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Primary Education and Augmented Reality. Other Form to Learn

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Abstract: Augmented reality is a great value resource in the area of education, as it allows the students to become immersed in a hybrid context between the real world and the digital one, bringing realities closer to the classroom which would otherwise be impossible to reach, improving the student's motivation and also facilitating the construction of significant learning within themselves. Also, its inclusion within the classroom does not imply great costs, as the necessary hardware requirements for its implementation are limited to the availability of a Smartphone or digital tablet and an internet connection, making it the ideal technology that can be integrated into any educational stage. In the present work, we present the evaluation of augmented reality as a didactic resource within Primary Education, by future teachers. The research is addressed from a quantitative methodology, through the use of a questionnaire, created ad hoc and composed by 32 items that refer to specific educational aspects such as inclusion, special education needs, the teaching-learning processes, etc. An incidental sample of 208 students was utilized, who were enrolled in the Primary Education Degree at the Faculty of Education of the University of Cordoba. The conclusions indicate that the future teachers, in their initial training, consider augmented reality as a tool that could be valuable and relevant for the development of the curricula, as well as inclusive education.

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Subjects: Teaching & Learning - Education; Teaching & Learning; Technology in Education

Keywords: Augmented reality; primary education; student; curriculum; learning

1. Introduction

The fast development of information and communication technologies (ICT) has resulted in their presence in the academic life of individuals becoming evident and latent. In the last few years, one of the so-called emergent technologies is Augmented Reality (AR), and it is introduced as a digital resource that in the future, in less than 3 years, will be present in the education centers (Johnson et al., 2016). This will unchain a "micro-revolution" in education, as stated by Cubillo-Arribas et al. (2014), more specifically in teaching and learning. Nevertheless, as attested by Dunleavy and Dede (2014), research on AR is abundant, but that which links it with education is not excessive. Nevertheless, its use has evidenced the great number of advantages it can provide for society at large and for students in particular, but more specifically, what is AR? In the words of Cabero and Barroso (2016), AR is "a technology that allows the combination of digital and physical information in real time through different technological devices; meaning that it consists on utilizing a set of technological devices that add virtual information to physical information" (pg. 46).

In the Information and Knowledge Society in which we are immersed, more and more daily actions arise in which AR is used. This reality cannot remain alien to educational institutions, even more so as it is a technology with a tendency to stay (Bacca et al., 2014; Popel & Shyshkina, 2018). We must not forget that we have become pro-consumers of content and experiences. Teachers, as much as in practice and in training, should try to train and learn about the alternatives that these technologies can provide for a more real, creative, motivating and attractive teaching and learning process.

We considered that this research its necessary due to the above, but also in the search for educational agents to have an understanding of the versatility of AR in the educational field for the obligatory educational stages.

This research was carried out under the auspices of the RAFODIUM Project "Augmented reality to increase training. Design, production and evaluation of augmented reality programs for university education" (EDU-5746-P-RAFODIUN Project) financed by the Ministry of Economy and Competitiveness of the Government of Spain.

The research question appears from the premise that it is an emerging technology that is used in educational institutions and, according to studies, generates benefits in the teaching-learning process (Bacca et al., 2014). Therefore, the questions revolve around: what do the undergraduate students, future educational agents of the primary level, say about them about employment in the classrooms of the same?; Does the vision on the incorporation of AR in the classroom have significant differences based on sociodemographic variables (gender, age, use of certain devices, previous studies?

This study tries to know the point of view of teachers in pre-service for the prevention of future deficiencies in their didactic and pedagogical training in the incorporation of emerging technologies in the classroom.

The objective of this work is to reflect on the view of university students enrolled in the Primary Education Degree at a Spanish University, on the incorporation of AR in the classroom for the development of curricular contents.

The main result achieved is that the gender variable has an effect on the perception of pre-service teachers on AR, so that its use in their future teaching practice will be compromised.

2. Review of literature

The beginning of the 21st century brought with it a new revolution in educational technology. The so-called "emerging technologies" timidly begun to appear on the educational sphere, bringing new ways of seeing, feeling and understanding the act of education, as well as changes in the roles of teachers and students.

In 2012, the Horizon report (Durall et al., 2012) published that year presented AR as an emerging technology within the educational field; indicating the degree of penetration that it would have in educational centers worldwide, over the next 5 years, becoming one more element in the classrooms around 2020 (Johnson et al., 2016).

From that moment on, a technological race begins about everything related to it. Different software programs were developed, which, according to the different degrees of computer skills and/or knowledge, sometimes made possible the creation of AR itself and in others the use of what was generated by other researchers and designers in the classrooms (AUTHOR).

