p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35106-3-6 © 2023
https://doi.org/10.36315/2023v1end111

MIXED REALITY IN SECONDARY EDUCATION

Verónica Marín, Ignacio González, Belen Quintero, & Eloísa Reche
Department of Education, University of Córdoba (Spain)

Abstract

The advancement of emerging technologies in society has been underlined since 2020, during the confinements implemented in all countries to protect the population from COVID-19. This was the turning point in which specific digital tools forcefully positioned themselves within each area of society. Thus, in the area of education, the first step was to strengthen online training, and the second to provide methodologies that would bring laboratories and classrooms closer to the walls of the rooms in which students were carrying out their learning process.

In this sense, technologies such as virtual reality and augmented reality have been positioning themselves as resources that turn the training process around, by bringing workspaces that are difficult to access, or classified as either dangerous or unsafe, closer to students.

However, there are also negative aspects regarding their use, such as the lack of training for their use, or the scarcity of economic resources for acquiring the devices needed. Thus, this communication presents the results obtained regarding the knowledge possessed by secondary education teachers about them.

The objective of the work, as part of the larger project [Design, implementation and evaluation of Mixed Reality materials for learning environments (PID2019-108933GB-I00)], is to discover the knowledge possessed by secondary education teachers about Mixed Reality (virtual + augmented reality). With a sample of 121 teachers, and with a mean age of 41.3 years old (S.D. = 8.67), it was concluded that teachers, although they are aware of the existence of this emerging technology, don't have enough training for its use in secondary education classrooms.

Keywords: *Mixed reality, teacher training, pre-service teachers, secondary education.*

1. Introduction

Virtual Reality (from here on VR), and augmented reality (from here on AR), catalogued as emergent technologies, are now a reality in many education centers, and they have come, to the greatest extent possible, to provide support to the learning processes of students. VR, since its creation, was presented as a resource that was able to create a virtual environment within which one could interact in real time, from the education point of view (Pérez-Fuentes et al., 2011, p. 77), thus facilitating the acquisition of content through experience. The development of VR brought with it the so-called AR, which was an advancement in immersive learning processes, as it provided users with "tangible" information, as it allowed the use of different devices (smartphones and tables) without the need to become "isolated" from the world that surrounds them, as they do not have to use goggles that introduce the them to the digital stage.

The development of technology and the combination of both technologies (VR and AR), led to the creation of Mixed Reality (from here on MR), defined as a "blend of physical and digital worlds, unlocking the links between human, computer, and environment interactions" (Choi et al, 2022, p. 2). As we can observe, it takes the first-person experience from VR (Al-Gindy et al., 2020), and the immersion and real-time interactivity from AR, without losing one's environment. In conclusion, MR combines three elements: immersion, simulation, and interaction. This means that the information is presented in a manner that is more realistic and authentic, thereby promoting retention in our brain, as the experience is recorded in our memory.

Authors such as Li and Wang (2021), point out that the use MR will improve the learning experience, as it provides students with a greater level of interactivity and immediate feedback (Rossler, Sankaranarayanan & Hurutado, 2021). Research on the subject has shown that resources such as augmented books used in group activities in the classroom led to the improvement in comprehension of the readers (Danaei et al., 2020). Along this line, *Teach Me*^{tm} (Teaching in Mixed Reality environments)

presented by Black et al. (2016) shows how future teachers, through a virtual lab environment, learn how to be a teacher with MR, through the use of avatars that simulate students. Through the use of this technology and an immersive environment, the intention is not only for them to learn, but also to be able to manage the consequences that could be found in the classroom. Then, if they fail to teach well or make a mistake, these will not have an influence on the real learning of their students. In this way, pre-service teachers gain confidence on themselves.

MR in the field of education has the ability to stimulate the senses of the students who use it, and allows presenting information in a manner that is more realistic and authentic, thus increasing the interest and will of the students to interact with the content and the environment (Araiza-Alba et al., 2021).

Ultimately, MR is an education environment that helps improve the comprehension of complex cognitive structures; the learning is more effective and natural, and it promotes active participation and reflection. Also, the results of the activities performed are more immediate, visible, and palpable.

2. Method

The present study was designed as an ex post facto, descriptive, correlational and quantitative study. An ad hoc questionnaire was designed to collect the data, under the auspices of the R+D+I Design, implementation, and evaluation of Mixed Reality materials for learning environments (PID2019-108933GB-I00), financed by the Ministry of Science and Universities from the Government of Spain. This instrument measures the knowledge of Secondary Education teachers about mixed reality in the field of education. In this sense, the general objective was to determine the perception of Secondary Education teachers on the use of mixed reality within their profession. The following starting hypotheses were posited:

H1. Women are more prone to using MR in the teaching-learning process in the Secondary Education stage.

