# UNDERSTANDING MIXED REALITY KNOWLEDGE AMONG LATIN AMERICAN SECONDARY EDUCATION TEACHERS

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**Abstract**

*The development of emergent technologies is a fact that is no longer questioned, but this is not the case when it comes to the views, beliefs, and knowledge of educators about them. Through an ex post facto method, the aim of the present study is to determine the current knowledge of a group of Mexican and Dominican Republic teachers about Mixed Reality. Through the use of a questionnaire as the data collection instrument, and with a sample of 380 subjects, it was determined that age and the country of origin did not determine the pedagogical or technological knowledge associated with Mixed Reality. Likewise, it was observed that men had a greater knowledge about the portals where this technology could be found, as well as the devices needed to be able to implement it in the classroom. For this, we must conclude that Secondary School teachers from Mexico and the Dominican Republic need more training on this digital resource, with respect to its use in the development of their curricular content.*

**Keywords:** *Virtual reality, augmented reality, mixed reality, training, teacher, secondary education*

## 1. INTRODUCTION

The evolution of the society of information and communication has led to the development of digital tools, which has resulted in our inability to perform any social, economic, or educational actions without their presence. The growth of digital resources in the academic area is influenced by variables such as the financial possibilities to acquire them, and mainly, how knowledge, or lack thereof, about them will influence their use in class activities. Thus, the study of the beliefs or views, of both educators and learners about these technologies, will be pivotal for the development of active methodologies. In this case, the present work focuses on the figure of Compulsory Secondary Education teachers, and their knowledge or lack thereof, about Mixed Reality (from here on, MR). We must point out that there are many innovation and research studies in the past few years on the digital stance of teachers, with respect to classroom methodologies (Acosta, Martín & Hernández, 2019; Caicedo-Tamayo & Rojas-Espina, 2014; Cassany & Llach, 2017).

The current situation of pandemic, and due to the confinement during the year 2020, forced educators at all levels to redefine their teaching models. These models were supported by many types of technologies, which were continuously used in diverse ways in their teaching methodologies.

In the case of the so-called emerging technologies, some of them such as Virtual Reality (from here on, VR), or gamification, became greatly important, as they made learning more immersive (Soltani & Morice, 2020). Nevertheless, the availability of resources, in the case of VR, and knowledge on the methodological possibilities of videogames per se, did not mean that a significant improvement would be observed in the student's learning, although it did predispose them towards improvement, as they saw that their day-to-day elements also had a place within the four walls of their education center (Marín-Díaz, Sampedro & Figueroa, 2022).

In any case, the study of the teacher's knowledge about current technologies is indispensable, if we want education centers to move at the same speed as the society in which they are found (Marín-Díaz, Sampedro-requena & Vega-Gea, 2022).

## 2. MATERIALS AND METHODS

*2.1. Methods*

The present study is quantitative, descriptive, and correlational, with an ex post factor design (León & Montero, 2011, Jorrin et al, 2021) An ad hoc questionnaire for the collection of data was designed, under the R&D+i project "Design, implementation, and evaluation of Mixed Reality materials in learning environments" (PID2019-108933GB-I00), financed by the Spanish Ministry or Science and Universities of Spain. This instrument revolves around the Secondary Education teachers' knowledge about mixed reality in the area of education. In this sense, its general objective is to determine the perception of Secondary Education teachers on the use of mixed reality in their profession. The following specific objectives, as well as the starting hypotheses, were conceived from the general objective.

Specific objectives:

- To determine the knowledge of Mexican teachers about Mixed Reality in the area of secondary school teaching.
- To discover the knowledge of Dominican Republic teachers about Mixed Reality in the area of secondary education.
- To define a model that determines the methodological perception of secondary education teachers from Mexico and the Dominican Republic on the use of Mixed Reality in this stage of education.

Hypothesis:

- H1. Gender will show differences on the use of MR in classrooms; more specifically, women think that pedagogical knowledge is necessary for the use of MR in the Compulsory Secondary Education stage.
- H2. The age of the teachers will not show differences in MR knowledge in classrooms.
- H3. The country of origin of the teachers in the Compulsory Secondary Education will show significant differences, with those from Mexico placing more value on pedagogic knowledge, as compared to the techno-pedagogical ones in the application of mixed reality.

