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Opening Out the Educational Landscape
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AUGMENTED REALITY IN ONLINE EDUCATIONAL CONTEXTS: THE UOC CASE STUDY

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Introduction

The rapid growth of Information and Communication Technologies (ICTs) over the past decade has dramatically changed the ways in which people relate, communicate, and live. Technologies and applications that were hardly used some years ago (social networks, *smartphones* or tablets could be good examples) are already part of our daily lives. The educational field is not an exception in the 21st century trends, and ICTs have started to become common tools to support and guide the whole process of learning (Daly, Pachler, Mor & Mellar, 2010). Nowadays, learning environments are starting to integrate the use of computers, internet devices, multimedia materials, Web 2.0 authoring tools, simulations, games or, more recently, mobile phones and immersive technologies (Dror, 2008).

The application of ICTs in educational settings is particularly relevant for the European Higher Education Area (EHEA), an initiative of the Bologna process designed to create more comparable, compatible, and coherent higher education systems in Europe. The Bologna Declaration (Bologna Declaration, 1999) brought substantial reforms into High Education (HE) that implies changes in traditional teaching and learning strategies. Within this framework, there is a claim for adopting constructivist methodological approaches to learning. These approaches should be learner-centred and provide conditions to promote authentic learning activities. Precisely, Augmented Reality (AR) technology is increasingly being recognized as a new medium that could help HE institutions to meet some of the requirements of the EHEA (Fonseca, Martí, Redondo, Navarro & Sánchez, 2014; Mejías-Borrero & Andújar-Márquez, 2012). AR provides unique features which enable the development of situated, experiential, contextualized and authentic teaching/learning activities (Santos, Chen, Taketomi, Yamamoto, Miyazaki & Kato, 2014).

In a broad sense, AR can be defined as an emerging technology that allows the introduction of digital elements into the real world. That is, the user could see an image composed of the visualization of a real environment and virtual elements (such as videos, pictures, sounds, texts or 3d models) that are overlapped to it. One of the main aspects of AR is that virtual elements provide to the user relevant and useful data that is not available in the real world (Botella, Juan, Baños, Alcañiz, Guillém & Rey, 2005). Thereby, in educational settings AR has

a great potential to exploit the affordances of the real world by providing additional and contextual information that augments learners' experience of reality (Squire & Klopfer, 2007). AR allows for new ways to access information and to interact with the environments that can be used to design better learning experiences.

Is important to note that the term AR is closely related to Virtual Reality (VR), both are contained within the Milgram Reality-Virtuality Continuum (Milgram & Kishino 1994) (Figure 1) and reflect different levels of user's immersion in environments where physical and digital objects can co-exist. However, the main difference between them is that VR technology completely replaces the real environment with digital information, whereas AR complements the real world with virtual data (Azuma, 1997).

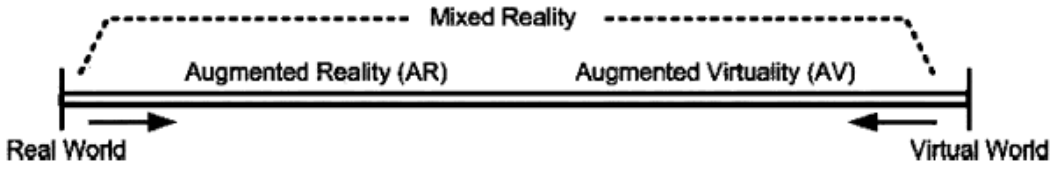

Figure 12. Reality-Virtuality Continuum proposed by Milgram & Kishino (1994)

Today, AR is enough mature and accessible for designing successful learning experiences. These experiences can be created and displayed by a wide range of technologies, including Head-Mounted Displays (HMD), desktop computers, laptops or handheld devices (such as *smartphones* or tablets). Generally, AR systems can be classified into four main categories (based on Johnson, Levine, Smith & Stone, 2010 and Lens-Fitzgerald, 2009):

