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Verónica Marín-Díaz
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THE RELATIONSHIPS BETWEEN *AUGMENTED REALITY* AND INCLUSIVE EDUCATION IN HIGHER EDUCATION

Relaciones entre la realidad aumentada *y la educación inclusiva en la educación superior*

VERÓNICA MARÍN-DÍAZ
Universidad de Córdoba

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Autora de contacto / Corresponding Author: Verónica Marín Díaz. E-mail: vmarin@uco.es

INTRODUCTION. *Augmented reality* is little by little becoming incorporated in the area of inclusive education as an emergent technology that fosters learning through discovery and experience by all in equal terms. **METHODS.** The study used a quasi-experimental design and a small sample of N=41 students enrolled in the Inclusive Education Master's program, who were provided with an ad hoc-designed questionnaire —composed of 31 items and with a Likert-type response scale with 5 options—. The student's opinions were used to answer if *augmented reality* could be used in the area of inclusive education. For this, an initial evaluation of their opinion on the subject matter was conducted —pre-test—, and afterwards an intervention was conducted in which they were exposed to the content and a variety of tasks linked to the subject matter. Once finished, they were provided with the questionnaire once again, for the post-test. **RESULTS.** The results achieved after the descriptive and inferential studies showed that *augmented reality* could be used to foster group and collaborative work in inclusive environments, and it can possibly be used with subjects who have diverse disabilities, as well as within inter and multicultural spheres. **DISCUSSION.** *Augmented reality* has possibilities for being used in inclusive education in general, and specifically for the development of the school curriculum. It might not be able to be used with subjects that have visual disabilities, and likewise it might not be able to be used to prevent cases of bullying at school, but it can emphasize the digital divide of the individuals.

Keywords: *Inclusive education, Education technology, Student opinion, Use of computers in education.*

Introduction

It is generally accepted that advances in technology in general, and of the Internet in particular, in the area of education, have come from the needs that the users have been demanding from society. However, in some key moments these have evolved and grown faster than their inclusion to the academic sphere, so that progress has not been equal in both cases. The Horizon 2012 report that linked both elements (Durall, Gros, Maina, Johnson and Adams, 2012) determined that some emergent technologies were going to set the future of the school curriculum. Within these technologies, *augmented reality* (AR) has become a creator of new ways of communicating content, as the combination it makes of text, images, videos, 3D models, etc., create a perspective of the contents that traditional textbooks cannot transmit. Authors such as Yilmaz (2016) believe that its main objective is to bring the reality of what the students are learning in the classroom closer to them, in order to improve academic performance (Fombona, Pascual and Madeira, 2012). The main advantages of its use in education, as discussed in the literature, are the immediacy and interactivity of the students with the content, as it supports the teacher's presentations (Leiva and Moreno, 2015).

On the other hand, the social and digital divide that can be created by this tool makes it so that teachers and researchers question its usefulness within the area of inclusive education (Forero, Alemán and Gómez, 2016). However, if we understand that inclusive education encompasses not "only the curricular and pedagogic aspects, but also the social and physical environment ones" (Gento, 2007: 582), then we are in agreement with Villaverde and Lezcano (2012: 11) in that inclusive education will focus on "learning, socialization and participation". Thus, the use of AR—as interactive material—, can be a valid instrument, as argued by Lin and Chao (2010) and Fombona *et al.* (2012), who underscore its viability for working with students who have special educational needs, as well as those who find themselves in socially-unstructured environments.

Also, if we consider that teaching that is supported by AR favours active learning (Cabero and Barroso, 2016), we should ask ourselves if those who will be responsible for the teaching work believe this to be true or not. Therefore, this research study asks the Inclusive Education Master's students if AR has a place in inclusive education.

Methods

The method used was descriptive and cause-and-effect type, with its design being specifically quasi-experimental. By taking into account the classification by Mateo (2012), the starting objective was defined, which was to determine if *augmented reality* could be used in the area of Inclusive Education. The hypotheses proponed from the objective mentioned above were:

1. *Augmented reality* can improve inclusive curricular development.
2. *Augmented reality* can be used in intercultural and multicultural contexts.
3. *Augmented reality can be used with* subjects who have different disabilities.
4. *Augmented reality* can foster the development of the digital divide.
5. *Augmented reality* can help prevent school bullying in inclusive environments.
6. Men have a positive view as compared to women towards the use of *augmented reality* as a tool for the development of inclusive education.

The study has a quasi-experimental character, according to the classification by Mateo (2012), and aims to evaluate the concept of *augmented reality* associated to inclusive education. The intervention was divided into three sessions. In the first session the measurement instrument (questionnaire) was administered to the students

enrolled in the Inclusive Education Masters at the University of Cordoba, without a theoretical explanation of the subject matter. Later in the same session, what *augmented reality* consisted of, its links to education in general, and to inclusion in particular were explained to them, and three different projects that were currently being conducted at the national level were presented, such as the Proyecto Azahara[1] and the *Pictograma Room*[2]. The students were then introduced to the game *Estarteco* (www.estarteco.com), based on AR, and two applications that allowed downloading markers to directly work with the students, which in this case were *Quiver* and *Chromville*. In the third session, the designed interventions were presented and the questionnaire was again administered.