*2.2 Instrument*

As indicated above, an ad hoc questionnaire was utilized to collect the data. This questionnaire was subjected to validity and reliability tests. Initially, it was composed by 18 items distributed into two sections. The first 4 referred to sociodemographic variables: gender, age, country, and subject taught, and the rest shaped the instrument itself. A 5-response option Likert-type scale was utilized, in which 1 = complete disagreement, and 5 complete agreement.

This questionnaire was subjected to a Cronbach alpha test to determine the initial reliability, which showed a score of .959. After the item-by-item discrimination, it was verified that the reliability remained high (see table 1).

| Item | Value | Item | Value |
|---|---|---|---|
| **1** | .956 | 8 | .954 |
| **2** | .955 | 9 | .955 |
| **3** | .958 | 10 | .954 |
| **4** | .959 | 11 | .954 |
| **5** | .955 | 12 | .956 |
| **6** | .955 | 13 | .955 |
| **7** | .954 | 14 | .957 |

**Table 1.** Item-by-item discrimination.

To determine the validity of the questionnaire, an exploratory factor analysis (EFA) was performed, with determined the existence of two factors. No items were eliminated, given that they all obtained values higher than .30 (Mavrou, 2015) (see table 2), which explained 64.061% of the variance. Also, the unweighted least squares (ULS), and the oblimin rotation method with Kaiser normalization were also calculated. The Kaiser-Meyer-Olkin (KMO) values obtained were .917 (very acceptable), and Bartletts' sphericity test was significant ($X^2$ [380] = 2144.802 and p<0.000). Thus, considering these results, the factorial structure was accepted (Ferrando & Anguiano-Carrasco, 2010).

| **Items** | **1** | **2** |
|---|---|---|
| 1. I know the security, privacy, social, ethical, and moral implications of the use of MR technology | .836 | |
| 2. I know about the technological support needed for the use of MR in an educational environment | .781 | |
| 3. I know MR portals | .769 | |
| 4. I am able to promote learning through the use of MR | .767 | |
| 5. I know the terminology specific to MR | .762 | |
| 6. I am familiarized with the variety of applications and programs available to create virtual spaces in MR | .745 | |
| 7. I know the characteristics of the computer system that are needed for the use of MR | .729 | |
| 8. I know how to create virtual spaces for their use in the subject(s) I teach | .657 | |
| 9. I know how to use immersive devices (goggles/headset) for the use of MR | | .858 |
| 10. I know about the holographic devices needed for the use of MR | | .796 |
| 11. I know how to use the movement controllers for the use of MR | | .785 |
| 12. I know about MR holograms | | .764 |
| 13. I know about immersive devices (goggles/headsets) necessary for the use of MR | | .751 |
| 14. I know about MR dioramas | | .696 |

**Table 2.** Exploratory factor analysis

To corroborate if the reliability values remained the same with the two dimensions obtained, a new Cronbach's alpha test was performed, which indicated high values in both of them (Rodríguez-Rodríguez & Reguant-Álvarez, 2020) (see table 3).

| **Factors** | **Value** |
|---|---|
| **Dimension 1: Techno-pedagogic knowledge** | .934 |
| **Dimension 2: Technological knowledge** | .934 |

**Table 3.** Item-by-item discrimination.

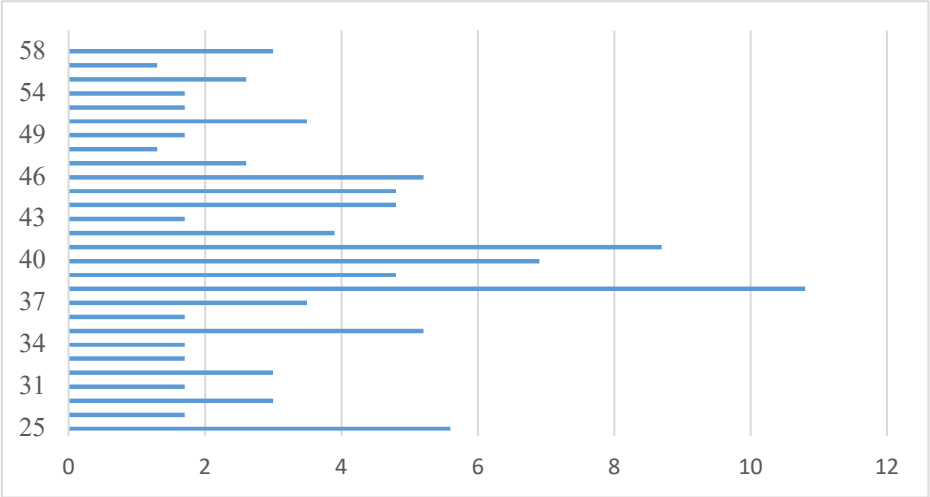
*2.3 Population and sample*

The study population was composed by Secondary Education teachers from Mexico and the Dominican Republic. To obtain the sample, a non-probabilistic, convenience sampling method was utilized

