experience [3], (c) a technology "blending" virtual and real world to create immersive learning experiences [4], (d) a form of digital technology that facilitates the "co-existence" of the real world with virtual information [5] and others.

AR technology is often mixed up with Virtual Reality. The main difference between them lies in the fact that AR does not deal only with virtual items, but combines digital content with physical reality. Consequently, AR may bridge the gap between the virtual and the real world [6]. A variety of devices is used so as to ensure the simultaneous blend and display of virtual and physical objects: head-mounted displays, glasses, computer monitors, tablets, and smartphones.

AR has been applied in many domains such as medicine, engineering, military, entertainment, architecture, and culture museums. During the last decade, it has been implemented in the educational field too, albeit limitedly [7]. Most frequently applications of AR are found in primary school rather than any other educational setting [8]. AR is implemented in K-12 in the framework of STEAM (Science, Technology, Engineering, Arts, Mathematics) Education, focusing often on Science and Mathematics using augmented 3D models [9], on Art Education [10] and on Programming [11]. Additionally, in the last decade, there have been several studies examining the AR impact on learning regarding Science, Maths, and Language across various educational levels [7,12]. AR learning may encompass principles of Bronfenbrenner's Development Ecology theory [13] too, which can contribute to our better understanding of the way young learners behave and develop. Based on the Development Ecology model, there are four different environmental systems in which children change, interact, learn and develop: the Microsystem, the Mesosystem, the Exosystem and the Macrosystem [14]. AR technology can be related to these systems and facilitate the children's knowledge-gain process and skills promotion.

Nowadays, education attracts more and more researchers' attention so as to investigate AR's potential impact on students thoroughly [15]. Findings emerging from conducted studies highlight both the advantages and disadvantages of AR applications in school classrooms. Regarding the advantages, gains, such as the following, are mentioned in Garzon et al.'s [8] study: enhanced learning outcomes, increased students' motivation, a better understanding of abstract ideas, autonomy, "sensory engagement", improved memory, cooperation, creativity, and accessibility. Moreover, AR technology is believed to contribute to students' promotion of skills and social interactions [12,16,17]. Related to the disadvantages of AR: resistance from teachers, the complexity of equipment, technical difficulties in using AR devices [8] and usability and acceptance of AR tools [18] are identified.

Although AR seems to bring about several benefits to children–students, this is not fully explored in the educational field [19], especially in preschool [20]. Consequently, this current paper explores preschoolers' and their educators' opinions on the AR learning experience when a traditional lesson is enriched with AR technology.

The rest of the paper is organized as follows: Section 2 depicts the methodology of the paper and in Section 3, the results are presented. Section 4 discusses the findings of the paper and Section 5 leads us to the conclusions drawn. Finally, the limitations of the paper are provided in Section 6.

1.1. Theoretical Background

AR technology may enhance the learning process by creating effective learning experiences for both students and teachers supporting in that way the learning and teaching process [21]. AR is based on a range of learning theories and principles, which are presented as follows.

1.2. Learning through AR

To start with, the AR approach integrates constructivism traits. According to these, the teacher can mentor the students to construct new, useful knowledge based on their own experiences, beliefs and attitudes in order to perceive reality [22]. Accordingly, in AR activities, learners discover knowledge by reflecting upon previous experiences and gaining information.

Furthermore, connectivism comes to add technological and digital character to the constructivist theory, which influences AR practices. Connectivism is a learning approach, according to Goldie [23], which regards learning as "a network phenomenon". Therefore, knowledge emerges from connections being supported by technology and social interactions [23]. Additionally, based on this theory created by Siemens [24], learning arises in various ways and develops as a lifelong process that can be facilitated by technology.

Consequently, it may be enriched through different "connections" that we experience in our environments [24].

In addition to Connectivism theory that influences AR learning, Thorndike's "Connectionism theory" [25] reinforces it as well. Based on this, technology assists learners to have access to different sources of information in their environments. AR technology may support them to interact with them physically in real time by facilitating discovery-based learning.