H2. Age is a determining factor on the use of MR for teaching in Secondary Education.

2.1. Instrument

As described above, a questionnaire was utilized to collect the data, and was subjected to validity and reliability tests. It was initially composed by 39 items distributed into two sections. The first inquired about the sociodemographic variables of the participant, which in this case were: gender, age, and macro area of teaching. The second was composed by the rest of the items (36), referring to MR itself. A 5-option Likert-type response scale was utilized, in which 1 indicated complete disagreement, and 5 complete agreements (Matas, 2018).

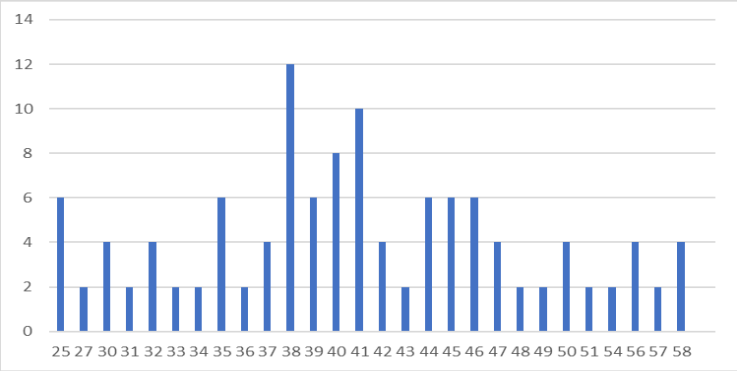
The questionnaire was subjected to a Cronbach's alpha test to determine its initial reliability. The test provided a score of .959. Once an item-by-item discrimination was performed, the results showed that the reliability was still high.

To determine the validity of the questionnaire, an exploratory factor analysis was performed, which determined the existence of two factors –one referring to knowledge and use of MR in the classroom, and another on the view and use of MR in inclusive environments-. Also, two items were eliminated [I know how to integrate MR in learning strategies directed towards the achievement of class objectives, and I am able to collaborate with other teachers to apply the MR methodology], given that all of them obtained scores higher than .30 (Mavrou, 2015); lastly, the remaining 37 items explained 81.769% of the variance. To corroborate if the reliability values were maintained in the two dimensions obtained, Cronbach's alpha was performed again, with high values obtained for both of them, .981 and .978 respectively.

2.2. Sample

The study participants were Spanish, Mexican, and Dominican Republic secondary school teachers, during academic year 2021-2022. To obtain this sample, a non-probabilistic, convenience sampling method was utilized (Otzen and Manterola, 2017) for an N = 121. Of these, 37.3% were men and 62.3% women. Considering the distribution of the sample according to age, the mean age was 41.3 years old (S.D. = 8.67) (see figure 1). When focusing on the country of origin, 60% were Spanish, 10% Mexican, and 30% from the Dominican Republic.

Figure 1. Distribution of the sample according to age.



2.3. Procedure

The procedure followed for the collection of data was the application of an online questionnaire during the 2021-2022 academic year, through the use of the Google Forms platform.

3. Results

The analysis of the knowledge of secondary school teachers about MR in their education stage showed that they were largely unaware about this tool (see table 1), except for considering the reception of information for utilizing MR as a necessity (item 25).

Table 1. Knowledge about MR.

		M.	SD
1.	I am familiarized with the variety of applications and programs available for creating virtual spaces in MR	2.52	1.341
2.	I know the technological support necessary for the use of MR in an educational environment	2.30	1.300
3.	I know how to create virtual spaces for their use in the subject(s) I teach	2.65	1.442
4.	I know about immersive devices (goggles/headsets) necessary for the use of MR	2.48	1.303
5.	I know about the holographic devices for using MR	2.15	1.171
6.	I know how to use immersive devices (goggles/headset) for using MR	2.02	1.137
7.	I know how to use the movement controllers for using MR	1.82	1.061
8.	I know about MR portals	2.02	1.152
9.	I know about MR dioramas	1.67	.982
10.	I know about MR holograms	1.90	1.080
11.	I know the computer characteristics needed for using MR	1.93	1.098
12.	I know the safety, privacy, social, ethical, and moral implications of the use of MR technology	2.05	1.166
13.	I know the terminology specific for the MR environment	1.90	1.032
14.	I am able to promote learning through the use of MR	2.17	1.337
15.	I know how to plan teaching and learning strategies with MR adjusted to a specific length of time	2.12	1.189
16.	I know how to efficiently implement MR depending on the context where it is used	1.92	1.164
17.	I have experience in the use of MR resources in the teaching and learning process	1.85	1.097
18.	I know how to use MR to encourage students to participate in the teaching process	1.97	1.188
19.	I know how to use MR to encourage students to participate in their own learning	2.03	1.188
20.	I know how to use MR to motivate students towards learning	2.10	1.198
21.	I know how to use MR to develop key competencies	1.98	1.167
22.	I know how to use MR in cooperative/collaborative learning	2.00	1.145
23.	I know how to design tasks associated with real situations through MR	2.03	1.159
24.	I know how to use MR to promote transversal learning of contents	2.08	1.206
25.	I consider MR training necessary	3.97	1.256
26.	I am able to use MR to promote inclusive education	2.15	1.294
27.	I know how to use MR to promote intercultural and/or multicultural education	2.02	1.167