(Hernández & Carpio, 2019; Otzen & Manterola, 2017). The total sample was composed by 380 teachers.

With respect to gender, 51.5% were men, and 48.8% women, with a mean age of 40.57 years old (SD = 7.9007) (see figure 1).

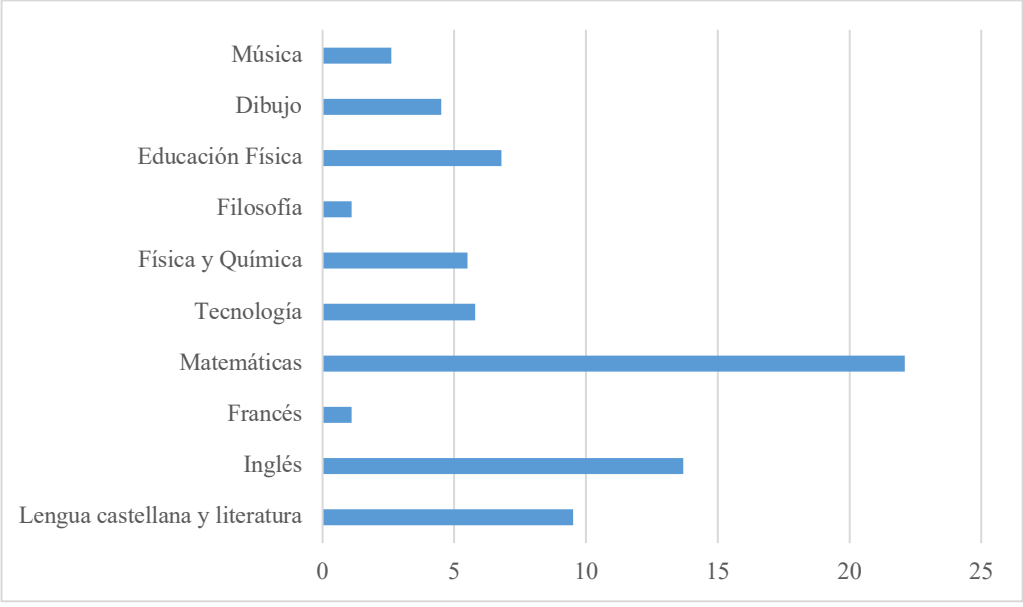
**Fig. 1.** Distribution of the sample according to age.




Considering the country of residence, 40.7% of them lived in Mexico, and 59.30 in the Dominican Republic.

As shown in Figure 2, most of the participants taught Mathematics (22.1%) while 13.7% English, as compared to the low participation of teachers of other subjects, as in the case of French (or second language), with a representation of only 1.1%.

**Fig. 2.** Distribution of the sample according to school subjects



*2.4 Procedure and analysis strategy*

To collect the data, all of the participants were contacted by mass-emailing all of the Secondary Education teachers. The teachers were asked to participate anonymously in completing the instrument, during the 2020-2021 academic year.

The quantitative data obtained will be first descriptive (central tendency and dispersion [mean and standard deviation], and then of distribution [kurtosis and asymmetry]). In second place, an inferential study was performed, considering the variable gender, age, and country of residence. Lastly, an analysis of the correlations between the factors obtained was performed.

## 3 RESULTS

*3.1 Descriptive study*

In dimension 1 (Techno-pedagogical knowledge about Mixed Reality), the participants believed they did not have knowledge about the implications of the use of MR at the level of security, privacy, or those of social, ethical, and/or moral character (M=2.38; SD=1.128). It was also significant that they did not know how necessary technical support is for implementing this technology in the classroom (M=2.48; SD=1.225). Likewise, they did not know what technology supports MR (M=2.08; SD=1.146), the applications or programs they can use in the classroom (M=2.58; SD=1.125), or the characteristics of the computer system needed to use them in the classroom (M=2.14, SD=1.188).