Additionally, AR teaching may be based on the Activity theory. This theory expands Vygotsky's and illustrates that teacher–children's interactions and the suitable use of technology tools can influence a learner's development and may facilitate self-learning in various activity systems that interact with each other [26].

Furthermore, AR might encompass the framework of twenty-first-century skills. These are competencies that could contribute to success in life, learning, and working places. Typically, these skills are the 4Cs (Critical thinking, Communication, Collaboration, Creativity) [27], Media-technology skills, and Life-Career skills. All these may be fostered through AR technology, which is thought to create a multi-sensory learning experience [28].

Based on findings from conducted research, during AR activities, students may be motivated and engaged highly in the learning process while discovering knowledge and learning through the exploration of concepts, phenomena, environments, and places that are beyond the walls of a typical, traditional classroom [1]. Texts, videos, and pictures are used to visualize events not easily accessed in reality [5]. Additionally, traditional teaching tools, for instance, books, can be used together with AR devices and create interactive learning materials [29], empowering the learning process and placing the students in the center of it. AR tools and materials might positively affect the learning outcomes in subjects such as Engineering [8], Maths [30,31], Science, Physics [32] Language, Geography [33] and social studies [34] in primary school and higher education.

Therefore, according to some researchers' claims, AR technology may arise as an effective educational tool to enhance children's motivation and engagement in learning and contribute to learners' creativity [30,31]. Additionally, AR may improve engaged learning together with technology literacy from an early age [35]. Furthermore, children with autism spectrum disorders (ASD) might be motivated and engaged in interactive learning activities, thus promoting cognitive and social skills through AR technology [36]. Thus, based on researchers' claims, AR technology may benefit students' performance and learning at almost every educational level, as long as suitable instruction and guidance are given [37]. Yet, preschool is limitedly studied regarding AR effects on learners' authentic performance, on the promotion of computational thinking skills and on collaborative learning [38].

1.3. AR in Preschool

Preschoolers are confined to seeing reality only from their own perspective [39]. Thus, they may encounter difficulties in understanding easily others' views and it is even harder for them to understand abstract ideas. However, through their interactions and playing with peers, they gradually visualize them. Nowadays, this interaction is enriched by technology and by interesting tools and devices. AR equipment may be one of them that contributes to children's interactions so as to gain the highest potential learning outcomes and develop useful life-long skills. AR technology integrates and utilizes sound, colorful images and touch stimulating preschoolers' senses [40] facilitating them to explore and discover new knowledge [5].

Based on Oranc and Kuntay [41], AR can be an effective educational tool for preschoolers contributing to their gain of knowledge and skills development. This is facilitated by the fact that by the age of 7 years old, children may develop skills required for the use of AR devices and applications, which can enhance their learning experience [42]. In educational settings, and especially in preschool, children learn at ease while playing [43]. In addition to this, education diverts into entertainment and becomes "edutainment" when multimedia tools are utilized [44]. Accordingly, preschoolers like and want to use AR devices again and again while interacting with AR applications, peers, and teachers [45]. They are supported to visualize objects in their minds through AR technology, which combines virtual and physical environments and helps them with understanding abstract ideas [45]. Moreover, the learning process becomes fun and interesting and collaborative learning is promoted. Yet, according to Yilmaz et al. [46], AR applications may be effective tools in preschool, as long as they are easy to use and can facilitate interactions [21].

AR technology has been implemented in early childhood in the last decade [10]. Nevertheless, preschool education seems to be limitedly examined compared to other educational levels [47]. Yet, there have been studies among others examining: (a) preschoolers' attitudes towards AR picture books [46], (b) the creation of mathematical learning experiences from AR applications in preschool educational settings [48], (c) AR as a teaching aid for teaching music [49], (d) AR technology contributing to interactive educational games [50], (e) literacy skills' promotion via AR [51].