Instrument for data gathering

The survey technique was employed for the gathering of data, and within it, the design of an online format questionnaire was opted for. This was constructed ad hoc, and was composed of a total 32 items in the end, where the first 4 corresponded to identification or dependent variables (sex, age, the higher education degree used to access the Master's program and the digital devices owned —Tablet, portable computer, Smartphone, desktop computer—), with the other 28 used to answer the starting hypothesis. The response scale of the first set was nominal, and for the second set a Likert scale was used, where 1 indicated complete disagreement, and 5 indicated complete agreement.

To determine the instrument's reliability, a Cronbach's Alpha test was applied. For the entire questionnaire, the reliability obtained was 0.778, which according to Mateo (2012) can be considered high. When this test was applied to each of the items individually, it oscillated between 0.729 and 0.889, as shown in table 1. The high reliability or consistency of the instrument was thus confirmed.

Table 1. Cronbach's Alpha

	Alpha
Item 1. Augmented reality enables the development of education	.739
Item 2. Augmented reality enables the development of inclusive education	.729
Item 3. Augmented reality fosters creativity	.745
Item 4. Augmented reality enables collaborative work	.789
Item 5. Augmented reality enables cooperative work	.762
Item 6. Augmented reality enables group work	.745
Item 7. Augmented reality facilitates real learning of the content	.750
Item 8. Augmented reality fosters teaching through experimentation	.740
Item 9. Augmented reality fosters teaching through free discovery	.744
Item 10. Augmented reality can be used by persons with visual impairments	.744
Item 11. Augmented reality can be used by persons with motor difficulties	.740
Item 12. Augmented reality can be used by persons with psychological difficulties	.729
Item 13. Augmented reality can be used by persons with hearing difficulties	.734
Item 14. Augmented reality can foster the transversal teaching of content	.737

Table 1. Cronbach's Alpha (cont.)

	Alpha
Item 15. Augmented reality fosters intercultural learning	.730
Item 16. Augmented reality facilitates the comprehension of curricular content	.749
Item 17. Augmented reality complements the curricular content explained in class	.743
Item 18. Augmented reality needs great technological support for its use in the classroom	.787
Item 19. Augmented reality facilitates communication between students and teachers	.736
Item 20. Augmented reality facilitates communication between students	.729
Item 21. To use Augmented reality ty, computer skills are needed	.780
Item 22. Augmented reality is easy to use for the students	.772
Item 23. The use of Augmented reality makes difficult the acquisition of content	.783
Item 24. Learning how to use Augmented reality takes a long time	.788
Item 25. Augmented reality can be used by persons with high abilities	.729
Item 26. Augmented reality fosters multicultural learning	.745
Item 27. Augmented reality fosters the digital divide	.757
Item 28. Augmented reality can be used to prevent situations of bullying at school	.748

Taking into account the validity of the construct, we took into consideration Hernández, Fernández and Baptista (2006), who considered the validity of the construct to be more important than the content's, as it indicates if the instrument represents and measures the theoretical concepts found within it. This requisite was approached through the use of a factorial analysis. But previous to this analysis, a Barlett's sphericity test (approximate Chi-square 7711.8061 and significance values 0.000) was applied, and the Kaiser-Meyer-Olkin index was calculated as well (KMO=0.529).

In reference to the factor analysis, the principal elements were extracted, taking into account the ones that had a self-value greater than 1, considering a Varimax rotation with Kaiser normalization method. The result of the extraction of principal components showed that there were six factors where the total variance explained was 80.9%, which revealed an optimum equilibrium between all the components of the instrument that were representative of the theoretical concept. Then, we verified if the Cronbach's Alpha test would give internal consistency to the items, and the results showed that this was indeed the case. For factor 1, Alpha obtained a value of .788, for the second it was .766, for the third, .745, for the fourth, .772, and for the fifth and sixth, .732 and .756, respectively.

Table 2. Factorial Analysis

	1	2	3	4	5	6
Item 26	.822					
Item 14	.802					
Item 27	.798					
Item 15	.775					
Item 19	.631					
Item 20	.620					
Item 16	.505					

Table 2. Factorial Analysis (cont.)

	1	2	3	4	5	6
Item 11		.860				
Item 12		.761				
Item 13		.723				
Item 10		.668				
Item 25		.588				
Item 28		.569				
Item 6			.963			
Item 4			.851			
Item 5			.834			
Item 2			.483			
Item 23				.891		
Item 22				.615		
Item 24				.615		
Item 3				.542		
Item 9				.514		
Item 18					.874	
Item 21					.833	
Item 7						.797
Item 8						.721
Item 1						.607
Item 17						.678

Population-sample

The starting population were the students who applied for admission to the Master's degree in Inclusive Education that the University of Cordoba offered, with the total sample being the students that were finally admitted to the program (N=41), with a distribution of 87.8% women and 12.2% men. Addressing the data contributed by Gialamas, Nikiolopoulu and Koutromanos (2013), it can be verified that there was no bias in the sample selection, as traditionally, there tends to be more women in the Social and Judicial Science fields of study.

The age results show that the sample was distributed as shown in figure 1, with most of the students aged 22 (19.5%), 23 (12.2%) and 24 (9.8%), respectively.