- Physical World Hyper Linking: This is the oldest form of AR and includes the use of 1D codes (barcodes) and 2D codes (QR Codes). Some authors don't consider it a real form of AR.
- Marker type: The markers (black and white square images) are placed in front of a camera connected to a device. Once the marker comes into the view, digital elements are superimposed to it.
- Marker-less type: This is the most heterogeneous and emergent AR category. Markerless-based applications need a tracking system that involves a GPS, a compass, and an image recognition device instead of using a marker.
- Augmented Vision (AV). This category is still under development and includes unobtrusive devices such as smart glasses or contact lenses. AV allows for natural free-hands interaction with any object in the real world.

For the last ten years, educational institutions managed to adopt modern devices and new possibilities for teaching and learning provided by AR have been increasingly recognized. Consequently, several AR systems have been developed for enhancing traditional learning and training practices. Note, for example, that it has been used to develop simulation games performed in the real world, illustrate complex spatial or temporal relationships, visualize abstract concepts, experience phenomena that is not accessible in the real world, interact with 2D or 3D learning objects, develop narratives that cannot been developed in other

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technological environments, enhance paper-and-pencil educational formats, deal with the information and interact with theories in an innovative way or to learn foreign languages, among others (Billinghurst & Duenser, 2012; Chang, Morreale & Medicherla, 2010; Santos et al., 2014; Wu, Lee, Chang & Liang, 2013). As pointed by Johnston et al. (2010):

> *"AR has a strong potential to provide both powerful contextual, on-site learning experiences and serendipitous exploration and discovery of the connected nature of information in the real world" (p.21).*

These educational benefits have made AR one of the key emerging technologies for education over the next years. However, beyond the proliferation of AR applications in education, the use of this technology in eLearning contexts is still in a very immature stage. AR provides huge opportunities for eLearning, especially in disciplines that are unsuited to completely non-classroom training and that requires practical training (Mejías-Borreo & Andújar-Márquez, 2012), but its potential is just now being explored (Tsai, Shen & Fan, 2014). In addition, studies that investigate instructional strategies for applying AR are still lacking (Santos et al., 2014). As pointed by Fabregat (2012), there is no information available about the criteria to consider when using AR in eLearning. Nowadays, more research is needed to better understand when and under what circumstances could be useful integrate AR technologies in eLearning contexts.

Research objectives

The specialized literature reveals a relatively large volume of published studies that report advantages, limitations, effectiveness or challenges of using AR in education (Bacca, Baldiris, Fabregat, Graf & Kinshuk, 2014; Tsai, Shen & Fa, 2014). However, almost all these studies focused on the role of AR in face-to-face learning environments (Wu, Lee, Chang & Liang, 2013). In addition, the few experiences on AR and online education have been conducted as isolated practices in traditional face-to-face universities.

Today, there are no precedents in using AR as a transversal strategy in a fully online university. It is important to start to understand the possible impact of its use in online educational settings, describing how can be used it to generate authentic learning activities. More research is also needed to understand which are the most appropriate instructional designs for implementing AR in online education environments. Precisely, the present study is aimed to explore UOC's faculty opinions and recommendations regarding the introduction of AR technology within the UOC's virtual classrooms.

This research is part of a broader project in which AR technologies will be implemented within the UOC educational model. The UOC eLearning educational model gives the central focus on the students learning activity and includes three essential elements: the learning resources (referred to the items needed to perform a learning activity), the collaboration (includes a set of tools that encourages communication and teamwork among students) and the accompaniment (group of actions performed by the teaching collaborators) (García, 2013). The educational model of the UOC is outlined at Figure 2.