Regarding the gains emerging from the utilization of AR technology in preschool reality:

- It may raise young learners' attention helping them to focus on activities [52] and may contribute to children's cognitive development [40].
- It may enhance preschoolers' spatial skills [53] adding value to playing innovative games and to hands-on ability [54].
- It may motivate young children to get engaged in the learning process by utilizing context (for example, animation) appealing to them [55].
- It may create fast, fun and effective learning experiences [56].
- It could improve Preschoolers' musical skills helping them to express their emotions easily [57].
- It could enhance children's creativity and foster their meeting with the arts physically [58].
- It may support children's social skills and peer relationships through interactions [59].

On the other hand, AR technology might have a negative impact on preschoolers as well:

- It may confuse young learners due to its multitasking character [8].
- It may be too complex for preschoolers to use and may cause discomfort to them [16].
- It could limit children's privacy [60].
- It might confuse young children about where fantasy ends and reality begins [4].

Regarding gender and its impact on the potential adoption and benefits of AR, there is little to know. The studies conducted so far focus on the gender effect on students in general and not on preschoolers specifically. For instance, according to Dirin et al. [61], females aged from 19 to 34 years old may manage New Technologies and AR better than males do because they get more emotionally involved with the content of them and get more enthusiasm from such innovative applications. On the other hand, there have been studies concluding that, in general, males tend to adopt New Technologies more easily than females [62].

To conclude thus far, while some researchers claim that AR technology may divert the learning process into an interactive action allowing school stakeholders to have control of their learning with less mental effort in a hybrid learning environment [63], there are others who conclude that AR might cause discomfort and might not facilitate so much young children's learning [4,60] Moreover, some researchers claim that AR content is inflexible and cannot be tailored easily to children's interests and needs [6,64].

Therefore, (a) there are studies leading to controversial deductions regarding AR effects on young learners although it seems that AR technology contributes to students' high motivation and engagement in learning activities, (b) preschool education seems to be limitedly explored especially regarding the children's promotion of skills through AR technology, and (c) there is limited evidence related to educators' acceptance and utilization of AR devices and applications as significant teaching aid tools. Regarding AR technology and students' motivation and engagement, AR applications may attract students' interest and engage them highly in learning activities [45]. Furthermore, as for AR's potential to promote students' skills, AR tools and materials are integrated into New Technologies and the STEAM framework which sets the skills' promotion as a significant goal. Additionally, AR might be an effective teaching tool in preschool classrooms because educators seem to accept and utilize it at ease and effectively. Consequently, this study aims to explore these findings by focusing on preschool.

Hence, this paper aims to explore AR's impact on preschoolers during a learning activity about the solar system and the planets utilizing AR technology in a traditional lesson. Furthermore, this seems to be a topic that has not been examined through AR in a preschool classroom. Additionally, this current paper attempts to capture the educators' views of AR technology while being integrated into a traditional learning activity in preschool reality. In order to meet the above goals, we addressed the following Research Questions (RQ):

RQ1. Do preschoolers prefer traditional teaching activities or AR activities?

RQ2. Are there any gender differences regarding the preschoolers' preferences?

RQ3. What are educators' views on AR applications in preschool classrooms?

2. Materials and Methods

In order to answer the research questions, mixed methods with an experimental design and semi-structured interviews were used. In detail, regarding the experimental design, the children initially engaged in traditional activities related to the planetary system, as shown in Figure 1. Subsequently, they had the opportunity to "observe the planets up close" using the "AR Solar System" application, as shown in Figure 2.

The main goal in both activities was for the children to see and interact with the heliocentric model of the solar system. Finally, the children completed Likert-scale questionnaires to express their preferences regarding the two types of activities.

Figure 1. Traditional activity.

Figure 2. Catching the Sun via AR application.

2.1. Participants and Procedure

This study involved 71 children, comprising 32 girls (45%) and 39 boys (55%), aged 3 to 6 years. Due to the fact that the AR intervention had been teamwork and was clearly presented to the children's parents, they all happily agreed and provided permission for their children to participate in the AR activity. The research was conducted according to the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of the Aristotle University of Thessaloniki. Moreover, the study was conducted by five educators from five urban areas in Greece.

