USES AND INTEGRATION OF AUGMENTED REALITY IN THE EDUCATIONAL COOPERATIVES OF ANDALUSIA (SPAIN)

Jesús López-Belmonte[1,2] ID, **Santiago Pozo-Sánchez[2]** ID, **Arturo Fuentes-Cabrera[2]** ID,
José María Romero-Rodríguez[2] ID

[1]Universidad Internacional de Valencia (Spain)
[2]Grupo de investigación AREA (Hum-672). Universidad de Granada (Spain)

jesus.lopezb@campusviu.es, santiagopozo@correo.ugr.es, arturofuentes@ugr.es, romejo@ugr.es

Abstract

The use of mobile devices in classrooms is becoming more and more common. The introduction of these resources to produce learning is part of the mobile learning methodology. Among the possibilities of these devices provide we can find, as an emerging technology, augmented reality, which combines elements of the real world with virtual images. The purpose of this paper is to know the impact of the augmented reality in the educational cooperatives of Andalusia. In this regard, educational cooperatives are centers characterized in their origin by promoting the development of methodologies based on Information and Communication Technologies (ICT). The data collection instrument used in this questionnaire is a quantitative methodology of a descriptive nature. The questionnaire was prepared ad hoc according to the existing literature and the answers coded on a Likert scale. The results show that only a minority of teachers implement the augmented reality in their classes. In addition, there are statistically significant differences in terms of professional experience, so that younger teachers tend to implement methodologies based on the use of emerging mobile technologies such as augmented reality. Finally, it is emphasized that despite the constant technological advance of mobile devices in society, their application in the classroom occurs slowly.

Keywords – Mobile devices, Mobile learning, Augmented reality, ICT, Teaching.

To cite this article:

----

1. Introduction

Today's society is immerse in a reality dominated by information and communication technologies (ICT). The digital era has left behind the analogue era in a world in which almost the entire population uses technological devices in their daily lives (Jódar, 2010).

Consequently, each social individual has been forced to undergo an unconscious learning process that has led him to digital literacy (Trujillo, López & Pérez, 2011). This process has been much faster and more

natural in the youngest population, since from an early age they have been exposed to all kinds of digital stimuli generated by different technological devices, originating - in such a way - a great attraction for these innovative resources (Area, 2015). According to this, there are two individuals within the same society: digital natives, those who use technology innately as an intrinsic part of their reality; and on the other hand, digital immigrants, those individuals who have had to make an effort to learn how work and how to use these technologies to keep up with the innovation to which society is exposed every day (Sánchez & Castro, 2013; Rodríguez-García, Romero & Campos, 2018).

Within this context, education is trying to adapt itself to the new technological paradigm and is focusing its efforts on the creation of new methodologies based on the application of digital age resources (Cubillo, Martín, Castro & Colmenar, 2014). Under this premise, ICT allows the optimization of learning spaces thanks to its potential interactive and socializing characteristics that allow learners to build autonomously their learning (Cabero, 2017). Technology also makes it possible for students to be able to search for information ubiquitously, that is, without limitation of space and time (Fombona & Pascual, 2017).

Within all the resources that technology provides to teachers, augmented reality (hereinafter AR) is positioned as a technology with enormous potential (Lorenzo & Scagliarini, 2018). Due to its positive potential character, AR has undergone a rapid evolution during the last decades (Prendes, 2015; Yuen, Yaoyuneyong & Johnson, 2013) mainly because this technology allows us to combine digital and physical information instantly through mobile devices (Barroso, Cabero, García, Calle, Gallego & Casado, 2017).

As shown in Figure 1, AR is based on the superposition of different nature information edited virtually so that it can be linked to any object in the real world (Ierache, Igarza, Mangiarua, Becerra, Bevacqua, Verdicchio et al., 2014), generating a greater amount of information through the application of mobile learning (Aznar, Cáceres & Romero, 2018), that is, the use of electronic mobile devices such as tablets or smartphones as tools for the teaching and learning process (Gómez, Trujillo, Aznar & Cáceres, 2018).
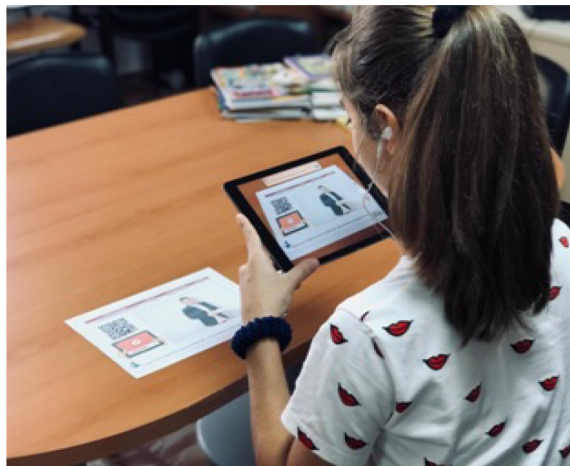

Figure 1. Student practices with AR

The use of AR allows students to assume an active role taking part in the construction of their learning and making them protagonists of the process (Cabero, Llorente & Marín, 2017; Fernández, 2018) which is a highly desired change in education.