The association of Augmented Reality with teaching-learning processes implies, according to Cabero and Barroso (2016), Villalustre (2020), and Garzón et al. (2020) an improvement in the mark of the educational system. Thus, as proof of the advantages that its incorporation in the classrooms in the teaching process, it has been shown that its use increases the interactivity of the students with the ChanLin et al. (2019); and as a result their motivation for learning grows (Barroso & Gallego, 2017; Beiro, 2014; Chen et al., 2015; Cózar-Gutiérrez et al., 2015; Harley et al., 2016; Villalustre, 2020), it offers information that in the classroom is difficult to experience, meaning that it allows experiencing the events of daily life, aside from allowing and facilitating its search (Vichivanives & Ralangarm, 2015; Villota & Vásconez, 2020; Wu et al., 2013), so that it brings what is studied closer to the student. Also, it provides help for improving spatial skills and concept comprehension (Wojciechowski & Cellary, 2013); the immersion into learning promoted by the use of AR also implies a reduction of the cognitive load, reduces the costs of the experiments (Fidan & Tuncel, 2019; Wei et al., 2015), and allows the development of manipulation skills.

Based on the advantages reported by its use, it must be pointed out that the work experiences using AR in the classroom begin to be exhaustive. Thus, in the early childhood education stage, we find the work by Marín and Muñoz (2018), who used this technology to deepen the learning of the concept that students aged from 3 to 5 years old had of themselves, with this content described in Spanish legislation as a key part of the curriculum. If we remain in Primary Education, we find the experience called "The educational sandbox", designed by Álvarez Sánchez et al. (2017), in which the authors approach the concept of volume in the area of mathematics, through the use of an interactive sandbox designed with AR technology, using a camera that allowed the students to visualize the three-dimensional nature of the area, and project water lagoons onto it. At the Secondary Education level, we find the work carried out by Saundarajan et al. (2020) with Malaysian students using the Photomath App, with the aim of learning content in the area of algebra. In the three cases mentioned, the researchers reflected on the virtues and advantages of promoting immersive learning as compared to rote learning.

We share with Miguélez-Juan et al. (2019), the idea of the need for a renewal in the academic relationships that are established between society and the educational system in general, in the first instance; and secondly, between the teaching staff and the digital resources or tools that it creates. This leads to teaching innovation taking on a new dimension, which can provoke a greater effort by the academic body. In this sense, Tagua and Fazio (2020) advocates a methodology based on action research, so that innovation processes also involve researchers, with the well-known benefit that can be provided by both cases.

On the other hand, it should also be noted that AR has several drawbacks: complexity of the technology itself (Gómez et al., 2020; Hsio, 2013; Marín-Díaz, 2017; Villalustre, 2020); cost of the

devices (Villalustre, 2020; Yip et al., 2019); design errors that slow down devices or learning (Akçayır & Akçayır, 2017; Gavilanes et al., 2018); device compatibility with existing resources (Villalustre, 2020); difficulty in using it by students with visual difficulties (Chiang et al., 2014; Marín-Díaz, 2017); and lack of teacher training to create the materials (Marín-Díaz, 2017; Toledo & Sánchez, 2017).

Consequently, the teacher's vision is the element to be studied when analyzing the viability of AR in the classrooms. In general, it must be analyzed to clarify those elements, both training and material resources, that can or should be improved, eliminated, or supported, so what the Horizon reports (Pelletier et al., 2021) point out as what should now be, become a reality.

3. Methods

The main objective of the study is to reflect on the view, by second-year Primary Education Degree students from the University of Cordova, of some educational aspects about the use of augmented reality in the classroom.

The subject of AR was explained in the classroom of the Primary Education Degree, later the students experimented with it and, finally, a questionnaire was elaborated based on the context of the RAFODIUM project.

3.1. Design

The design followed in this study, according to the degree of intervention, is ex post facto and descriptive (Sabariego-Puig & Bisquerra-Alzina, 2012), given that the aspects or elements established by the evaluation of students polled, with respect to specific aspects of the use of augmented reality in the classroom, are described at posteriori.

3.2. Sample

The sample was obtained through accidental sampling, as it is the most utilized in the area of Social Sciences and Education research (Hernández-Sampieri et al., 2014). The size of the sample, 208 enrolled students, represents a sampling error of 2.5% with a level of confidence of 95%, a relative variance with a confidence level of z = 1.9599 and pq (population variance) of 0.25 for a population of 240 students. The sample had the following characteristics: 64.4% were women and 35.6% men, 74.0% were aged 19–21 years old; 16.3% were 22–24, and 9.6% were older than 24. As for their level of education before their acceptance into the Primary Education Degree, 4 out of 10 came from some type of Advanced Vocational Degree Program (AVDP, 35.6%), and the rest had received a High School Degree and taken the university entrance examination.