For the current intervention, the AR app used is the "AR Solar System", developed by Arthur Arzumanyan and it is available from Google Play (https://play.google.com/store/apps/details?id=com.ar.solar first access 19 September 2022). This is an app that can be used by educators as an educational tool. The user needs only to print or display a marker image on the screen of a digital device, run the program and point the camera of the portable device on the marker. AR technology overlays then the digital content of the solar system onto the user's physical, real world and they can zoom in and out, rotate and navigate the solar system. Moreover, with this particular app, users can adjust the scale of distances between the planets.

In addition to this, a 3 h training course was conducted with the aim of familiarizing educators with AR technology equipment before implementing the intervention with the children in the school classroom. The training course specifically utilized smartphones and tablets in conjunction with AR applications.

2.2. Instruments

Two anonymized questionnaires, the "This or That" [65] and the "Smilyometer" [66], were employed to gather data on children's preferences. They are self-reported measures/questionnaires with one question for each item. The 5-point rating scale was chosen for young learners since this is believed to be less confusing, easier to use and to increase respondents' rates [67]. The questionnaires allowed the children to indicate their choices regarding the conducted activities: (a) the one they liked the most, (b) the one they would like to do again, and (c) the one they found the most playful. Additionally, the children responded to statements (S) using a 5-point scale ranging from "Strongly Disagree" to "Strongly Agree":

S1. I liked the traditional activity most
S2. I liked the AR activity the most
S3. I would like to do the traditional activity again

S4. I would like to do the AR activity again
S5. I found the traditional activity the most playful
S6. I found the AR activity the most playful
To implement statistical analysis, children's responses were scored as shown in Table 1.

Table 1. Smilyometer's score.

Answer	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Score	1	2	3	4	5

In addition, educators responded to a 7-point scale questionnaire, as shown in Table 2. A 7-point scale was selected because this is thought to reflect effectively the respondents' true and subjective ideas and feelings [67].

Table 2. Educators' questionnaire.

Questions	
Q1	The AR activities were not boring for the children
Q2	Children exhibited a greater level of attention span during AR activities in contrast to conventional activities
Q3	AR activities sparked motivation among children who typically exhibit minimal interest in participating
Q4	I have a keen interest in incorporating additional AR activities into my lessons
Q5	I am of the opinion that AR activities have great potential for educational purposes.
Q6	I believe that AR activities have the ability to promote collaboration among children
Q7	Integrating AR activities into a school classroom was a straightforward process
Q8	AR activities have the potential to serve as playful learning tools in a school classroom

To implement statistical analysis, educators' responses were scored, as shown in Table 3.

Table 3. Educators' questionnaire score.

Answer	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
Score	1	2	3	4	5	6	7

Finally, in order to explore the participating educators' views on the issue of using AR technology in school classrooms, semi-structured interviews were conducted. Their format was based on findings from existing literature related to AR's impact on children's motivation and engagement, on their skills promotion via AR and on the extent educators accept and use AR technology as an educational tool. Consequently, the semi-structured interviews were oriented by three axes: (a) young learners' motivation and engagement in AR activities, (b) AR's potential to promote children's skills, and (c) AR as a teaching aid tool in preschool classrooms.

2.3. Data Analysis

For data analysis, independent/paired-sample t-tests and chi-square tests were utilized with IBM SPSS Statistics 26. Cronbach's Alpha is calculated to evaluate the reliability of the questionnaires. This is a measure of internal consistency and indicates how closely related the items in a questionnaire are to each other [68]. Moreover, to enhance the statistical analysis, bootstrapping methods consisting of estimating 95% confidence intervals (CI) with 1000 samples were implemented [69–71].