Following Chen, Liu, Cheng and Huang (2017), AR technology provides the possibility of generating great and new learning experiences thanks to electronic devices. Garay, Tejada and Castaño (2017) postulate that AR is an innovative tool that can be easily adapted to each of the educational stages and training centers of regulated education.

Recent studies regarding the benefits of AR in the educational field report that this technology fosters collaborative, ubiquitous, constructivist and significant learning (Cabero & Barroso, 2018). It also allows an improvement in the attitude, attention, interest, autonomy and motivation of the students during the learning process (Marín, Cabero & Gallego, 2018).

However, for an optimal inclusion of such technology, it is essential to have a correct technological training of the teacher, students with a minimum level of digital competence, sufficient material resources and an adequate infrastructure to be able to put technological activities into practice (Álvarez, Delgado, Gimeno, Martín, Almaraz & Ruiz, 2017).

According to this, the efforts for the creation of the INNOVACOOP project converge. An educational program that pursues the promotion and technological inclusion in educational centers through the creation of a working group constituted among the members of the teaching staff. In this way, it is intended to actively promote the use of technology as a tool for teaching and learning processes.

In particular, the study purpose was focused within a specific modality of educational center: the educational cooperatives. These educational institutions are the less common of the three types of centers existing in the Spanish state (public and private centers and cooperatives). Educational cooperatives are conceived as places that foster and pursue innovation at a multidisciplinary level, concentrating their efforts on the empowerment of their teachers so as to offer a quality service based on the excellence of their pedagogical models (López & Fuentes, 2018; López, Moreno & Pozo, 2018).

In order to succeed in integrating ICT in educational spaces, educational cooperatives know the importance of leadership, usually represented in the multimember figure of the management team (Fernández, Fernández & Rodríguez, 2017). This body plays a crucial role in the implementation of innovation in the centers they manage, directing their policies towards the promotion of an effective technological leadership and promoting the development of pedagogical methodologies based on ICT (Estévez & Sánchez, 2017; Santiago, Navaridas & Andía, 2016).

Thus, for the inclusion of AR within educational spaces, the figure of the technological leader is paramount. This is an individual capable of eliminating false prejudices about ICT and convincing the rest of the educational community of the need to move towards the inclusion of technology, as an indispensable resource for the teaching-learning process (Sosa & Valverde, 2015).

The origin of this research lies in the current problems faced by teachers when promoting technological inclusion in learning spaces due to their lack of competence in the digital field, which limits the use of innovative resources and tools such as AR.

The following sections of this work describe the methodology used for the deployment of the study, as well as the most relevant findings and conclusions reached and that will serve to expand the field of knowledge on this topic in specialized scientific literature.

2. Methodology
2.1. Research Problem

There is no doubt that today's society is immerse in a digital era, generated by the enormous technological advances and the impact they have had and continue to have on people's lives. Particularly, in the field of education, technology has favored a wide range of resources and digital tools to optimize teaching and learning processes in schools, fostering work not only in classrooms with conventional material, but also in virtual environments ubiquitously, at any time and space, whether or not it has a place within the school ecosystem, which allows a mobile and permanent work of the learners in their new facet of active agents and protagonists who pursue new emerging methodologies.

As it has been previously mentioned, AR has established itself as a technology of great impact and scope in the educational field, offering great possibilities for the acquisition of competences and achievement of the objectives by the students.

The main problem this type of innovative methodologies originates in the classroom is the necessary competence level in digital matter of the teacher needed for an optimal and efficient use of these digital resources, both in its preparation and in its implementation (Fernández, 2018). Therefore, this paper will focus on the study of the digital competence of teachers, the implementation of training courses in ICT, the degree of use of AR in educational centers of a cooperative nature, as well as the incidence of certain variables on the use of AR as an educational technology.

2.2. Context

The context of this research is the educational cooperatives (EC) of the Autonomous Community of Andalusia (Spain). According to the recent studies carried out by López, Fuentes and Moreno (2018) and López, Moreno and Pozo (2018), EC are school entities that offer the Educational Community the possibility of receiving an innovative and quality education, due to the peculiarities of the educational projects they develop to achieve excellence and effectiveness in learning processes.

The selection of this type of educational centers to carry out the research lies in their innovative ideology.

EC have experienced a rapid growth in recent years, with a proliferation of the number of educational centers established in different parts of the Spanish geography. This fact is an answer to the current demands of society, articulated by a new type of student that has grown hand in hand with technology (Fuentes & López, 2018).

These educational centers integrate all types of students, without making any religious or cultural distinction, have a ratio similar to public centers, favor an intercultural as well as innovative education, with the purpose of promoting quality and equity in teaching and learning processes suitable for the information and knowledge society (Fuentes, Pozo, López, Moreno, Martínez, Gómez et al., 2019).

2.3. Purpose

The main purpose of this study is to know impact of augmented reality in the educational cooperatives of Andalusia.

Some questions were posed to guarantee that the course of the investigation was followed and to assess the achievement of its goal:

- What is the sociological profile of the teaching staff of educational cooperatives?
- What is the degree of digital competence of the teaching staff to prepare and make didactic material using augmented reality?
- Does the teaching staff follow training activities related to ICT?
- How many professionals use augmented reality as an emergent methodology compared to other techniques?
- Does the teacher's gender influence the use of augmented reality in the school setting?
- Does the age of the teachers influence the use of resources with augmented reality?
- Is there a correlation between teaching experience and the application of augmented reality techniques?