It can be necessary to point out that the students who come from the Advanced Vocational Degree Program have an experience in educational centers of between 6 and 9 months. On the other hand, the entire sample has had a compulsory internship period, as a subject of the studies of the Primary Education Degree.

Lastly, when examining the type of device available to them, 1.4% had a Desktop computer; 4.3% had a Laptop computer; 7.7% had a Smartphone; 1.9% had a Smartphone and Desktop computer; 27.4% had a Smartphone and Laptop Computer; 13.9% had a Smartphone, Laptop Computer and Desktop Computer; 3.4% had a Tablet, 1.9% had a Tablet and Laptop Computer; 1.4% had a Tablet and Desktop Computer; 13.9% had a Tablet, Smartphone and Laptop Computer, and 22.6% had a Tablet, Smartphone, Laptop Computer and Desktop Computer (see, Table 1).

3.3. Instrument

The instrument created ad hoc was composed of 32 items, with the first four related to identification variables such as gender, age, education prior to enrolling in the university degree, and digital devices available. The rest of the items were related to specific educational aspects: to foment inclusive education, the specific educational needs, the process of teaching-learning and diverse skills that could be developed with the use and application of augmented reality in the classroom.

Table 1. Distribution of the sample according to the device used

	Frequency	Percentage
Computer	3	1.4%
Laptop	9	4.3%
Smartphone	16	7.7%
Smartphone and Computer	4	1.9%
Smartphone and Laptop	57	27.4%
Smartphone, Laptop and Computer	29	13.9%
Tablet	7	3.4%
Tablet and Laptop	4	1.9%
Tablet and Computer	3	1.4%
Tablet, Smartphone and Laptop	29	13.9%
Tablet, Smartphone, Laptop and Computer	47	22.6%

These were measured with a Likert scale with five response options, where 1 indicated complete disagreement and 5 complete agreement.

This questionnaire was designed by researcher was implemented to undergraduate students by the same researchers, online, through the GoogleForms application.

The reliability measured with Cronbach's Alpha indicated a good internal consistency, given that the value obtained was 0.809. Likewise, the correlation test of each item with the entire scale (coefficient of homogeneity), showed results ranging from 0.795 and 0.824 for Cronbach's Alpha for all the items, suggesting that all of them measured a part of the characteristics measured in the present study, and also had a good reliability (Hernández-Sampieri et al., 2014). Lastly, as for the validity of the construct, the exploratory factorial analysis conducted, with an extraction of the principal elements taking into account those that had a self-value greater than 1, with the method of Kaiser-varimax rotation, whose Kaiser-Meyer-Olkin (KMO) index was 0.806 and Bartlett's sphericity test ($\chi 2 = 1933.2$ and $p < 0.001$); indicated that 65.5% of the total variance explained is dependent on five factors.

3.4. Procedure

The instrument was given to the students after a two-month intervention with all of the students in the classroom. During this time, the students took part in a session about the theoretical aspects of emergent technologies in general and AR in particular. The presentation utilized for this can be viewed at https://view.genial.ly/5c6132394e10564933e167d4/interactive-content'raprim1819

The presentation and explanation of the activity lasted 1 and a half hours

Afterwards, they took part in a curricular activity in which they had to implement the use of AR for the development of some type of content described in the Spanish legislation for the primary school stage.

The implementation was carried out for 5 hours, using free software. Subsequently, own resources created for this purpose were used, which lasted three class sessions (a total of 5 hours). Finally, for 6 weeks, the students designed in AR content related to the Primary Education stage, in accordance with Spanish educational laws.

Table 2. Means and standard deviation of the items

Item	N	Mean	Standard deviation
Item 5	208	4.48	0.621
Item 6	208	4.15	0.656
Item 7	208	4.52	0.735
Item 8	208	3.31	1.118
Item 9	208	3.97	0.834
Item 10	208	3.96	0.836
Item 11	208	4.49	0.644
Item 12	208	4.49	0.780
Item 13	208	4.22	0.816
Item 14	208	3.01	1.103
Item 15	208	3.83	0.843
Item 16	208	3.86	0.791
Item 17	208	4.39	0.720
Item 18	208	4.37	0.730
Item 19	208	4.27	0.657
Item 20	208	4.01	0.681
Item 21	208	4.01	0.681
Item 22	208	3.92	0.975
Item 23	208	3.32	0.809
Item 24	208	4.28	0.761
Item 25	208	4.41	0.805
Item 26	208	3.78	1.066
Item 27	208	3.93	0.825
Item 28	208	3.99	0.795
Item 29	208	3.49	1.012
Item 30	208	4.13	0.725
Item 31	208	2.38	1.317
Item 32	208	2.23	1.092

4. Results

The results show that the students polled were in disagreement with the ideas that "utilizing Augmented Reality makes difficult the acquisition of content ($\bar{X} = 2.38$)"; and, "learning to use Augmented Reality takes a lot of time" ($\bar{X} = 2.23$; see, Table 2).