The results on the degrees used to access the Master's degree showed that 41.9% had a Primary Education Certificate or the now-obsolete Diploma in Primary Education —with respect to this modality of access, 9.8% had the specialization or mention of Special Education, 2.4% had Physical Education and 2.9 had Musical Education—, 43.9% had an Infant Education Certificate or the now-obsolete

Figure 1. Sample distribution according to gender

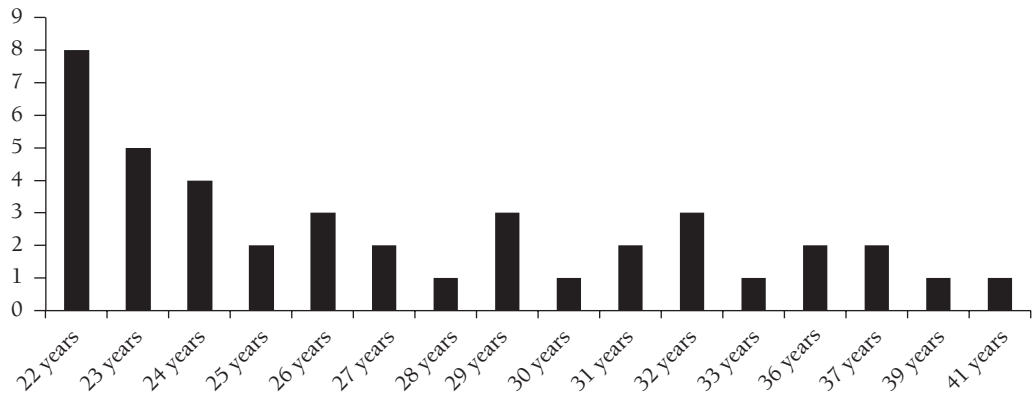
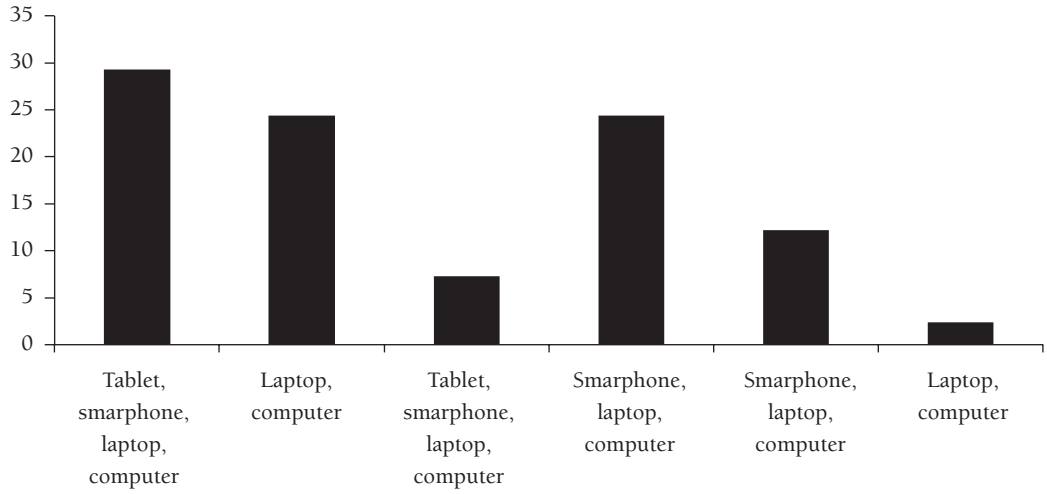


Figure 2. Technological devices owned by the students in the sample



Diploma in Infant Education, 9.8% had a Bachelor's Degree in Psychopedagogy, and 2.4% accessed the Master's through other university degrees.

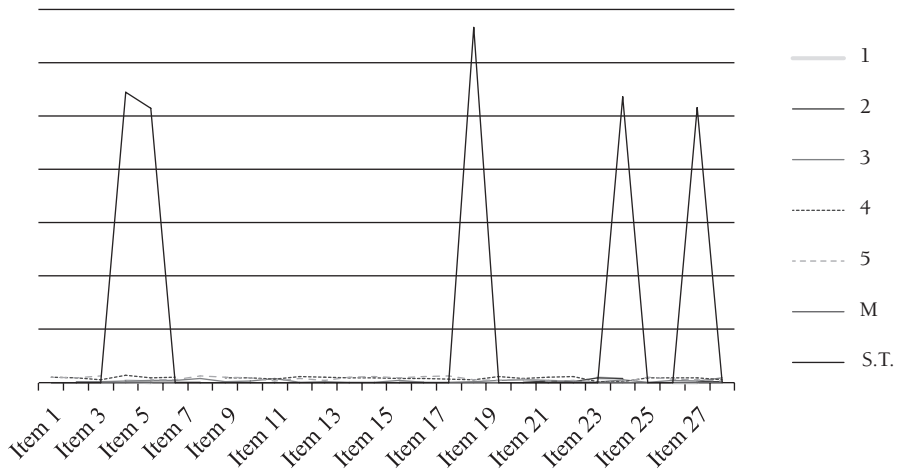
As for the digital devices that the students owned (see figure 2), we verified that a large percentage had many of them: 29.3% had a tablet, smartphone, portable and desktop computers, as compared to 2.4% who only had a portable computer.