2.4. Design

The study of the established purpose implied a descriptive design to reveal the current state of the art (Hernández, Fernández & Baptista, 2014). Likewise, the approach applied was of a correlational type, to check the incidence of some variables over others, based on the quantitative method (McMillan & Schumacher, 2005).

2.5. Variables

To develop the research, the researchers have taken into account the variables that may be incidental to the object of study, grouped into different categories (social, competency, educational and methodological).

These are coded and are related below:

- Social variables:
    - Gender (GEN)
    - Age (AGE).
    - Work experience (EXPE).

- Competency variables concerning each of the areas of digital teaching competence, established by the Spanish National Institute of Educational Technology and Teacher Training (*Instituto Nacional de Tecnología Educativa y Formación del profesorado*, INTEF, 2017):
    - Information and information literacy (AREA-1).
    - Communication and collaboration (AREA-2).
    - Creation of digital contents (AREA-3).
    - Security (AREA-4).
    - Problem solving (AREA-5).

- Educational variables:
    - ICT courses conducted per year (COURSE).
    - Theme of the training courses (THEM).
    - Course modalities (MOD).

- Methodological variables:
    - Use of augmented reality (USEAR).
    - Traditional techniques (TRAD).
    - Other innovative methodologies (METHOINN).

2.6. Participants

The sampling was intentional, contacting the members directly (Hernández et al., 2014). The Andalusian Association of Teaching Institutions of the Social Economy (*Asociación Andaluza de Centros de Enseñanza de la Economía Social,* ACES), offers a repository on the internet, including the contact data of different educational cooperatives located in Andalusia used.

Subsequently, the researchers made the sample according to the availability of the participants. In total, 428 teachers belonging to different Secondary Education educational cooperatives in Southern Spain.

The most significant characteristics of the participating subjects are shown in Table 1.

2.7. Instrument

The survey has been used as a technique to collect data collection, through an ad hoc questionnaire, prepared according to the guidelines set by Alaminos and Castejón (2006).

The tool consists of four dimensions: 1-Social (7 items); 2-Competency (22 items); 3-Educational (8 items); 4-Methodological (11 items). Likewise, the questionnaire integrates a total of 48 items with different format of answer, some of them are closed-ended answers and other follow the Likert format on a scale of 1-4 (1=nothing, 2=little, 3=enough and 4=totally).

To validate the tool, we consulted a board of experts (Escobar & Cuervo, 2008) composed of four Doctors in educational technology, belonging to the Universities of Granada, Seville and Malaga. The feedback from these specialists was quite positive, not resulting in substantial modifications of the questionnaire.

Gender distribution		
	n	**%**
Man	197	46.03
Woman	231	53.97
Age distribution		
20-30 years	92	21.49
31-40 years	102	29.45
41-50 years	126	23.83
More than 50 years	108	25.23
Work experience		
1-10 years	116	27.1
11-20 years	109	25.47
21-30 years	135	31.54
More than 30 years	68	15.88

Table 1. Subjects of the sample by gender, age and work experience distribution

After the qualitative validation, a multivariate analysis was carried out through the Principal Components Analysis (PCA), to reduce the data without losing information, using the Kaiser-Meyer-Olkin test (KMO: $p=.913$) and the Bartlett's sphericity ($p=.0005$). The statistical data revealed a relevant PCA. In addition, an oblique rotation Promax with Kaiser Normalization was used to increase the interpretation of the data (Pérez, 2005).

Afterwards, the Cronbach's Alpha (α) was applied to analyze the reliability of the questionnaire, which revealed the following results: a) Social Dimension: $\alpha=.839$; b) Competency Dimension: $\alpha=.872$; c) Educational Dimension: $\alpha=.864$; d) Methodological dimension: $\alpha=.811$. Reaching an average value of $\alpha=.847$, considered a reliable instrument for this research (Bisquerra, 2004).

2.8. Analysis of Data

The specialized program Statistical Package for the Social Sciences (SPSS), version 22, has been used to process the data. It has been postulated as a statistically significant difference the values of $p<.05$ with a confidence level of 95% ($Z=1.96$) and a margin of error of 5% ($e=.05$).

We have followed the recommendations of Landero and González (2006), such as the mean (M_e), the standard deviation (SD), the Pearson asymmetry coefficient (PAC) and the Fisher's pointing coefficient (FPC) and the Chi-square (χ^2) and V of Cramer (V_{Cramer}) tests for the comparison of variables and their intensity of relationship.

2.9. Procedure

The start of this study dates back to 2017, when the researchers had to collect telephone contacts and email addresses from the ACES database. Later, they explained the aims of this research to school management of the educational cooperatives of the Andalusian region and reached a collaboration agreement.

After the first contact with this type of educational centers, the sample of participating subjects was established, reaching a large number of professionals from teaching the Secondary Education educational cooperatives in the area.