On the other hand, the students seemed to be in agreement in that AR helps with the teaching-learning process, as it promotes creativity ($\bar{X} = 4.52$); allows the development of the pre-school-primary stage of education ($\bar{X} = 4.48$); facilitates the real learning of the content ($\bar{X} = 4.49$); foments learning through experience ($\bar{X} = 4.49$); and complements the curricular content explained in class ($\bar{X} = 4.41$).

4.1. Results in relation to gender

Also, when taking into account the participant's gender, a Student's t test (n. s. = 0.05) was performed, obtaining distinctive results which can be observed in Table 3.

Table 3. Student's t test according to gender

Item	Gender	N	Mean	s	T and p
Item 5	Men	74	4.35	0.560	T = −2.254 and p = 0.025 favorable to the women
	Women	134	4.55	0.644	
Item 6	Men	74	4.00	0.619	T = −2.597 and p = 0.010 favorable to the women
	Women	134	4.24	0.662	
Item 7	Men	74	4.38	0.806	T = −2.142 and p = 0.033 favorable to the women
	Women	134	4.60	0.683	
Item 9	Men	74	3.81	0.788	T = −2.078 and p = 0.039 favorable to the women
	Women	134	4.06	0.847	
Item 11	Men	74	4.34	0.625	T = −2.488 and p = 0.014 favorable to the women
	Women	134	4.57	0.642	
Item 13	Men	74	3.97	0.758	T = −3.412 and p = 0.001 favorable to the women
	Women	134	4.36	0.817	
Item 17	Men	74	4.22	0.763	T = −2.612 and p = 0.010 favorable to the women
	Women	134	4.49	0.680	
Item 19	Men	74	3.96	0.671	T = −5.479 and p = 0.000 favorable to the women
	Women	134	4.45	0.583	
Item 20	Men	74	3.88	0.640	T = −2.082 and p = 0.039 favorable to the women
	Women	134	4.08	0.694	
Item 21	Men	74	3.86	0.709	T = −2.302 and p = 0.022 favorable to the women
	Women	134	4.09	0.654	
Item 24	Men	74	4.05	0.792	T = −3.238 and p = 0.001 favorable to the women
	Women	134	4.40	0.716	
Item 25	Men	74	4.12	1.006	T = −3.465 and p = 0.001 favorable to the women
	Women	134	4.57	0.619	
Item 29	Men	74	3.30	0.975	T = −2.009 and p = 0.046 favorable to the women
	Women	134	3.59	1.020	
Item 31	Men	74	2.78	1.347	T = 3.255 and p = 0.001 favorable to the men
	Women	134	2.16	1.252	

The women were almost in total agreement more often than the men in that AR: allows the development of the pre-school-primary stage (t = −2.254 and p = 0.025, $\bar{X} = 4.55$); allows the development of inclusive education t = −2.597 and p = 0.010, $\bar{X} = 4.49$); promotes creativity (t = −2.142 and p = 0.033, $\bar{X} = 4.60$); facilitates the real learning of the content (t = −2.488 and p = 0.014, $\bar{X} = 4.60$); promotes learning through free discovery (t = −3.412 and p = 0.001, $\bar{X} = 4.36$); can be used by gifted subjects (t = −2.612 and p = 0.010, $\bar{X} = 4.49$); can promote the transversal teaching of the content (t = −5.479 and p < 0.001, $\bar{X} = 4.45$); facilitates the comprehension of curricular contents (t = −3.238 and p = 0.001, $\bar{X} = 4.40$); and complements curricular contents explained in class (t = −3.465 and p = 0.001, $\bar{X} = 4.57$).

Likewise, the women were only in agreement with the idea that AR allows cooperative work t = −2.078 and p = 0.039, $\bar{X} = 4.06$); promotes intercultural learning (t = −2.082 and p = 0.039, $\bar{X} = 4.08$); promotes multicultural learning (t = −2.302 and p = 0.022, $\bar{X} = 4.09$); and that to use it, computer knowledge is necessary (t = −2.009 and p = 0.046, $\bar{X} = 3.59$); as compared to the men.

However, the men, as opposed to the women, were more in disagreement, almost to the point of indifference, with the premise that states that the use of AR makes difficult the acquisition of content (t = 3.255 and p = 0.001, $\bar{X} = 2.78$).