Results

Pre-test study

As we can observe in figure 3, the students who participated in the study were in agreement in most of the items that comprised the instrument. Nevertheless, items 3 (*augmented reality* fosters creativity) and 4 (*augmented reality* enables collaborative work), are interesting, as the students were in total agreement with them

Figure 3. Pre-test descriptive study



even when at the time the questionnaire was given, their knowledge on *augmented reality* was null or scarce. On the other hand, they were indifferent on the items that referred to the possibility of using AR with those who were visually impaired (item 10), the time needed to learn how to use it (item 24) and that it can be used to prevent bullying situations (item 28).

Their disagreement with item 23 (the use of *augmented reality* makes difficult the acquisition of content) was notable, leading us to infer that even without having notions on the tool they sensed that it could be a resource to keep in mind for the classroom.

As the statistics used were sensitive to the sample size, Cohen's d was calculated (Cohen, 1977; Wolf, 1986). Its interpretation suggested that values of .2, .5 and .8 represented effect sizes small, medium and large, respectively. However, the interpretation of the effect size could depend on the specific area of study, as in the education area .25 could be considered significant (Fritz, Morris and Richler, 2012).

The result of Student's t-test for independent values (n.s =0.05) applied to gender, showed that in some items there were statistically-significant differences (see table 3). In the case of women, these were more in favour of using AR in items 2, 6, 7, 10, 11, 12, 13, 21, 23, 25 and 27. In general, the women believed that this tool enabled the development of inclusive education, group work and facilitates real learning of the content. It was also interesting to note that they believed that subjects that had some kind of disability, in general, could use AR for their learning goals. It was also significant that they believed that the use of AR could make difficult the acquisition of content, and could foster a digital divide and the need for computer skills. As for the men, they were clearly in favour of the items related to collaborative as well as cooperative work, the possibility that AR brings to teaching through experimentation, the development of interculturalism and multiculturalism in the classrooms, the need for a great technological support in the classrooms, and that AR can increase communication between the teacher and the students, taking into account that they believed that AR is easy to use for the students.

Table 3. Pre-test Student's t-test

		N	Media	D.T.	t & p	Cohen's d
Item 1	Men	5	4.40	.548	t=1.420; p=0.468	0.41
	Women	36	4.19	.525		
Item 2	Men	5	4.00	.000	t=-1.167; p=0.024	0.12
	Women	36	3.94	.924		
Item 3	Men	5	4.80	.447	t=-0.850; p=0.396	0.67
	Women	36	4.42	.649		
Item 4	Men	5	3.80	.447	t=2.407; p=0.001	0.49
	Women	36	3.50	.878		
Item 5	Men	5	4.00	.000	t=2.666; p=0.009	0.21
	Women	35	3.83	.822		
Item 6	Men	5	4.00	.000	t=4.718; p=0.000	0.22
	Women	36	4.03	.696		

Table 3. Pre-test Student's t-test (cont.)

		N	Media	D.T.	t & p	Cohen's d
Item 7	Men	5	4.00	.707	t=2.953; p=0.003	-0.35
	Women	36	4.28	.701		
Item 8	Men	5	4.20	.447	t=5.154; p=0.000	0.09
	Women	36	4.14	.723		
Item 9	Men	5	4.20	.447	t=3.464; p=0.001	0.21
	Women	35	4.06	.765		
Item 10	Men	5	3.00	.000	t=2.951; p=0.003	-0.35
	Women	36	3.25	.732		
Item 11	Men	5	3.60	.548	t=2.508; p=0.013	-0.80
	Women	35	4.17	.568		
Item 12	Men	5	3.60	.894	t=2.350; p=0.027	-0.74
	Women	36	4.14	.639		
Item 13	Men	5	4.20	.447	t=3.265; p=0.000	-0.07
	Women	35	4.26	.561		
Item 14	Men	5	4.60	.548	t=2.374; p=0.097	0.29
	Women	36	4.36	.683		
Item 15	Men	5	4.20	.447	t=3.650; p=0.000	0.09
	Women	36	4.14	.867		
Item 16	Men	5	4.40	.548	t=2.923; p=0.056	0.024
	Women	36	4.25	.649		
Item 17	Men	5	4.80	.447	t=1.881; p=0.661	0.89
	Women	35	4.34	.539		
Item 18	Men	5	3.80	1.095	t=3.325; p=0.001	0.00
	Women	36	3.67	1.171		
Item 19	Men	5	4.20	.837	t=3.508; p=0.001	0.62
	Women	36	3.75	.732		
Item 20	Men	5	4.20	.837	t=2.089; p=0.039	0.51
	Women	36	3.83	.775		
Item 21	Men	5	3.60	.894	t=2.666; p=0.008	-0.40
	Women	36	3.89	.854		
Item 22	Men	5	4.00	.707	t=3.126; p=0.002	0.64
	Women	36	3.53	.774		
Item 23	Men	5	1.60	.894	t=3.310; p=0.001	-0.46
	Women	36	1.94	.826		
Item 24	Men	5	3.00	1.000	t=3.494; p=0.001	0.42
	Women	36	2.69	.951		

Table 3. Pre-test Student's t-test (cont.)