Then the researchers sent a questionnaire (reliable and valid for this study according to the tests carried out and the board of experts) virtually to preserve the environment, reduce the economic costs, accelerate the transmission of the data and facilitate the access and manipulation of the information collected. To complete it, the tool was an automatically closed 3 weeks after it was sent.

The last phase consisted in the statistical treatment, through the SPSS software, of the information collected. This application has facilitated the task of handling large volumes of data and perform in-depth statistical tests, allowing the presentation of data in various tables and figures.

3. Results

The main results of this study, which set the basis for the issue addressed in this paper, are the following. In reference to the competency variables analyzed (Table 2), the data obtained reveals that the areas of digital competence related to information and information literacy and that related to communication and collaboration among teachers have been those that have reached higher values, revealing teachers adequate skills. They are followed closely, but with a lower level of competence at the digital level, by the skills and abilities concomitant with problem solving and security. Being the creation of digital content the most deficient aspect. The Pearson asymmetry coefficient and Fisher's pointing coefficient have been used to know the degree of asymmetry of the distribution. The first one reflected a positive asymmetry given in the values of PAC> 0 and the second one found a leftward tendency of the data with respect to the mean (FPC<0), giving rise to a platykurtic pointing of the distribution.

Similarly, Figure 2 derives from the results discussed above. This has been designed to facilitate a better visual understanding of the findings in the digital competence of teachers, showing certain competency similarities between areas 1, 2 and 5.

With respect to the continuous training of teachers, Figure 3 contains the data related to the courses taken, the topics and the modality. The COURSE variable shows a training shortage (n=186 < 1 course). Among the results, it is worth noting that the majority of the courses are of a general nature (n=158), close to the number of participants who have not carried out ICT training (n=137). Likewise, there is a remarkable number of subjects (n=214) who follow a classroom modality in the training processes.

	Likert Scale n (%)				Parameters			
	Nothing	**Little**	**Enough**	**Totally**	M_e	**SD**	**PAC**	**FPC**
AREA-1	43 (10.04)	81 (18.9)	123 (28.73)	181 (42.28)	3.03	1.00	2.01	-.75
AREA-2	45 (10.51)	62 (14.48)	191 (44.62)	130 (30.37)	2.94	.93	2.09	-.33
AREA-3	204 (47.66)	130 (30.37)	63 (14.72)	31 (7.24)	1.81	.93	.86	-.21
AREA-4	91 (21.26)	102 (23.83)	123 (28.73)	112 (26.16)	2.59	1.09	1.46	-1.27
AREA-5	58 (13.55)	75 (17.52)	151 (35.28)	144 (33.64)	2.89	1.02	1.85	-.83

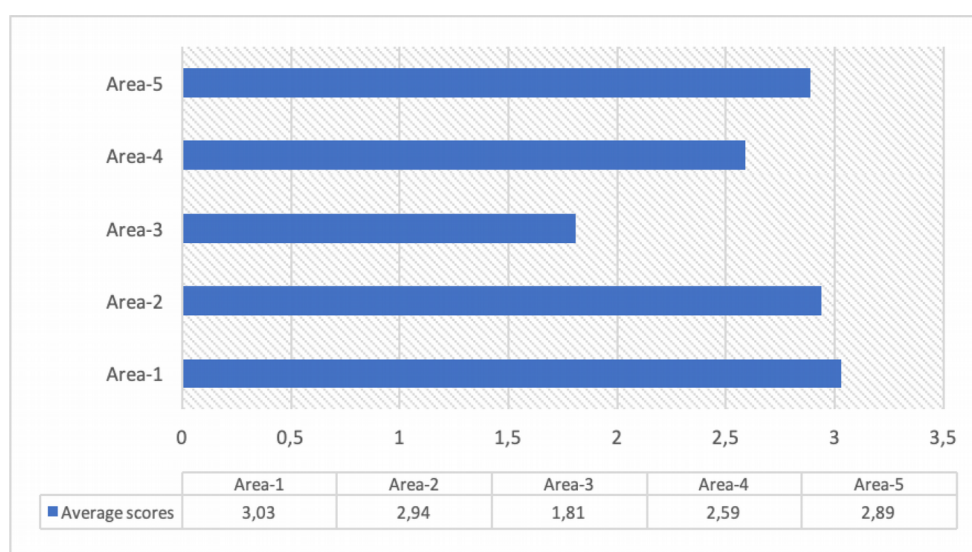Table 2. Results obtained for the competency variables