4.2. Results according to age

Age was another variable with significant differences in some of the propositions analyzed in this study, and to address it, an analysis of variance (ANOVA, n.s. = 0.05) was performed, with the results show on Table 4.

The students in the 19–21 age group pointed out to being more in agreement with the idea that AR promotes creativity, F (2.205) = 3.975, p = 0.020, η2 = 0.037, than the students who were older than 24, t (205) = 2.814, p = 0.016; while significant data for the rest of the comparisons was not found.

The students who were aged between 22 and 24 were more in agreement in that AR allows cooperative work, F (2.205) = 3.410, p = 0.035, η2 = 0.032, than those older than 24, t (205) = 2.612, p = 0.029. However, the post hoc test applied did not provide statistically significant data for the rest of the binary comparisons.

Likewise, those in the 22–24 age group indicated that AR promotes learning through free discovery, F (2.205) = 3.945, p = 0.021, η2 = 0.037, as compared to those in the 19 to 21 age range, t(205) = 2.776, p = 0.018, although no significant Bonferroni data was found for the rest of the comparisons.

Also, the 22–24 age group was more in agreement with the premise that states that AR can be utilized by individuals who have psychological difficulties, F (2.205) = 4.976, p = 0.008, η2 = 0.046, as compared to the 19–21 age group, t (205) = 3.034, p = 0.008, although the rest of the combinations did not show relevant results.

In addition, the individuals in the 22–24 age group were more in agreement with the idea that AR complements the curricular contents explained in class, F (2.205) = 4.634, p = 0.011, η2 = 0.043, as compared to the 19–21 group, t (205) = 2.827, p = 0.016; on the other hand, there were no relevant Bonferroni values for the rest of the comparisons.

Lastly, students older than 24 completely agreed with the idea that suggests that AR could promote the transversal teaching of the contents, F (2.205) = 3.887, p = 0.022, η2 = 0.037, as compared to those in the 19–21 age group (205) = 2.616, p = 0.029 and those in the 22–24 age

Table 4. ANOVA results according to age

Item	Age (years old)	N	Mean	s	F and p
Item 7	19–21	154	4.58	0.711	F = 3.975 and p = 0.020 favorable to 19–21 olds
	22–24	34	4.50	0.564	
	Older than 24	20	4.10	1.021	
Item 9	19–21	154	3.97	0.836	F = 3.410 and p = 0.035 favorable to 22–24 old
	22–24	34	4.21	0.592	
	Older than 24	20	3.60	1.046	
Item 13	19–21	154	4.14	0.871	F = 3.945 and p = 0.021 favorable to 22–24 olds
	22–24	34	4.56	0.504	
	Older than 24	20	4.30	0.657	
Item 16	19–21	154	3.76	0.841	F = 4.976 and p = 0.008 favorable to 22–24 olds
	22–24	34	4.21	0.538	
	Older than 24	20	4.00	0.562	
Item 19	19–21	154	4.25	0.660	F = 3.887 and p = 0.022 favorable to those older than 24
	22–24	34	4.18	0.673	
	Older than 24	20	4.65	0.489	
Item 25	19–21	154	4.31	0.875	F = 4.634 and p = 0.011 favorable to 22–24 olds
	22–24	34	4.74	0.448	
	Older than 24	20	4.60	0.503	

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group, t (205) = 2.590, p = 0.031. While the comparison between the 19–21 and 22–24 groups did not result in statistically significant results in the post hoc tests applied.

4.3. Results in relation to studies prior to the primary education degree

Related with this, for the analysis of the student's education prior to beginning their Primary Education Degree a Student's t test was performed (n.s. = 0.05), with the results shown in Table 5.

The students who accessed the Primary Education Degree studies after completing an Advanced Vocational Degree Program were more in agreement with the premise that AR: promotes teaching through free discovery (t = −2.205 and p = 0.029, $\bar{X} = 4.50$); can promote the teaching of transversal contents (t = −2.272 and p = 0.024, $\bar{X} = 4.50$); promotes the digital divide (t = −2.092 and p = 0.038, $\bar{X} = 4.24$); and facilitates communication between the students and teachers (t = −2.092 and p = 0.041, $\bar{X} = 4.15$); as compared to those who accessed their university studies through a High School Diploma and a posterior entrance examination. However, the rest of the propositions addressed did not show statistically significant results.

4.4. Results in relation to the device used

Lastly, the device available to the students was another variable where significant differences were found in some of the propositions analyzed in this study, and to address this issue, an ANOVA (n.s. = 0.05) was performed (see, Table 6).