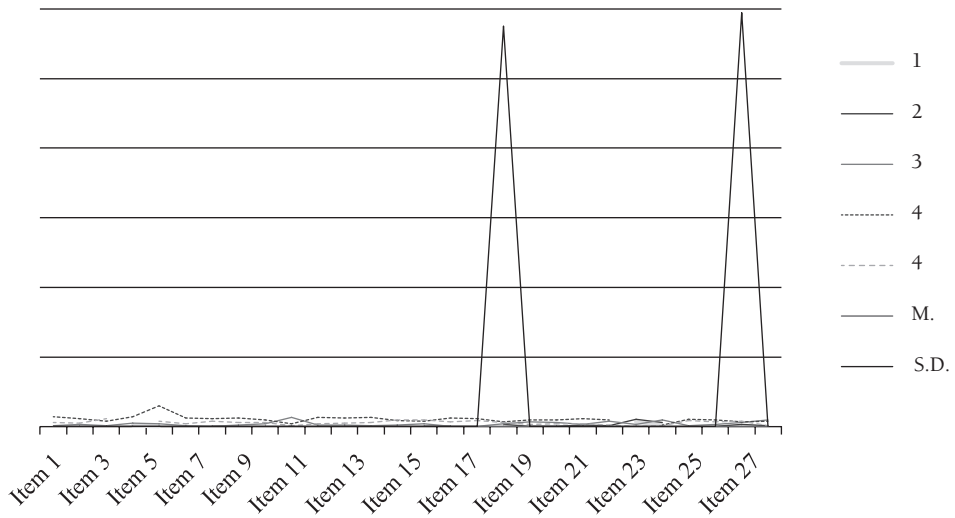
		N	Media	D.T.	t & p	Cohen's d
Item 25	Men	5	4.20	.447	t=3.354; p=0.001	-0.38
	Women	36	4.42	.604		
Item 26	Men	5	4.20	.447	t=2.710; p=0.008	0.12
	Women	36	4.11	.820		
Item 27	Men	5	3.20	1.483	t=1.067; p=0.040	-0.09
	Women	36	3.31	1.167		
Item 28	Men	5	3.40	.548	t=2.906; p=0.058	-1.42.
	Women	36	3.44	.773		

An ANOVA test was the conducted, and the results showed that there were no significant differences as for the degree used to access the Master's degree.

Post-test study

Once the intervention with the Master's students was completed, the questionnaire was once again given. As we can observe in figure 4, the student's perceptions were similar to the ones before the didactic session, although there was a greater change in answer 5 (Completely agree). However, we found nuances in their indifferences in item 10 (*augmented reality* can be employed by persons with visual impairment), although its weigh was reduced to half, changing from a total of 36.6% of those who manifested this indifference in the post-test as compared to 68.9% that were found in the pre-test.

Figure 4. Post-test descriptive study



Item 18 —related to the need of great technological support in the classroom—, had the same results in the positioning of agreement and disagreement, with it being 29.3%, respectively.

In item 23 (the use of *augmented reality* makes difficult the acquisition of content), we found that the students maintained their positon of complete disagreement (43% *vs.* 31.7% in the pre-test) and disagreement (41.5% *vs.* 51.2% in the pre-test), although its complete refusal is emphasized, which increased considerably.

Once the non-parametric Student's t-test was applied after the intervention, we found that in most of the items there were no differences according to gender, although we did find that in items 2, 7, 10 and 25 the differences were found to be in favour of women, and in items 3, 15, 16, 17, 19 and 20, there were differences in favour of the men.

Table 4. Post-test student's t-test

		N	Media	S. D.	t & p	Cohen's d
Item 1	Men	5	4.42	.669	t=1.301; p=0.078	0.11
	Women	36	4.36	.552		
Item 2	Men	5	4.42	.515	t=1.699; p=0.003	-0.07
	Women	36	4.49	.996		
Item 3	Men	5	4.92	.289	t=2.239; p=0.000	0.72
	Women	36	4.50	.628		
Item 4	Men	5	3.17	1.337	t=-1.214; p=0.078	-0.40
	Women	36	3.55	.921		
Item 5	Men	5	3.75	1.357	t=0.319; p=0.003	-0.10
	Women	35	3.84	.834		
Item 6	Men	5	4.08	.669	t=0.463; p=0.017	0.15
	Women	36	3.98	.688		
Item 7	Men	5	4.42	.669	t=1.165; p=0.004	-0.09
	Women	36	4.48	.721		
Item 8	Men	5	4.42	.669	t=1.970; p=0.008	0.29
	Women	36	4.21	.744		
Item 9	Men	5	4.33	.651	t=.773; p=0.081	0.24
	Women	35	4.16	.727		
Item 10	Men	5	3.08	.289	t=-1.254; p=0.000	-0.39
	Women	36	3.41	.899		
Item 11	Men	5	4.00	.739	t=-1.495; p=0.004	-0.49
	Women	35	4.28	.559		
Item 12	Men	5	4.00	.853	t=-1.205; p=0.005	-0.40
	Women	36	4.26	.637		

Table 4. Post-test student's t-test (cont.)