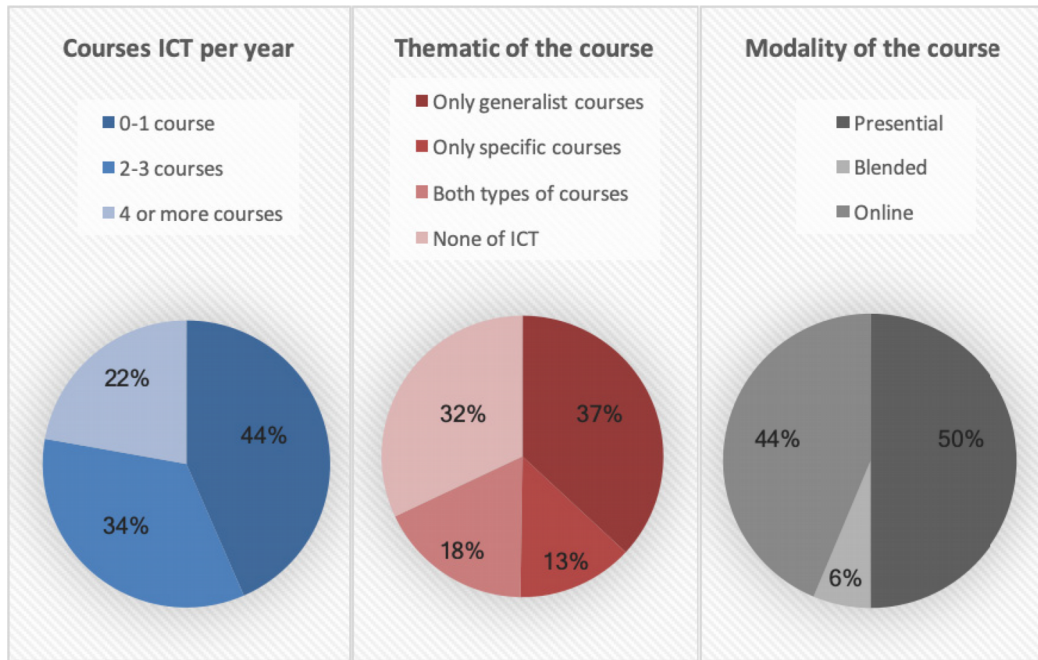Figure 2. Average scores obtained in the different areas of the digital teaching competence

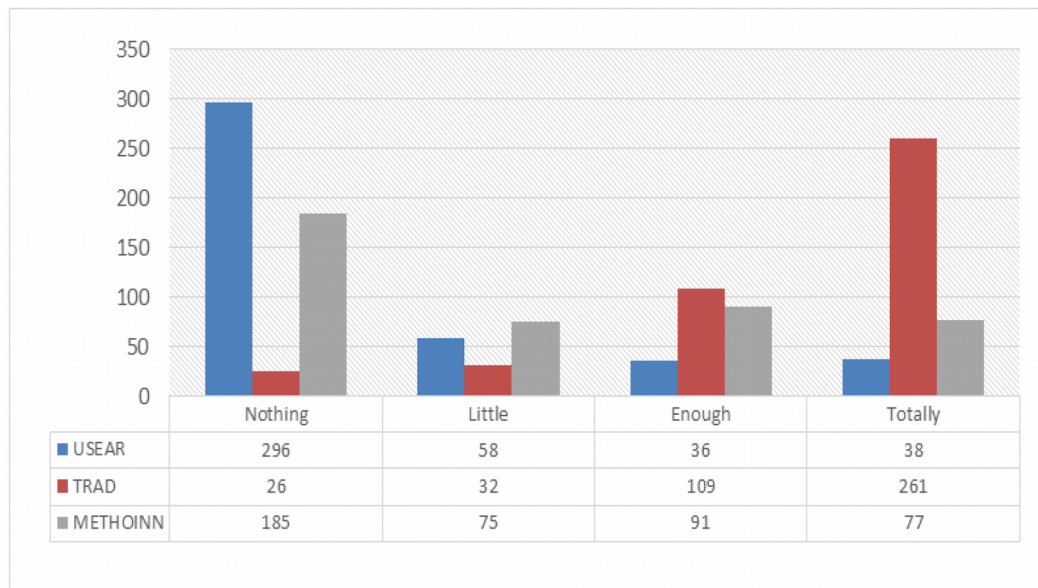Figure 3. Complementary teacher training

Figure 4. Methodological frequency of the teaching staff

The most outstanding figures at the methodological level (Figure 4) show that a large part of the teaching staff (n=261) continues to use traditional techniques and resources in the teaching and learning processes. This result is consistent with an overwhelming number of subjects (n=296), who do not use augmented reality or other innovative methodologies in their daily practice.

To know the influence of the GEN variable on the use by teachers of augmented reality resources (Table 3), a correlation between both has been established, applying Pearson's nonparametric Chi-square test. The results have not shown signs of significant statistical value ($\chi^2(3)=2.48$, $p>.05$), showing little strength of association between the variables, reflected in the size of the effect resulting of the V_{Cramer} test.

	Gender		Parameters		
	Man	**Woman**	**χ^2(df)**	***p*-value**	**V_{Cramer}**
USEAR	**n (%)**		2.48(3)	.478	.076
Nothing	140 (32.71)	156 (36.45)			
Little	28 (6.54)	30 (7.01)			
Enough	16 (3.74)	20 (4.67)			
Totally	13 (3.04)	25 (5.84)			

Table 3. Association between the gender of teachers and the USEAR variable

	Age				Parameters		
	20-30 years	**31-40 years**	**41-50 years**	**More than 50**	**χ^2(df)**	***p*-value**	**Cont.**
USEAR	**n (%)**				72.92(9)	<.001	.382
Nothing	43 (10.05)	69 (16.12)	102 (23.8)	82 (19.15)			
Little	9 (2.1)	11 (2.57)	17 (3.97)	21 (4.91)			
Enough	18 (4.21)	12 (2.8)	3 (.71)	3 (.71)			
Totally	22 (5.14)	10 (2.33)	4 (.93)	2 (.47)			