The students who only had a Smartphone indicated to be more in agreement with the idea that AR promotes creativity, F(10.198) = 2.471, p = 0.008, η2 = 0.111, as compared to those who only have a laptop computer, t (198) = 3.659, p = 0.018, with the same being observed with those who have a Smartphone and a laptop computer as compared with those who only have a laptop computer, t (198) = 3.372, p = 0.049, those who have a Smartphone, laptop computer and desktop computer as compared to those who only have a laptop computer t(198) = 3.395, p = 0.046, those who have a Tablet, Smartphone and laptop computer, compared to those who only have a laptop computer, t (198) = 3.900, p = 0.007, and those who have all the devices as compared to only a laptop computer, t (198) = 3.519, p = 0.030. Nevertheless, no significant data was found in the rest of the comparisons.

The students who owned a Smartphone and a laptop computer indicated being more in agreement with the premise "augmented reality facilitates the real learning of the contents", F (10.198) = 4.019, p < 0.001, η2 = 0.169, as compared to those who possessed all the devices, t (198) = 3.933, p = 0.006. This was also observed with those who possessed a Table, Smartphone and laptop computer as compared to those who had all the devices, t (198) = 3.937, p = 0.006. However, the post hoc tests applied did not provide statistically significant data for the rest of the comparisons.

As for the idea that AR promotes learning through experience, F (10.198) = 1.899, p = 0.047, η2 = 0.088, the students who only possessed a desktop computer indicated to be more in agreement; nevertheless, the post hoc tests utilized failed to reveal any significance in these comparisons.

The students who had a Smartphone, laptop computer and desktop computer were more in agreement with the idea that AR promotes learning through free discovery, F (10.198) = 2.074, p = 0.028, η2 = 0.095, as compared to those who only had a desktop computer, t (198) = 3.474, p = 0.034. Likewise, for those who have a Tablet, Smartphone and laptop computer, t(198) = 3.760, p = 0.012; and those who have all the devices as compared to those only had a desktop computer, t(198) = 3.440, p = 0.039. However, no significant Bonferroni data was found for the rest of the comparisons.

As for the results for the premise "augmented reality can be utilized by individuals with psychological difficulties", F (10.198) = 2.422, p = 0.010, η2 = 0.109, the students who were

Table 5. Results of student's t test as a function of the studies prior to the university degree

Item	Prior education	N	Mean	s	T and p
Item 13	High School	134	4.16	0.852	T = −2.205 and p = 0.029 favorable to AVDP
	AVDP	74	4.50	0.564	
Item 19	High School	134	4.22	0.675	T = −2.272 and p = 0.024 favorable to AVDP
	AVDP	74	4.50	0.508	
Item 22	High School	134	3.85	1.004	T = −2.092 and p = 0.038 favorable to AVDP
	AVDP	74	4.24	0.781	
Item 27	High School	134	3.89	0.857	T = −2.092 and p = 0.041 favorable to AVDP
	AVDP	74	4.15	0.610	

The acronym AVDP correspond to Advanced Vocational Degree Program

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Table 6. ANOVA result as a function of the device

Item	Device[1]	N	Mean	s	F and p
Item 7	OM	3	4.00	0.000	F = 2.471 y p = 0.008 favorable to SM>OP SM+OP>OP SM+OP+OM>OP TA+SM+OP>OP TA+SM+OP+OM>OP
	OP	9	3.67	1.118	
	SM	16	4.75	0.447	
	SM+OM	4	4.25	1.500	
	SM+OP	57	4.53	0.658	
	SM+OP+OM	29	4.59	0.501	
	TA	7	4.57	0.535	
	TA+OP	4	3.75	1.500	
	TA+SM	3	4.33	0.577	
	TA+SM+OP	29	4.72	0.455	
	TA+SM+OP+OM	47	4.57	0.853	
Item 11	OM	3	4.00	0.000	F = 4.019 and p < 0.001 favorable to SM+OP>TA+SM+OP+OM TA+SM+OP>TA+SM+OP+OM
	OP	9	4.11	0.928	
	SM	16	4.44	0.629	
	SM+OM	4	4.25	0.500	
	SM+OP	57	4.70	0.462	
	SM+OP+OM	29	4.59	0.568	
	TA	7	4.00	1.414	
	TA+OP	4	4.50	0.577	
	TA+SM	3	3.67	0.577	
	TA+SM+OP	29	4.79	0.412	
	TA+SM+OP+OM	47	4.23	0.633	

(*Continued*)

Table6. (*Continued*)