28. I know how to design learning proposals with MR for students with high intellectual abilities	1.93	1.200
29. I know how to design learning proposals with MR for students with motor disabilities	1.68	1.029
30. I know how to design learning proposals with MR for students with hearing disabilities	1.67	.947
31. I know how to design learning proposals with MR for students with visual disabilities	1.60	.938
32. I know how to design learning proposals with MR for students with intellectual disabilities	1.63	.970
33. I know how to design learning proposals with MR for students with severe developmental disorders	1.57	.905
34. I know how to design learning proposals with MR for students with ADHD	1.70	1.026
35. I know how to design learning proposals with MR for students with learning difficulties	1.73	1.035
36. I know how to design learning proposals with MR for students who entered the educational system late	1.75	1.079
37. I know how to design learning proposals with MR for students at risk of social exclusion	1.72	.989

To determine the existence or not, of differences in the participating sample, considering the variable gender, and to provide an answer to hypothesis 1 (Women are more prone to using MR in the teaching-learning process in the Secondary Education stage), a Student's t test for independent samples was performed, which provided results in favor of the women (see table 2).

Table 2. Distribution of the sample according to sex.

		M.	S.D.	p.	t.
I know how to create virtual spaces for their use in the subject(s) I teach	Male	2.83	1.355	.031	1.399
	Female	2.47	1.512		
I know about immersive devices (goggles/headsets) necessary for the use of MR	Male	2.37	1.119	.001	-.981
	Female	2.60	1.464		
I know how to use MR to promote transversal learning of contents	Male	2.03	1.089	.038	-.453
	Female	2.13	1.321		
I know how to design learning proposals with MR for students with visual disabilities	Male	1.57	.722	.006	-.388
	Female	1.63	1.119		
I know how to design learning proposals with MR for students with learning difficulties	Male	1.70	.830	.006	-.352
	Female	1.77	1.212		

The ANOVA performed to determine the existence or not of differences, considering the variable age, showed the lack of differences, so that H2 can be rejected (Age is a determining factor on the use of MR for teaching in Secondary Education).

4. Discussion and conclusions

The advancement of emerging technologies have re-defined learning processes that are supported by the beliefs and knowledge of teachers about them. Therefore, a study of these views is an essential pillar for the advancement of education based on ICT in general, given that the positive results of learning mediated by MR lie in its use, as indicated by Araiza-Alba et al. (2021).

The factorial structure of the instrument differed from other works conducted with a similar population and context (Marín et al, 2022), although the dimension that referred to inclusive environments was maintained (Marín and Sampedro, 2023).

In contrast to the works by Aso et al. (2021) and Fuentes et al. (2019) the study participants did not consider themselves to be prepared and trained for the use of MR in secondary education. It is notable that they did not believe that its use would promote the transversal learning of the content (Aso et al., 2021, Fuentes et al., 2019), active learning, or greater motivation (Vasilevski and Birt, 2020).

As for MR, it was verified, as in the work by Marín, Sampedro and Vega (2023), that the variable age did not have an effect on having knowledge on how to use MR or not, in educational and inclusive contexts. However, with respect to gender, and in contrast to the data from Bursztyn et al.

(2017), in aspects such as the creation of virtual spaces, knowing about the immersion devices (goggles/headsets) needed for using MR, or knowing how to create training spaces for the visually disabled or those with learning difficulties, the women were more predisposed towards them.

Thus, it can be concluded that there is a great lack of knowledge and a need for specific training in the use of this technology for the development of immersive training processes.