		N	Media	S. D.	t & p	Cohen's d
Item 13	Men	5	4.50	.522	t=1.086; p=0.004	-0.19
	Women	35	4.60	.597		
Item 14	Men	5	4.50	.674	t= .178; p=0.009	0.05
	Women	36	4.47	.599		
Item 15	Men	5	4.17	.718	t= .265; p=0.004	0.08
	Women	36	4.09	.996		
Item 16	Men	5	4.50	.674	t=.887; p=0.000	0.28
	Women	36	4.26	.890		
Item 17	Men	5	4.92	.289	t=3.001; p=0.000	0.97
	Women	35	4.41	.563		
Item 18	Men	5	3.25	1.357	t=-1.269; p=0.006	-0.36
	Women	36	3.74	1.193		
Item 19	Men	5	4.33	.778	t=1.607;; p=0.002	0.52
	Women	36	3.93	.792		
Item 20	Men	5	4.42	.793	t=2.080; p=0.001	0.68
	Women	36	3.90	.788		
Item 21	Men	5	3.42	.793	t=-1.767; p=0.002	0.01
	Women	36	3.91	.904		
Item 22	Men	5	4.17	.718	t=1.904; p=0.001	0.61
	Women	36	3.66	.870		
Item 23	Men	5	1.83	1.030	t= .210; p=0.007	0.00
	Women	36	1.83	.841		
Item 24	Men	5	2.50	1.168	t=-.315; p=0.027	-0.10
	Women	36	2.60	1.008		
Item 25	Men	5	4.25	.622	t=-1.406; p=0.004	-0.46
	Women	36	4.51	.571		
Item 26	Men	5	4.17	.718	t=1.592; p=0.070	0.19
	Women	36	4.00	.918		
Item 27	Men	5	4.08	1.240	t=1.161; p=0.034	0.37
	Women	36	3.66	1.148		
Item 28	Men	5	3.42	.900	t=-0.255; p=0.078	-0.08
	Women	36	3.48	.800		

After the application of the ANOVA test, just as with the pre-test, no significant differences were found in the degree used for admission into the Master's program.

Comparison between the pre-test and post-test studies

In order to determine if there were changes in the student's opinion once the activities with *augmented reality* were completed, a Student's t-test was conducted with the pre-test and post-test administered. As shown in table 5, there were statistically-significant differences in many items from the questionnaire. It was interesting to note that the students continued having the same attitude towards the items that referred to the possibility of using AR as a tool for cooperative and group work (items 5 and 6), fosters learning through experimentation (item 8), facilitates communication between the student and the teacher (item 20), it's easy to use for the students (item 22), and fosters the digital divide (item 27), while in the rest of them, there was a change in their perception of AR, in the items related to its use in inclusive education.

It was also noted that there were no significant differences in the items referring to inclusive education (item 2), teaching through free discovery (item 9), its use with by persons with hearing difficulties (item 13), transversal learning of content (item 14), the difficulty of acquisition of content (item 23) and the time it takes to learn how to use the tool (item 24), so that we understood that the results presented in the post-test were maintained.

Table 5. Student's t-test of pre-test-post-test comparison

		N	Media	D.T.	t & p	Cohen's d
Item 1	Pretest	5	4.22	.530	t=1.639; p=0.001	-0.54
	Postest	36	4.49	.506		
Item 2	Pretest	5	4.00	.816	t=.464; p=1.071	-0.47
	Postest	36	4.34	.728		
Item 3	Pretest	5	4.50	.599	t=4.583; p=0.000	-0.10
	Postest	36	4.56	.634		
Item 4	Pretest	5	3.53	.847	t=-.805; p=0.004	-0.04
	Postest	36	3.37	1.090		
Item 5	Pretest	5	3.85	.779	t=0.428; p=0.004	0.05
	Postest	35	3.80	1.030		
Item 6	Pretest	5	4.10	.660	t=1.087; p=0.003	0.07
	Postest	36	4.05	.773		
Item 7	Pretest	5	4.55	.707	t=1.195; p=0.005	-0.02
	Postest	36	4.56	.634		
Item 8	Pretest	5	4.45	.700	t=1.153; p=0.003	0.02
	Postest	36	4.44	.634		
Item 9	Pretest	5	4.38	.739	t=1.187; p=0.043	0.09
	Postest	35	4.32	.687		
Item 10	Pretest	5	3.23	.698	t=-1.189; p=0.002	-0.32
	Postest	36	3.51	.914		
Item 11	Pretest	5	4.10	.598	t=-1.150; p=0.005	-0.51
	Postest	35	4.37	.536		

Table 5. Student's t-test of pre-test-post-test comparison (cont.)