Item	Device[1]	N	Mean	s	F and p
Item 13	OM	3	2.67	1.155	F = 2.074 and p = 0.028 favorable to SM+OP+OM>OM TA+SM+OP>OM TA+SM+OP+OM>OM
	OP	9	3.89	1.269	
	SM	16	4.19	0.655	
	SM+OM	4	4.00	0.000	
	SM+OP	57	4.21	0.773	
	SM+OP+OM	29	4.34	0.721	
	TA	7	3.86	1.345	
	TA+OP	4	3.75	0.500	
	TA+SM	3	4.00	0.000	
	TA+SM+OP	29	4.48	0.574	
	TA+SM+OP+OM	47	4.30	0.858	
Item 17	OM	3	4.00	0.000	F = 2.625 and p = 0.005 favorable to SM>OP SM+OP>OP SM+OP+OM>OP TA+SM+OP>OP TA+SM+OP+OM>OP
	OP	9	3.44	0.527	
	SM	16	4.44	0.727	
	SM+OM	4	4.25	0.500	
	SM+OP	57	4.58	0.565	
	SM+OP+OM	29	4.55	0.632	
	TA	7	4.57	0.535	
	TA+OP	4	4.25	0.500	
	TA+SM	3	4.00	0.000	
	TA+SM+OP	29	4.34	0.857	
	TA+SM+OP+OM	47	4.30	0.832	

(*Continued*)

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Table6. (*Continued*)

Item	Device[1]	N	Mean	s	F and p
Item 23	OM	3	4.67	0.577	F = 2.196 and p = 0.020 favorable to OM>SM+OP+OM
	OP	9	3.33	0.707	
	SM	16	3.38	0.806	
	SM+OM	4	3.25	0.500	
	SM+OP	57	3.32	0.805	
	SM+OP+OM	29	2.86	0.875	
	TA	7	3.43	0.787	
	TA+OP	4	3.75	0.500	
	TA+SM	3	3.00	1.000	
	TA+SM+OP	29	3.38	0.622	
	TA+SM+OP+OM	47	3.45	0.829	
Item 25	OM	3	2.67	1.155	F = 2.961 and p = 0.002 favorable to SM+OP>OM SM+OP+OM>OM TA+SM+OP>OM TA+SM+OP+OM>OM
	OP	9	4.11	0.928	
	SM	16	4.00	1.265	
	SM+OM	4	4.25	0.500	
	SM+OP	57	4.56	0.682	
	SM+OP+OM	29	4.52	0.509	
	TA	7	4.43	0.535	
	TA+OP	4	4.00	1.414	
	TA+SM	3	4.33	0.577	
	TA+SM+OP	29	4.69	0.471	
	TA+SM+OP+OM	47	4.34	0.867	

[1]The abbreviations utilized mean: OM = Computer; OP = Laptop; SM = Smartphone; SM+OM = Smartphone and Computer; SM+OP = Smartphone and Laptop; SM+OP+OM = Smartphone, Laptop and Computer; TA = Tablet; TA+OP = Tablet and Laptop TA+SM = Tablet and Computer; TA+SM+OP = Tablet, Smartphone and Laptop; and TA+SM+OP+OM = Tablet, Smartphone, Laptop and Computer.

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more in agreement with it were those who possessed a Tablet, Smartphone and laptop computer, although the post hoc tests did not provide significance for the comparisons.

The students who only had a Smartphone were more in agreement with the idea that AR can be employed by gifted individuals, F (10.198) = 2.625, p = 0.005, η2 = 0.118, as compared to those who only had a laptop computer, t (198) = 3.436, p = 0.040. The same was observed with those who possessed a Smartphone and laptop computer as compared to those who only had a laptop, t(198) = 4.558, p < 0.001. Likewise for those who had a Smartphone, laptop computer and desktop computer as compared to those only had a laptop computer, t (198) = 4.177, p = 0.002. Those who have a Tablet, Smartphone and laptop computer were also more in agreement with this statement as compared to those who only possessed a laptop computer, t (198) = 3.396, p = 0.045; Likewise for those who have all the devices as compared to those who have a laptop computer, t(198) = 3.385, p = 0.048, with the rest of the combinations not showing relevant results.

The students who had a desktop computer were more in agreement with the idea that AR could be employed for preventing situations of school bullying, F (10.198) = 2.196, p = 0.020, η2 = 0.100, as compared to those who have a Smartphone, laptop computer and desktop computer, t (198) = 3.784, p = 0.011, although significant Bonferroni data were not found for the rest of the comparisons.