3. Results

3.1. Children's Preferences

Table 4 presents the mean scores of the preschoolers on the "Smilyometer", demonstrating a preference for AR activities. The reliability of questions S1, S3, and S5 for the traditional activity was assessed and found to be acceptable, with a Cronbach's alpha of 0.59 and inter-item correlations of 0.4. Similarly, the reliability of questions S2, S4, and S6 for the AR activity was assessed and found to be acceptable, with a Cronbach's alpha of 0.76 and inter-item correlations of 0.53. These alpha values are considered acceptable given the small number of items (less than 10) [72,73].

Table 4. "Smilyometer" mean score.

Statement	N	Mean (Max = 5)	Std. Deviation	Skewness	Kurtosis
S1	71	4.32	0.907	−1.643	3.314
S2	71	4.77	0.540	−2.374	4.698
S3	71	4.37	0.760	−0.734	−0.884
S4	71	4.76	0.686	−3.479	13.768
S5	71	3.63	1.570	−0.711	−1.051
S6	71	4.82	0.617	−4.384	22.304

As far as skewness and kurtosis are concerned, acceptable values are typically considered to fall within the range of −2 to 2. According to Table 4, statements such as S4 and S6 exhibit values outside this range, indicating that the distribution of responses is not normal. However, the bootstrapping approach treats the non-normal data as if it were normal, drawing random subsamples from the original data collected. Furthermore, bootstrapping is a commonly employed solution because it does not require knowledge of the sampling distribution of the target statistic [71].

Table 5 shows the children's answers to "This or That". Again, there is a preference for AR activities.

Table 5. "This or That" frequency results.

Question	Activity	Frequency	Percent (%)
Which type of activity I like the most	Traditional	14	19.7
	AR	57	80.3
Which type of activity I would like to do again	Traditional	13	18.3
	AR	58	81.7
Which type of activity I found the most playful	Traditional	11	15.5
	AR	60	84.5

Table 6 presents the paired-sample *t*-test results, which show statistically significant differences in children's preferences for AR activities.

Considering the differences between traditional and AR activities, a preference for AR ones arises. In the first two pairs, a moderate effect size was observed, while in the third pair, a large effect size was observed.

Moreover, regarding the gender factor, according to Tables 7 and 8, there are no statistically significant differences in preferences related to traditional teaching and AR between boys and girls. In other words, both genders provided similar responses in the "This or That" and the "Smilyometer".

Table 6. Paired-sample *t*-test (based on 1000 bootstrap samples).

Differences	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-Tailed)	Effect Size (Cohen's d)
				Lower	Upper				
S1–S2	−0.451	0.983	0.113	−0.676	−0.239	−3.865	70	0.002	−0.458
S3–S4	−0.394	0.948	0.107	−0.606	−0.169	−3.504	70	0.002	−0.415
S5–S6	−1.183	1.552	0.187	−1.563	−0.789	−6.423	70	0.001	−0.762

Table 7. Independent samples *t*-test for "Smilyometer" (based on 1000 bootstrap samples).

	t	df	Sig. (2-Tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
S1	−0.884	69	0.396	−0.192	0.218	−0.632	0.226
S2	0.533	69	0.600	0.069	0.127	−0.184	0.320
S3	−0.851	69	0.390	−0.155	0.177	−0.506	0.189
S4	−1.164	69	0.298	−0.190	0.172	−0.564	0.096
S5	0.562	69	0.585	0.212	0.367	−0.513	0.934
S6	−0.439	69	0.701	−0.065	0.140	−0.336	0.211

Table 8. Chi-square test for "This or That" (based on 1000 bootstrap samples).

Question	Activity	Gender	Frequency	Result
Which type of activity I like the most	Traditional	Boys	9	X^2 (1, N = 71) = 0.617, *p* = 0.432
		Girls	5	
	AR	Boys	30	
		Girls	27	
Which type of activity I would like to do again	Traditional	Boys	8	X^2 (1, N = 71) = 0.281, *p* = 0.596
		Girls	5	
	AR	Boys	31	
		Girls	27	
Which type of activity I found the most playful	Traditional	Boys	6	X^2 (1, N = 71) = 0.001, *p* = 0.978
		Girls	5	
	AR	Boys	33	
		Girls	27	

3.2. Educators' Views

In this section, educators' views emerging from (a) questionnaires and (b) semi-structured interviews are presented to better understand whether educators can accept and utilize effectively AR technology as an educational tool.