Table 4. Association between the age of the teaching staff and the USEAR variable

	Teaching experience				Parameters		
	1-10 years	**11-21 years**	**21-30 years**	**More than 30**	**χ^2(df)**	***p*-value**	**Cont.**
USEAR	**n (%)**				81.92(9)	<.001	.401
Nothing	57 (13.32)	85 (19.85)	107 (25)	47 (10.98)			
Little	12 (2.81)	6 (1.41)	22 (5.14)	18 (4.21)			
Enough	21 (4.91)	10 (2.34)	3 (.71)	2 (.47)			
Totally	26 (6.07)	8 (1.87)	3 (.71)	1 (.24)			

Table 5. Association between the teaching experience and the USEAR variable

Regarding the established correlation between age and the use of augmented reality (Table 4), the statistical test (χ^2(9)=72.92, p<.05) has revealed statistically significant differences between the variables used (AGE-USEAR) with a high degree of association between them (V_{Cramer}>.6). The results show that age influences the use of augmented reality, being the youngest teachers (20-30 years) the ones who use it the most.

Table 5 presents the analysis between the EXPE-USEAR variables, again showing statistically significant differences and with a high strength of association (V_{Cramer}>.6) between the teaching experience and the use of augmented reality (χ^2(9)=81.92, p<.05). The use of resources with augmented reality is more propitious in teachers among limited experience (1-10 years).

4. Discussion

The data obtained show a general overview of the degree of integration of augmented reality in the educational cooperatives of Andalusia. In this regard, the analysis of teachers' digital competence shows that the areas with the best scores are those related to information and information literacy and communication and collaboration (elementary areas of digital competence) (INTEF, 2017). While the area of problem solving and security obtains average values. On the contrary, content creation, the area with the highest incidence in augmented reality, obtains low values. Likewise, the fact of having an adequate digital competence is key for the implementation of any technological resource (Álvarez et al., 2017; Chen et al., 2017).

The low digital competence of teachers regarding the areas that require advanced technological knowledge is due, in the first instance, to the scarcity of training on ICT that they have received. Therefore, it is essential to achieve a minimum level of digital literacy in order to move effectively in our environment (Trujillo et al., 2011).

Regarding the teaching methodology, most teachers use traditional techniques and resources, far from a generalized use of technological methodologies (Cubillo et al., 2014; Fombona & Pascual, 2017). This implies a traditional typology, where the teacher reproduces models based on the lecture and the unidirectional transmission of information. As a result, most of them do not take into account the virtues of the AR, leaving aside the benefits that it brings, such as collaborative, constructivist and significant work (Cabero & Barroso, 2018; Marín et al., 2018).

On the other hand, the results show that there are no statistically significant differences in terms of gender. However, it is remarkable the difference age poses. This indicates the dichotomy between natives and digital immigrants, in such a way that younger teachers are more prone to apply emerging technologies in their teaching (Area, 2015; Rodríguez-García et al., 2018; Sánchez & Castro, 2013).

In general, the data show that despite the rapid technological evolution, the real implementation in the classroom presents a certain slowness in terms of mobile learning (Aznar et al., 2018) and emerging mobile technologies, such as augmented reality (Lorenzo & Scagliarini, 2018; Prendes, 2015; Yuen et al., 2013). This fact contrasts with the premise that educational cooperatives are, in their origin, centers of innovation that promote the development of methodologies based on ICT (Estévez & Sánchez, 2017; López & Fuentes, 2018; López, Moreno & Pozo, 2018; Santiago et al., 2016).

Therefore, it is essential to train teachers in the implementation of technological resources in the classroom, accompanied by examples of good teaching practices (Aznar et al., 2018). In the years to come, the application of technology in education will be widespread and teachers have to be ready for it. Thus, literacy and digital competence are key factors in teacher education in the 21st century. From all this derives the possibility of being able to extrapolate this type of analysis research on the implementation of ICT. In the first instance, to know the difficulties the teachers find and, in the second instance, to implement improvement training plans for the correct application of the technological resources.

5. Conclusions

Augmented reality is an emerging mobile technology that, due to its characteristics, can substantially improve learning outcomes. In this paper, the researchers have addressed the implementation of augmented reality in the educational cooperatives of Andalusia. Therefore, they have answered the different research questions: establishing the sociological profile of the teaching staff that integrates the educational cooperatives; the degree of digital teaching competence; the ICT training actions taken by teachers; the percentage of teachers who integrate augmented reality in their classrooms; the influence of gender in the use of mobile technologies; the influence of age on the use of technological resources and; the correlation between teaching experience and the application of augmented reality techniques.

According to this, they have fulfilled the main purpose of the paper, knowing the impact of augmented reality in the educational cooperatives of Andalusia.

On the other hand, unlike other works, this study gathers significant findings for the scientific community in relation to the establishment of statistically significant differences about the influence of age in the use of augmented reality, being the youngest teachers (and those with less experience) those who use it the most. At the same time, it is highlighted that a large part of the teaching staff continues to use traditional techniques and resources.