		N	Media	D.T.	t & p	Cohen's d
Item 12	Pretest	5	4.08	.694	t=.856; p=0.002	-0.47
	Postest	36	4.37	.623		
Item 13	Pretest	5	4.56	.549	t=.692; p=0.502	0.21
	Postest	35	4.44	.594		
Item 14	Pretest	5	4.43	.636	t=.381; p=0.054	-0.15
	Postest	36	4.51	.553		
Item 15	Pretest	5	4.18	.813	t= .403; p=0.003	-0.10
	Postest	36	4.27	.834		
Item 16	Pretest	5	4.68	.640	t=.589; p=0.000	-0.02
	Postest	36	4.69	.675		
Item 17	Pretest	5	4.95	.549	t=4.084; p=0.000	0.66
	Postest	35	4.60	.545		
Item 18	Pretest	5	3.65	1.145	t=-1.372; p=0.005	-0.02
	Postest	36	3.76	1.334		
Item 19	Pretest	5	3.83	.747	t=1.691; p=0.005	-0.27
	Postest	36	4.00	.671		
Item 20	Pretest	5	4.90	.778	t=2.310; p=0.005	1.07
	Postest	36	4.02	.851		
Item 21	Pretest	5	3.85	.864	t=1.370; p=0.003	-0.15
	Postest	36	3.98	.879		
Item 22	Pretest	5	4.60	.778	t=1.654; p=0.004	0.84
	Postest	36	3.93	.818		
Item 23	Pretest	5	1.90	.841	t= .424; p=0.009	0.07
	Postest	36	1.83	.998		
Item 24	Pretest	5	2.73	.960	t=-1.375; p=0.023	0.31
	Postest	36	2.41	1.072		
Item 25	Pretest	5	4.40	.591	t=-2.215; p=0.005	-0.26
	Postest	36	4.55	.597		
Item 26	Pretest	5	4.15	.770	t=1.497; p=0.004	-0.08
	Postest	36	4.22	.880		
Item 27	Pretest	5	4.33	1.185	t=2.263; p=0.009	0.42
	Postest	36	3.90	1.033		
Item 28	Pretest	5	3.45	.749	t=-0.167; p=0.088	-0.10
	Postest	36	3.54	.897		

The differences found after the application of the Student's t-test and ANOVAs were contrasted with the results from the measurement of the effect size, which in this case was Cohen's d. A d value of .20 or higher indicated a small effect, a value starting from .50 was a moderate effect, and a value of .80 or higher pointed to a large effect (Cohen, 1977).

Discussion and conclusions

Augmented Reality has started to timidly be introduced in the educational sphere as shown by the view of the students in this research work (Chen and Tsai, 2012; Cozar *et al*., 2015; Wei, Weng, Liu and Wang 2015; Seo, Kim and Kim, 2006). When used in the training sphere (hypothesis 1) it drives and motivates creativity in the students, as they can experience the content they are learning in the first person, meaning that the link between theory and experimentation becomes evident (Chen and Tsai, 2012; Wei *et al.,* 2015). If we focus on the main objective of this study, which was none other than determining if AR can be used in the area of inclusive education (Lin and Chao; Fombona *et al.,* 2012), we verified that students enrolled in the Master's degree in Inclusive Education agree that it can, just as in the works by Chen, Lee and Lin (2016), which reflected on the possibility of using it with autistic children, or the work by McMahon, Cihak, David and Wright (2015), who presented their advances also with autistic children as well as those who had intellectual disability, or the work by Lin and Chang (2015), as well as interculturalism and multiculturalism, visual, motor, psychological, hearing disabilities or those who have high abilities (hypothesis 2 and 3) (Seo *et al.,* 2006; Cozar *et al.,* 2015; Wojciechowski and Cellary, 2013). Nonetheless, just as in the work by Chiang, Yang and Hwang (2014), we found that the variety of devices, as well as images and their quality or lack of, make it so that AR cannot be a tool to be used with those who are visually impaired. We verified then, that there is positive position. Elements such as real learning of the content, as pointed out by Sommerauer and Müller (2014) or learning through experimentation and free discovery, are elements that AR can foster (Yilmaz, 2016; Coimbra, Cardosa and Mateus 2015; Wei *et al.,* 2015), as well as the possibility of working the contents transversally (Solak and Cakir, 2015) and their acquisition, reusing that it could make difficult their acquisition. Thus, the students indicate, just as Durall *et al.* (2012), Joen (2015) and Cozar *et al.* (2015), that AR enables the completion of the curricular content as well as their explanation in the classroom. On the other hand, aspects such as enabling collaborative, cooperative and group work is possible, according to the participating student's thoughts, and as indicated by Martín-Gutiérrez, Fabiani, Benesova, Meneses and Mora (2015), Estepa and Nadolny (2015) and Solak and Cakir (2015). Also, creativity, a necessary element for learning, can be driven by AR, just as the participating students believed, sharing their thoughts with data from Zhou, Cheok and Pan (2004) and from Yuen, Yaoyuneyong and Johnson (2011).

On the other hand, AR also affects communication between the teacher and the learner. The students consulted believed that it can facilitate the teacher-student and student-student relationships (Chen *et al.,* 2015). As for the students, they also indicated that it could an easy element for them to use but it would be necessary to have basic computer skills (Cabero and Barroso, 2016, Cubillo, Martín, Cantro and Colmenar, 2014). Also, the time is takes to master, as pointed by Reinosa (2012), is a challenge, which implies a constant updating of their training and large technological support, as pointed by those participating in the study.

As for hypotheses 4 and 5 (augmented reality *can foster the development of the digital divide and* augmented reality *can help prevent school bullying in inclusive environments*), the participants believed that it did drive the digital divide,

however, there was no assurance that it could prevent situations of bullying at school.