3.2.1. Educators' Views through Questionnaires

The mean scores obtained from the educators' answers to the administered questionnaire are presented in Table 9. Most of the questions had an average score ranging from 6.4 to 6.8. However, the question regarding the promotion of cooperation among children in the AR activity had the lowest mean score. The reliability of the questionnaire was checked and found to be excellent, with a Cronbach's alpha of 0.91 and inter-item correlations of 0.52.

Table 9. Educators' mean score.

Question	N	Mean (Max = 7)	Std. Deviation
Q1	5	6.60	0.894
Q2	5	6.60	0.894
Q3	5	6.40	0.894
Q4	5	6.80	0.447
Q5	5	6.80	0.447
Q6	5	5.60	0.894
Q7	5	6.40	1.342
Q8	5	6.40	0.894

Figure 3 displays the educators' mean values of their responses to the questionnaire, along with the inclusion of 95% CI bars.

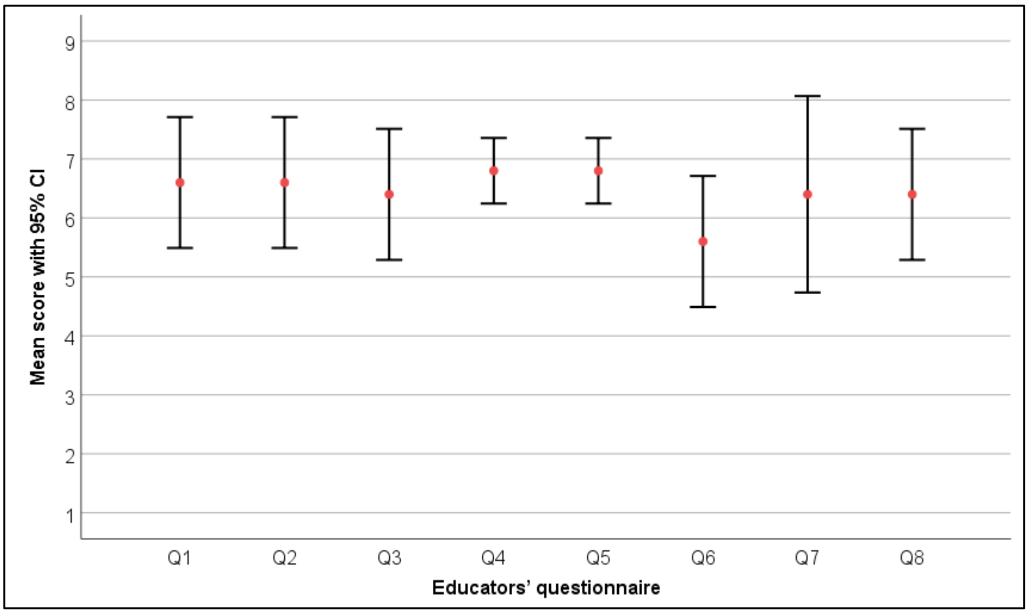

Figure 3. Educators' responses.

3.2.2. Educators' Views from Semi-Structured Interview

This section describes educators' views related to AR technology and highlights key points that emerged from the semi-structured interviews and the 3 defined axes.

Young Learners' Motivation and Engagement

According to the educators' comments in the semi-structured interviews, the children were too enthusiastic to utilize AR technology. In particular, the educators commented on the fact that the children were too excited about the journey to the planets of the solar system and experienced it as a game. Moreover, their curiosity was evoked and they showed great interest in participating in the activity. Additionally, all the preschoolers "asked to do more AR activities". In fact, such was the impact of AR on them that, in some cases, the children "after the end of the intervention, they asked to continue with AR activities rather than going out into the yard".