Among the limitations of the work, we must mention that although the general sample is broad, some provinces present a low sample with comparison to others. In future works it would be interesting to increase the sample and to equalize it in all the regions of Andalusia. However, it should emphasised that for a first approach, the sample size obtained is more than enough.

On the other hand, as work prospects, we highlight: (i) the continuity of the line of research on the implementation of ICT in educational cooperatives (López, Fuentes & Moreno, 2018; López, Moreno & Pozo, 2018). This type of centers is a focus of interest, largely unexplored, which can yield important data

on experiences in educational technology. (ii) The comparison with other public centers, to verify the degree of implementation of augmented reality in both types of centers. (iii) The analysis of how teachers are implementing augmented reality in the classroom, in order to verify if it is a good teaching practice. (iv) The design and application of training programs to increase the digital teaching competence and the use of emerging technologies such as AR.

Declaration of Conflicting Interests

Funding

References

Alaminos, A., & Castejón, J.L. (2006). *Elaboración, análisis e interpretación de encuestas, cuestionarios y escalas de opinión.* Alicante, España: Marfil.

Álvarez, S., Delgado, L., Gimeno, M.A., Martín, T., Almaraz, F., & Ruiz, C. (2017). El arenero educativo: la realidad aumentada un nuevo recurso para la enseñanza. *EDMETIC*, 6(1), 105-123. https://doi.org/10.21071/edmetic.v6i1.5810

Area, M. (2015). La alfabetización digital y la formación de la ciudadanía del siglo XXI. *Revista Integra Educativa,* 7(3), 21-33.

Aznar, I., Cáceres, M.P., & Romero, J.M. (2018). Indicadores de calidad para evaluar buenas prácticas docentes de «mobile learning» en Educación Superior. *Education in the Knowledge Society (EKS),* 19(3), 53-68. https://doi.org/10.14201/eks20181935368

Barroso, J., Cabero, J., García, F., Calle, F.M., Gallego, O., & Casado, I. (2017). *Diseño, producción, evaluación y utilización educativa de la realidad aumentada.* Secretariado de Recursos Audiovisuales y NNTT. Sevilla, España: Universidad de Sevilla.

Bisquerra, R. (2004). *Metodología de la investigación educativa.* Madrid, España: La Muralla.

Cabero, J. (2017). La formación en la era digital: ambientes enriquecidos por la tecnología. *Revista Gestión de la Innovación en Educación Superior*, 2(2), 41-64.

Cabero, J., & Barroso, J. (2018). Los escenarios tecnológicos en Realidad Aumentada (RA): posibilidades educativas. *Aula Abierta,* 47(3), 327-336. https://doi.org/10.17811/rifie.47.3.2018.327-336

Cabero, J., Llorente, M.C., & Marín, V. (2017). Comunidades virtuales de aprendizaje. El Caso del proyecto de realidad aumentada: RAFODIUM. *Perspectiva Educacional. Formación de Profesores*, 56(2), 117-138.

Chen, P., Liu, X., Cheng, W., & Huang, R. (2017). A review of using Augmented Reality in Education from 2011 to 2016. In Popescu, E., Kinshuk, M.K., Huang, R, Jemni, M., Chen, N.S., & Sampson, D.G. (Eds.), *Innovations in Smart Learning* (13-18). Singapore: Springer. https://doi.org/10.1007/978-981-10-2419-1_2

Cubillo, J., Martín, S., Castro, M., & Colmenar, C. (2014). Recursos digitales autónomos mediante realidad aumentada. *RIED. Revista Iberoamericana de Educación a Distancia*, 17(2), 241-274. https://doi.org/10.5944/ried.17.2.12686

Escobar, J., & Cuervo, A. (2008). Validez de contenido y juicio de expertos: una aproximación a su utilización. *Avances en medición,* 6(1), 27-36.

Estévez, O.V., & Sánchez, M.M. (2017). La formación de equipos directivos e-competentes y el fomento de las nuevas tecnologías en la universidad. *Transformación*, 13(1), 96-104.

Fernández, B. (2018). La utilización de objetos de aprendizaje de realidad aumentada en la enseñanza universitaria de Educación Primaria. *IJERI: International Journal of Educational Research and Innovation*, 9, 90-104.

Fernández, F.J., Fernández, M.J., & Rodríguez, J.M. (2017). El proceso de integración y uso pedagógico de las TIC en los centros educativos madrileños. *Educación XX1,* 21(2), 395-416. https://doi.org/10.5944/educxx1.17907

Fombona, J., & Pascual, M.A. (2017). La producción científica sobre Realidad Aumentada, un análisis de la situación educativa desde la perspectiva SCOPUS. *EDMETIC*, 6(1), 39-61.https://doi.org/10.21071/edmetic.v6i1.5807

Fuentes, A., & López, J. (2018). TIC-TAC: Las tecnologías de la información y la comunicación en la era del acceso. Una experiencia en la educación superior. In Del Arco, I., & Silva, P. (Eds.), *Tendencias nacionales e internacionales en organización educativa: entre la estabilidad y el cambio* (712-727). Madrid, España: Wolters Kluwer.