On the other hand, they have some knowledge on the portals that offer MR support (M=2.48; SD=1.225), which allows them to state that they are competent in the creation of virtual spaces in which they can use MR, always within the subjects they teach (M=2.71; SD=1.399).

With respect to the second dimension (Technological knowledge about Mixed Reality), in general, the participants indicated not having knowledge about immersive devices (M=2.23; SD=1.162), or their use (M=2.66; SD=1.249), the head-mounted displays needed to use MR (M=2.13; SD=1.099), or the controllers for movement (M=2.00; SD=1.087), what holograms are (M=1.94; SD=1.082), or dioramas in MR (M=1.82; SD=1.012).

| | | | | | | Asymmetry | | Kurtosis | |
|---|---|---|---|---|---|---|---|---|---|
| | **N** | **Min.** | **Max.** | **Mean** | **SD** | **Statistic value** | **E.S.** | **Statistic value** | **E.S.** |
| **Dimension 1** | 380 | 8 | 40 | 19.0289 | 8.05730 | .472 | .125 | .686 | .250 |
| **Dimension 2** | 380 | 6 | 30 | 12.7947 | 5.81691 | -.472 | .125 | -.4150 | .250 |

**Table 4.** Descriptive study.

*3.2 Inferential study*

The Student's t test results for independent samples, considering both gender and country of origin, showed statistically significant differences as a function of gender, but not country of origin.

With respect to gender (see table 5), the results corroborated differences only in items 3 and 8 in the first dimension, in favor of the men, who knew about the MR portals, as well as how to create virtual spaces for the subjects they teach.

| | | N | Mean | SD | p. | t. | Cohen's D |
|---|---|---|---|---|---|---|---|
| **Item 3** | **Men** | 161 | 2.14 | 1.61 | .017 | 2.303 | .24 |
| | **Women** | 215 | 1.88 | 1.014 | | | |
| **Item 8** | **Men** | 161 | 2.34 | 1.265 | .000 | 2.966 | .31 |
| | **Women** | 215 | 1.98 | 1.113 | | | |

**Table 5.** Inferential study.

To corroborate H2 (*The age of the teachers will not show differences in MR knowledge in classrooms*) an ANOVA was performed, using age as the selection variable. In this case, it must be pointed out that dimension 1 was not confirmed, with respect to knowledge of the application and programs to create MR virtual spaces, given that teachers who were 25-30 years old did show differences when compared to those 31-40 years old [F (3, 376) = T = 3.378, p. = .018, $\eta^2$ = .026; as well as the creation of virtual spaces, in which the teachers aged 41-50 years old showed differences with those aged 25-30 years old [F(3,376) = T = 3.980, p. = .026, $\eta^2$ = 1.82]; and lastly, when referring to knowledge of specific terminology, with differences observed in favor of teachers aged 25-30 years old versus 31-40 years old [F (3,376) = T = 4.052, p. = .016, $\eta^2$ =.03].

As for dimension 2, no differences were found, so the hypothesis posed can be accepted.

*3.3 Correlational study*

To corroborate if the dimensions established by the EFA caused the relationship between the items that composed them, a correlation was performed with each of the established dimensions (see tables 6 and 7).

In dimension 1, it was verified that all the items that composed it were related amongst themselves, with a confidence level of p=0.001 of significance. With respect to dimension 2, the same result was observed.

| | | 1 | 2 | 8 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **R** | 1 | | | | | | | |
| | **P** | | | | | | | | |
| **2** | **R** | .633** | 1 | | | | | | |
| | **P** | .000 | | | | | | | |
| **3** | **R** | .675** | .704** | 1 | | | | | |
| | **P** | .000 | .000 | | | | | | |
| **4** | **R** | .708** | .609** | .635** | 1 | | | | |
| | **P** | .000 | .000 | .000 | | | | | |
| **5** | **R** | .672** | .641** | .744** | .636** | 1 | | | |
| | **P** | .000 | .000 | .000 | .000 | | | | |
| **6** | **R** | .586** | .808** | .649** | .575** | .637** | 1 | | |
| | **P** | .000 | .000 | .000 | .000 | .000 | | | |
| **7** | **R** | .735** | .644** | .835** | .653** | .688** | .568** | 1 | |
| | **P** | .000 | .000 | .000 | .000 | .000 | .000 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **8** | **R** | .553** | .661** | .592** | .534** | .594** | .605** | .532** | 1 |
| | **P** | .000 | .000 | .000 | .000 | .000 | .000 | .000 | |