AR's Potential to Promote Children's Skills

The educators remarked that the AR technology fostered young learners' skills to design a plan and distribute roles in a working team, search for information, organize data and share it with peers. In detail, "the children decided for themselves who would hold the tablet, who would zoom in/out, who would rotate the planets. On Earth, they tried to find Greece, and as they circled the planet, they often remarked on the presence of daytime in certain areas and nighttime in others". However, educators also remarked that there have been cases when children were so enthusiastic to experience AR technology that they were not able to share devices and materials with their peers and wanted them exclusively for themselves.

AR as a Teaching Aid Tool in Preschool Classrooms

Regarding possible difficulties encountered by the educators during the implementation, in one case "there were problems with the AR application, as the camera did not work properly at first, but restarting the device solved the problem". In addition, "it would have been better if there were more tablets/smartphones for the children". Hence, educators seem to identify a shortage of AR tools and devices to use in school classrooms and a lack of support for their effective usage of AR technology.

Finally, all the educators agreed that AR technology could be an effective teaching tool that would facilitate them to design and implement fun, interesting and effective learning experiences for the young learners. "I believe that such activities depict reality in a playful way and are easily understood by children", while "can be used for teaching purposes".

4. Discussion

There are only a few studies investigating students' views of AR technology in educational settings and especially from an early age. Hence, this paper focuses on preschool and explores young learners' preferences regarding traditional learning activity utilizing AR technology. Moreover, we attempt to capture the educators' views too of AR technology and its usage in preschool classrooms.

To start with, related to the first RQ and to what preschoolers prefer most between traditional teaching methods and AR activities, a statistically significant preference was identified in favor of AR. During the AR activities, the children's interest was raised and a pleasant playful atmosphere was created. It seems that AR applications may evoke children's excitement [44] and may contribute to the design of fully interactive lessons that young learners enjoy [45]. Moreover, preschoolers focused on the activities from the beginning to the end. That may be attributed to the fact that AR technology may raise young children's curiosity and attention [74] while motivating them to engage fully in the activities [46,75–78]. In addition to this, game-based learning was fostered during the AR activities, which appeal to preschoolers. Children were able to "construct" new knowledge by themselves in a simple manner and understand better abstract ideas while having fun during the learning activities that were meaningful to them based on Constructivism theory principles [22]. That, based on the literature, AR might motivate young learners to participate actively in the learning process [76]. Furthermore, young learners are supported to discover knowledge according to Connectionism theory and Thorndike [25]. Based on that, discovery learning is supported through empirical research and innovative tools. These are parameters that AR learning includes.

Regarding the second RQ and whether there is a statistical difference between boys' and girls' preference for AR technology, it seems, from our results, that gender plays no significant role. All the children, boys and girls, took part in the AR activities with equal enthusiasm and enjoyed them using all their senses. That may be explained by the conclusion that gender stereotypes related to technology tend to appear later and not from an early age [79]. Yet, preschoolers' gender has not been investigated enough to draw general conclusions about its effect on AR adoption. In addition to this, our result may be attributed to the fact that the content of our AR intervention (exploration of the solar system) seems to be very appealing to preschoolers. Hence, it may be helpful to design and conduct further research in the area of gender's impact and application content on young children's interaction with AR.

In terms of the third RQ and the educators' views on AR applications in preschool classrooms, all of them were fond of AR teaching. Also, they all agreed that AR can facilitate them to design and conduct fun and interesting activities in their classrooms. That may be because AR is an effective tool at teachers' disposal for preschoolers learning using innovative technological tools [29]. According to Sirakaya and Sirakaya [80], teachers are keen on AR because it helps them to evoke children's curiosity, attract their attention, keep their interest and may contribute to their professional development by motivating them to explore new technologies and innovative tools, which seems to align with the Connectivism theory [23]. AR technology can be the means of "connecting" new information and knowledge with the right learning context for young learners' development via a cycle of learning in these environments, which is one of the main principles of Siemen's Connectivism theory [24].