References

Al-Gindy, A., Felix, Ch., Ahmed, A., Matoug, A., & Alkhidir, M. (2020). Virtual Reality: Development of an Integrated Learning Environment for Education. *International Journal of Information and Education Technology, 10*(3),171-175. 10.18178/ijiet.2020.10.3.1358

Araiza-Alba, P., Keane, T., Chen, W. S., & Swinbu, J. K. (2021). Immersive virtual reality as a tool to learn problem-solving skills. *Computer & Education, 164*, 10421. https://doi.org/10.1016/j.compedu.2020.104121

Aso, B., Navarrro-Neri, I., García-Ceballos, S. & Rivero, P. (2021). Quality Requirements for Implementing Augmented Reality in Heritage Spaces: Teachers' Perspective. *Education Science, 11*(8), 405. https://doi.org/10.3390/educsci11080405

Black, J., Noltemeyer, A. L., Davis, D. R., & Schwart, T. (2016). Pre-Service Teachers' Responses to Student Behavior in a Mixed-Reality Environment. *SAGE Open*, *6*(1), 1-10. https://doi.org/10.1177/2158244016633494

Bursztyn, N., Shelton, B., Walker, A., & Pederson, J. (2017). Increasing undergraduate interest to learn geoscience with GPS-based augmented reality field trips on students' own smartphone. *GSA Today, 27*(5), 4-11. doi:10.1130/GSATG304A.1

Choi, S. H., Park, K. B., Roh, D. H., Lee, J. Y., Mohammed, M., Ghasemi, Y., & Jeong, H. (2022). An integrated mixed reality system for safety-aware human-robot collaboration using deep learning and digital twin generation. *Robotics and Computer-Integrated Manufacturing, 73*, 102258. https://doi.org/10.1016/j.rcim.2021.102258

Danaei, D., Jamali, H. R., Mansourian, Y., & Rastegarpour, H. (2020). Comparing reading comprehension between children reading augmented reality and print storybooks. *Computers & Education, 153*, 103900. https://doi.org/10.1016/j.compedu.2020.103900

Li, K., & Wang, S. (2021). Development and application of VR course resources based on embedded system in open education. *Microprocessors and Microsystems, 83*, 103989. https://doi.org/10.1016/j.micpro.2021.103989

Marín, V., & Sampedro, B. E. (2023). Secondary education teacher's views on mixed reality in inclusive environments. *Education and information Technologies*, En prensa.

Marín, V., Sampedro, B. E., Aznar, I., & Trujillo, J. M. (2022). Perceptions on the use of mixed reality in mobile environments in secondary education. *Education+Training, 65*(2). https://doi.org/10.1108/ET-06-2022-0248

Marín, V., Sampedro, B. E., & Vega, E. (2023). Creencias del profesorado de secundaria en torno al uso de la Realidad Mixta. *Revista Electrónica Interuniversitaria de Formación del Profesorado,26*(1). 85-97. https://doi.org/10.6018/reifop.543331

Matas, A. (2018). Diseño del formato de escalas tipo Likert: un estado de la cuestión. *Revista Electrónica de Investigación Educativa, 20*(1), 38-47. https://doi.org/10.24320/redie.2018.20.1.1347

Mavrou, I. (2015). Análisis factorial exploratorio: cuestiones conceptuales y metodológicas. *Revista Nebrija de Lingüística Aplicada a la Enseñanza de Lenguas*, (19), 71-80. https://doi.org/10.26378/rnlael019283

Otzen, T., & Manterola. C. (2017). Técnicas de muestreo sobre una población a estudio. *International Journal of Morphology*, 35(1), 227-232. http://dx.doi.org/10.4067/S0717-95022017000100037

Pérez-Fuentes, M. C., Álvarez-Bermejo, J. A., Molero, M. M., Gázquez, J. J., & López Vicente, M. A. (2011). Violencia Escolar y Rendimiento Académico (VERA): aplicación de realidad aumentada. *EJIHPE: European Journal of Investigation in Health, Education and Psychology, 1*(2), 71-84. Doi:10.1989/ejihpe.v1i2.6

Rossler, K. L., Sankaranarayanan, G., & Hurutado, M. H. (2021) Developing an immersive virtual reality medication administration scenario using the nominal group technique. *Nurse Education in Practice, 56*, 103191. https://doi.org/10.1016/j.nepr.2021.103191

Vasilevski, N., & Birt, J. (2020). Analysing construction student experiences of mobile mixed reality enhanced learning in virtual and augmented reality environment. *Research in Learning Technology, 28*, 2329. http://dx.doi.org/10.25304/rlt.v28.2329