**. The correlation is significant at .01 (two-tailed).

**Table 6.** Correlational study of dimension 1.

| | | **9** | **10** | **11** | **12** | **13** | **14** |
|---|---|---|---|---|---|---|---|
| **9** | **R** | 1 | | | | | |
| | **P** | | | | | | |
| **10** | **R** | .721** | 1 | | | | |
| | **P** | .000 | | | | | |
| **11** | **R** | .810** | .731** | 1 | | | |
| | **P** | .000 | .000 | | | | |
| **12** | **R** | .766** | .769** | .792** | 1 | | |
| | **P** | .000 | .000 | .000 | | | |
| **13** | **R** | .696** | .677** | .597** | .576** | 1 | |
| | **P** | .000 | .000 | .000 | .000 | | |
| **14** | **R** | .691** | .695** | .792** | .873** | .479** | 1 |
| | **P** | .000 | .000 | .000 | .000 | .000 | |

**. The correlation is significant at .01 (two-tailed).

**Table 7.** Correlational study of dimension 2.

## 4 DISCUSSION

*A priori* knowledge about a technology does not imply that it is more or less valued from the point of view of education. Nevertheless, this lack of knowledge will determine its overlap in classroom methodologies, with greater or lesser importance (Meyer, Omdahl & Makransky, 2019; Papas Giannakos & Sampson, 2019).

Considering the two specific objectives posed (*To determine the knowledge of Mexican teachers about Mixed Reality in the area of secondary school teaching; To discover the knowledge of Dominican Republic teachers about Mixed Reality in the area of secondary education*), it was corroborated that two types of knowledge were identified around MR in secondary education teachers from Mexico and the Dominical Republic. On the one hand, they possessed techno-pedagogical knowledge of the tool itself, and on the other hand, technological knowledge itself, as indicated in another work by Marín, Sampedro, Vega and Ruíz, (2023). The knowledge possessed by the teachers can be qualified as scarce, so that we can infer on the need for specific training for its implementation in the classroom (Bower, de Witt & Lai, 2020).

Considering hypothesis 1 (*Gender will show differences on the use of MR in classrooms; more specifically, women think that pedagogical knowledge is necessary for the use of MR in the Compulsory Secondary Education stage*) just as in the works by Bursztyn et al. (2017), Marín et al (2022) and Vasilevski and Birt (2020), in general, statistically significant differences were not found in either factor.

Nevertheless, slight divergences were determined in favor of men, as they had knowledge on MR portals, and the creation of virtual spaces, so that the hypothesis can be partially accepted.

In general, all the teachers consulted indicated not knowing about the implications of the use of MR in the classroom (Palomo, 2020). More specifically, they indicated not knowing how to use it, at the level of security or privacy, or the social, ethical, or moral character of its use (Marín et al, 2022). In this line, they indicated not knowing the technical needs necessary for its implementation in the classroom (Matome & Jantjies, 2019). Nevertheless, and providing an answer to the objective posed, it was corroborated that the younger teachers did know about the portals where they could find the digital resource, and those older (41-50 years old) knew how to create MR environments (Guadamuz-Villalobos, 2021; Marín et al, 2022; Marín et al, 2022). Therefore, hypothesis 2 (*The age of the teachers will not show differences in MR knowledge in classrooms*) must be rejected.

## 5 CONCLUSIONS

Given the results obtained, it can be concluded that the variable gender did not determine knowledge about MR for its use in compulsory secondary education classrooms, given that the differences observed were very scarce. On the other hand, it can also be concluded that age was not a determinant factor on its use, although it was on knowledge about it, given that older teachers did have knowledge with respect to the creation of MR spaces, although this does not indicate that they are able to include them in their classroom activities.

Lastly, it must be indicated that the variable country of origin does not have an effect on knowledge about this technology (hypothesis 3).

In light of these results, we believe that is it necessary to implement a training program or initiative to train teachers about the pedagogic use of this tool.

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