Moreover, the educators commented on the degree that AR contributed to preschoolers' better understanding of complex concepts (in the current intervention the educators remarked on the children's better understanding of the topic: time, day and night). This reinforces the connection between Papert's Connectivism theory [81], according to which "powerful, abstract ideas" can become easily understood, and AR learning. This is reinforced by existing literature which highlights that AR can display objects "embodying" abstract concepts and can therefore enhance children's comprehension [50,82]. Also, based on conclusions from conducted studies, young learners are supported by AR to think like scientists and they are likely to develop positive attitudes towards science in the future [82], a conclusion that coincides with Leontiev's Activity theory. According to this, teacher–children's interactions play an important role in the learning process and divert this into a social activity as long as the appropriate tools are used in the educational activities [26]. Additionally, educators noticed and underlined the children's reactions to reflect upon the displayed information via AR devices and build up new knowledge. It seems that AR may support children's critical thinking and facilitate them to apply what they learn in real life [83]. In addition to this, educators remarked that children could recall easily details from the AR content and wanted to share them with their peers. So, AR may improve children's ability to remember details from gained information and reflect upon it while interacting [84,85].

Furthermore, all the educators shared the willingness to use AR as a teaching aid tool in their classrooms because they all concluded that this technology could benefit young learners. Moreover, they admitted that the training course they received before the AR intervention helped them a lot. So, it would be helpful to support educators for (a) their utilizing AR gear and guiding their students and (b) for designing and implementing AR activities effectively. This may be supported by findings from studies that reveal the educators' lack of experience and knowledge of AR technology [16,86]. Based on these findings, educators seem to agree that AR introduces an approach different from the existing teacher-centered one using innovative rather than conventional teaching tools and methods for which they need support and training though [87].

Finally, the educators expressed their concern about the development of collaboration among preschoolers via AR technology. Although they noticed that the children added their own comments on augmented information, shared it with others and tried to cooperate, the last was hard to achieve. That does not align with the existing literature that presents AR technology as a tool and practice promoting children's collaboration and teamwork [88,89]. Perhaps, our finding could be explained by the fact that AR creates such realistic learning environments, which preschoolers might experience for the first time, that they are too enthusiastic to keep for themselves and not to share. Thus, this paper suggests designing learning activities enriched by AR technology, which could enable preschoolers to solve problems, reflect upon ideas and work with others using innovative technology by collaborating as members of a team.

5. Conclusions

This current paper investigates how preschoolers feel when a traditional learning activity utilizes AR technology. Additionally, it explores educators' views of AR in preschool reality. All the children showed greater interest in AR teaching than in a traditional method. Preschoolers seem to be much more motivated to engage in the learning process while utilizing AR technology in a conventional lesson. Moreover, AR activities are thought to facilitate young learners' active participation in the learning process, providing them with a fully sensory learning experience. Also, a gender analysis revealed no significant difference between the preferences of boys and girls regarding AR technology. Furthermore, based on the educators' answers in the semi-structured interviews, AR may be a type of innovative technology that could inspire them to design and implement fun and interesting learning activities, could promote their students' cognitive and social skills and would help to develop them professionally. However, concerns related to the promotion of collaboration among children have arisen and doubts about whether educators can utilize AR technology effectively and effortlessly without prior training occurred. Finally, future plans may include the design and conduct of research related to AR's impact on preschoolers' collaborative skills and to AR content tailored to early age supplying extra guidelines for educators to use.

6. Limitations

If limitations of this study were to be highlighted, these would be the following: although the educators attended a 3 h training program, they were not fully familiarized with the equipment. This may have influenced their self-exposure and comfort level in implementing the activities. In addition, there was a limited number of AR devices available to the educators for conducting the activities. As a result, children had to wait for their turn to utilize the devices. This waiting time may have affected their behaviors, including their desire to cooperate, during the AR intervention.

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