Fuentes, A., Pozo, S., López, J., Moreno, A.J., Martínez, J., Gómez, G. et al. (2019). Sociedad, educación e inclusión al borde de la frontera. Educación Social en la Ciudad Autónoma de Ceuta. In El Homrani, M., Arias, S.M., & Ávalos, I. (Eds.), *La inclusión: una apuesta educativa y social* (201-218). Madrid: Wolters Kluwer.

Garay, U., Tejada, E., & Castaño, C. (2017). Percepciones del alumnado hacia el aprendizaje mediante objetos educativos enriquecidos con realidad aumentada. *EDMETIC,* 6(1), 145-164. https://doi.org/10.21071/edmetic.v6i1.5812

Gómez, M., Trujillo, J.M., Aznar, I., & Cáceres, M.P. (2018). Augment reality and virtual reality for the improvement of spatial competences in Physical Education. *Journal of Human Sport and Exercise,* 13(2proc), 189-198.

Hernández, R., Fernández, C., & Baptista, M.P. (2014). *Metodología de la investigación.* Madrid, España: McGraw Hill.

Ierache, J., Igarza, S., Mangiarua, N.A., Becerra, M.E., Bevacqua, S.A., Verdicchio, N.N. et al. (2014). Herramienta de Realidad Aumentada para facilitar la enseñanza en contextos educativos mediante el uso de las TICs. *Revista Latinoamericana de Ingeniería de Software*, 2(6), 365-368. https://doi.org/10.18294/relais.2014.365-368

INTEF (2017). *Marco de Competencia Digital.* Madrid: Ministerio de Educación, Ciencia y Deportes.

Jódar, J. (2010). La era digital: Nuevos medios, nuevos usuarios y nuevos profesionales. *Razón y Palabra,* 15(71), 1-11.

Landero, R., & González, M. (2006). *Estadística con SPSS y metodología de la investigación.* México: Trillas.

López, J., & Fuentes, A. (2018). El liderazgo aplicado a los modelos diferenciados en educación: El caso de las cooperativas de enseñanza. In Gairín, J., & Mercader, C. (Eds.), *Liderazgo y gestión del talento en las organizaciones* (169-175). Madrid, España: Wolters Kluwer.

López, J., Fuentes, A., & Moreno, A.J. (2018). El liderazgo efectivo en los centros concertados de naturaleza cooperativa: Percepciones de sus docentes. *Revista actualidades investigativas en educación,* 18(3), 1-21.

López, J., Moreno, A.J., & Pozo, S. (2018). Influencia del género y la edad en la formación continua multidisciplinar de los docentes de cooperativas de enseñanza. *Revista Innova,* 3(8), 42-59. https://doi.org/10.33890/innova.v3.n8.1.2018.756

Lorenzo, G., & Scagliarini, C. (2018). Revisión bibliométrica sobre la realidad aumentada en Educación. *Revista general de información y documentación,* 28(1), 45-60. https://doi.org/10.5209/RGID.60805

Marín, V., Cabero, J., & Gallego, O.M. (2018). Motivación y realidad aumentada: Alumnos como consumidores y productores de objetos de aprendizaje. *Aula Abierta,* 47(3), 337-346. https://doi.org/10.17811/rifie.47.3.2018.337-346

McMillan, J.H., & Schumacher, S. (2005). *Investigación educativa*. Madrid, España: Pearson.

Pérez, C. (2005). *Métodos estadísticos avanzados con SPSS*. Madrid, España: Thomson.

Prendes, C. (2015). Realidad aumentada y educación: análisis de experiencias prácticas. *Pixel-Bit. Revista de Medios y Educación*, 46, 187-203. https://doi.org/10.12795/pixelbit.2015.i46.12

Rodríguez-García, A.M., Romero, J.M., & Campos, M.N. (2018). De nativos digitales a aprendices digitales: la realidad que se esconde en las universidades españolas. In López-Meneses, E., Sirignano, F.M., Vázquez-Cano, E., & Martin-Padilla, A.H. (Eds.), *Innovaciones e investigaciones universitarias hispano-italianas* (116-132). Sevilla, España: GEFORAN.

Sánchez, A., & Castro, D. (2013). Cerrando la brecha entre nativos e inmigrantes digitales a través de las competencias informáticas e informacionales. *Apertura,* 5(2), 6-15.

Santiago, R., Navaridas, F., & Andía, L.A. (2016). Las percepciones de los directivos de centros escolares sobre el uso y el valor de las TIC para el cambio e innovación educativa. *Estudios sobre Educación*, 30, 145-174. https://doi.org/10.15581/004.30.145-174

Sosa, M., & Valverde, J. (2015). El Equipo Directivo «E-Competente» y su Liderazgo en el Proceso de Integración de las TIC en los Centros Educativos. *Revista Iberoamericana de Evaluación Educativa,* 8*(*2), 77-103

Trujillo, J.M., López, J.A., & Pérez, E. (2011). Caracterización de la alfabetización digital desde la perspectiva del profesorado: la competencia docente digital. *Revista Iberoamericana de Educación,* 55(4), 1-16.

Yuen, S.C., Yaoyuneyong, G., & Johnson, E. (2013). *Augmented reality and education: Applications and potentials*. Berlin, Alemania: Springer Heidelberg. https://doi.org/10.1007/978-3-642-32301-0_17