As for the results of hypothesis 6 (*Men have a positive view as compared to women towards the use of* augmented reality *as a tool for the development of inclusive education*), we have confirmed that there were no significant differences between men and women, either before or after the intervention.

Limitations of the study

As Gómez (2015) indicates, the addition of the Information and Communication Technologies (ICT) in education centres and in education in general, implies that the centres cannot remain on the fringe of the digital reality that surrounds it. However, the main limitation that we find when linking educational reality with social reality, are the study spaces within the Social Sciences that comply with the standards needed for traditional research, and this is where the main limitation comes from. We are conscious that the sample should be broader in order to be able to make better generalizations, although this is one of the strengths of the study, as it sets the basis on which a larger study can be begun, a study within a little-researched space such as AR and inclusive education.

Notes

[1] http://www.proyectoazahar.org/azahar/ChangeLocale.do?language=es&country=ES&page=/loggined.do

[2] http://www.pictogramas.org/proom/loggined.do

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Resumen

Relaciones entre la* realidad aumentada *y la educación inclusiva en la educación superior

INTRODUCCIÓN. La *realidad aumentada* poco a poco se está incorporando al ámbito de la educación inclusiva como una tecnología emergente que propicia el aprendizaje por descubrimiento y experimentación de todos en igualdad. MÉTODO. A través de un diseño cuasiexperimental y empleando un muestreo incidental de N=41 sujetos que cursan el Máster en Educación Inclusiva de la Universidad de Córdoba, a los cuales se les administró un cuestionario diseñado *ad hoc* —compuesto por 31 ítems y con una escala Likert de respuesta de 5 opciones—, se recogió la opinión con el fin de dar respuesta al objetivo de determinar si la *realidad aumentada* se puede emplear en el ámbito de la educación inclusiva. Para ello se realizó inicialmente una valoración de las opiniones sobre la temática —pre-test—, posteriormente se llevó a cabo una intervención en la que se expuso el contenido, así como la realización de una batería de actividades vinculadas a la temática y posteriormente se volvió a administrar el instrumento, post-test. RESULTADOS. Los resultados alcanzados tras realizar el estudio descriptivo así como inferencial ponen de manifiesto que la *realidad aumentada* puede ser empleada para potenciar el trabajo de grupo y colaborativo en ámbitos inclusivos, así como su posibilidad de ser empleada con sujetos que presenten diversas discapacidades, como en esferas inter y multiculturales. DISCUSIÓN. La

realidad aumentada **presenta posibilidades de ser empleada en la educación inclusiva en general y para desarrollar su currículo en particular. No se considera que pueda ser empleada con sujetos que presenten discapacidades visuales, e igualmente no se cree que pueda ayudar a prevenir el acoso escolar pero sí puede acentuar la brecha digital de los individuos.**

Palabras clave: *Educación inclusiva, Tecnología educativa, Opinión de los estudiantes, Usos de los ordenadores en educación.*

Résumé

Relations entre la realite et* éducation inclusive *accrue dans l'enseignement supérieur

INTRODUCTION. La Réalité Augmentée est peu à peu ´plus présente dans le domaine de l'éducation inclusive comme une technologie émergente qui favorise l'apprentissage par découverte et expérimentation de tous en égalité. MÉTHODE. Â travers une recherche quasi-expérimental et en employant un échantillonnage accidentel de N=41 participants qui suivent le Master d'Éducation inclusive de l'Université de Cordueaux quels il a été administré un questionnaire -conçu ad hoc et composé de 31 items et avec une échelle de réponse Likert à 5 options-, nous avons recueilli leurs opinions à fin de donner réponse à l'objectif de déterminer si la Réalité augmentée peutêtre employée dans le domaine de l'éducation inclusive. Pour cela, dans un premier moment, nous avons fait une valorisation des opinions sur le sujet (pré-test), suivie d'une intervention dans la quelle le contenu a été exposé et un esérie d'activités liées à la thématique on tété développées. Ultérieurement, nous avons administré à nouveau l'instrument (post-test). RÉSULTATS. Les résultats après l'analyse descriptive et inférentiellemettenten évidence que la Réalité Augmenté e peutêtre employée pour renforcer le travail en groupe et collaboratif dans des milieux inclusifs, de même qu'elle peutêtre utilisée avec des individus atteints de différents handicaps et dans des sphères inter et multiculturelles. DISCUSSION. La Réalité Augmentée offre des possibilités d'emploi dans l'éducation inclusive en général et pour développer son curriculum, en particulier. Cependant, son emploi n'est pas considéré comme possible avec des individus mal voyant set de même, on ne pense pas qu'elle puisse prévenir les harcèlements col aire bien qu'elle puisse accentuer la fracture numérique des individus.

Most clés: *Education inclusive, Technologie éducative, Opinion des étudiants, Utilisation des ordinateurs dans l'éducation.*

Perfil profesional de la autora

Verónica Marín-Díaz

Professor of University of Cordoba. She has been director of Máster in Inclusive Education of mentioned institution. Editor in chief of EDMETIC, Jorunal of Media Literacy and ICT. Member of research group e2i.
Correo electrónico de contacto: vmarin@uco.es
Dirección para la correspondencia: Faculty of Education, Avda. San Alberto Magno s/n, 14004-Cordoba (Spain).