Lastly, for the results to the premise "augmented reality complements the curricular content explained in class", F (10.198) = 2.961, p = 0.002, η2 = 0.131, the students who have a Smartphone and a laptop computer pointed out to being more in agreement as compared to those who have a desktop computer, t(198) = 4.155, p = 0.003, with the same being observed for those who have a Smartphone, laptop computer and desktop computer as compared to those who only have a desktop computer (198) = 3.964, p = 0.006; those who have a Tablet, Smartphone and laptop computer compared with those who only have a desktop computer t (198) = 4.332, p = 0.001; and those who have all the devices as compared to those who only have a desktop computer, t (198) = 3.655, p = 0.018, with no significant data found for the rest of the comparisons.

5. Discussion and conclusions

As previously indicated in the introduction section of the present article, AR is timidly being incorporated into the classroom methodologies at every educational level, allowing the students to experience the real world aside from facilitating their social interaction (Barroso & Gallego, 2017; Chen et al., 2015). However, this is not done equally, as the economic aspects of the centers, as well as the training of the teachers, beliefs and evaluations on this technology make this a crucial moment in time for today's teaching activities (Tzima et al., 2019).

In this study, it has been verified how the gender variable provokes significant differences in the ideas or premises analyzed about AR. More specifically, the women believed that in the development of the pre-school-primary school stage, it promotes creativity, facilitates the real learning of the contents, thus emphasizing teaching through free discovery, promotes the transversal teaching of the content, facilitates the comprehension of the curricular content, and complements the content explained in class, and it allows collaborative work (Chen et al., 2016; Cózar-Gutiérrez et al., 2015; Fidan & Tuncel, 2019; Author; Martín-Gutiérrez et al., 2015; Tzima et al., 2019; Zak, 2014). On the other hand, the students point that it also allows inclusive education to advance (Lee et al., 2018; Author, Author). Also, they believe that it can be utilized with and by gifted individuals, it can promote intercultural teaching and re-enforces multicultural learning (Cózar-Gutiérrez et al., 2015; Lin et al., 2010); although they also point out that computer skills are needed in order to use it. As for the men, they disagree that the use of augmented reality makes difficult the acquisition of contents (Cózar-Gutiérrez et al., 2015).

It was also found that the variable age favors the existence of relevant inequalities in the propositions set forth about AR. More specifically, the teachers-in-training who were aged 19–21 thought that it can promote creativity, those who are in the 22–24 age group state that it allows collaborative work, aside from promoting teaching through free discovery, and at the same time also believe that it could be utilized by individuals with psychological difficulties and that it could complement the curricular contents explained in class (ChanLin et al., 2019; Chen et al., 2016; Cózar-Gutiérrez et al., 2015; Lin et al., 2010; Author; Martínez, 2020; Martín-Gutiérrez et al., 2015; Zak, 2014). And those who are older than 24 believe that AR could promote the transversal teaching of the contents.

The education prior to accessing the University Degree showed significant differences, as those who were enrolled in an Advanced Vocational Degree Program thought that it promotes learning through free discovery; promote the transversal teaching of contents; promotes the digital divide and facilitates communication between the students and teachers (Carmigniani et al., 2011; Chen et al., 2016; Cózar-Gutiérrez et al., 2015; Fidan & Tuncel, 2019; Martín-Gutiérrez et al., 2015; Villalustre, 2020; Zak, 2014).

The possession of a number of devices also resulted in significant differences; more specifically: the more portable devices possessed, the more in agreement that AR promotes creativity and facilitates the real learning of the contents (Vazquez-Cano et al., 2020); the greater the availability of devices is, the more in agreement that it favors teaching through free discovery, and when the portable devices alternate with a desktop computer, the more they are in agreement that AR could be utilized by gifted individuals.

Those who only have a desktop computer are more in agreement that AR could be utilized to prevent situations of school bullying. The more portable devices possessed, the more in agreement in that AR complements the curricular contents explained in class (ChanLin et al., 2019; Garzón et al., 2020).

This study contributes to society, since it shows that future teachers see benefits and advantages in the incorporation of AR in the teaching and learning process. The study implies that the use of this emerging technology is considered as a didactic resource that brings together various elements of its own to develop abilities and skills in the primary stage. However, more research based on experimentation is required, as pointed out by Bacca et al. (2014).

Ultimately, AR is defined as a tool that in the judgment of the teachers-in-training consulted, could be valuable and relevant for the development of the curricula as well as inclusive education (Lee et al., 2018).

6. Limitations of the study

In future research studies it would be desirable to broaden the sample size in order for the results to be more generalized. On the other hand, it would also be interesting to conduct studies with other educational stages such as Infant education and High School to observe if their contents, as well as the characteristics of the students, could allow reaching the objectives set in the official curriculum.

7. Statements on open data, ethics and conflicts of interest

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

The reported research has been conducted within the ethical regulations in place at the hosting institution of both the researchers, professors and students.

The authors declare no conflicts of interest in the development of this work.

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