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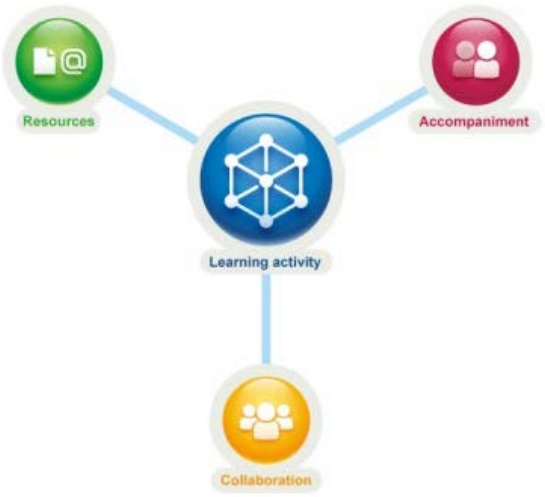

Figure 2. The UOC educative model

In particular, this study corresponds to an early stage aimed to explore the feasibility of implementing AR technologies within the UOC educational model. The specific objectives of the study were the following:

- Determine if AR can bring benefits to the students' learning.
- Identify what are the most appropriate AR tools and technologies for the UOC educational model.
- Identify what types of AR learning experiences can be designed to foster meaningful learning.
- Identify what types of instructional design are recommended when introducing AR in online education.

Methodology

Instruments

A mixed methods approach was used to collect data from fixed-choice and open-ended questions utilizing an on-line survey. The survey was primarily adapted from the Virtual Worlds Faculty Survey (Wood, 2010). In addition, new liker -scaled items and open-ended questions were included based on the objectives posed for the study and the review of the relevant literature. Finally, the survey was composed by four main blocks:

- Demographic questions. 8 questions
- Familiarization with AR and previous experience. 7 fixed-choice and 6 open-ended questions.
- **Faculty perceptions about AR technology**. 41 likert-scaled statements adapted from the Virtual Worlds Faculty Survey (Wood, 2010).
- **Faculty perceptions about the use of AR within the UOC educational model**. A set of 13 items in which likert-scaled statements and open-ended questions were combined.

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At the present work, only the most relevant data and findings will be presented.

Participants profile

Fifteen teachers from the UOC's Master in Education and ICT (eLearning) participated in the study. Nine were men (60%) and six were women (40%), with a mean age of 40.54 years (SD 7.70, range 31-55). Regarding the years of academic experience the mean was 16.80 years (SD 8.64, range 4-31). Sample demographics also identified 12 teachers (80%) and 3 course coordinators (20%).

It is important to note that the teachers of the Master in Education and ICT are highly familiarized with the instructional design, use and promotion of ICTs in eLearning. Therefore, they are well situated to reflect and judge about the possible integration of AR into the UOC educational model.

Discussion and conclusions

This study was designed to gain insights into UOC's faculty perception on using AR technology within online educational contexts. As far as we know, we would like to highlight that this is the first study addressed to the faculty members with the aim of asking them about the use and implementation of AR as a teaching and learning strategy in online learning environments. In this sense, the results obtained aim to provide some light for those interested in starting to use AR in an eLearning context or to those who are already using it, but would like to improve their current practices.

This study found that most of the faculty already knew what AR is and additionally knew that it could be used for educational purposes (93.3%). In addition, 53.3% of them had used it in his/her educational practices (the uses were mainly focused in using QR Codes to augment some elements of traditional textbooks) (Table 1). However, it is important to remember that the surveyed teachers are highly familiarized with the use of ICTs in education. This could have a positive effect on these findings.

Table 15: Types of AR used by UOC's faculty members in educational contexts

AR type	Frequency	Percentage
QR Codes	8	53.3%
Marker-based	5	33.3%
Geolocation	1	6.7%
Other forms	0	0%

Besides that, the number of teachers considering that they have good knowledge about the benefits, costs and AR educative applications was very low (Table 2). They perceived that do not possess the necessary skills and knowledge to learn how to use AR in an online classroom. It is important to note that these results were confirmed by the qualitative findings of the open-ended questions.

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Table 2: Degree of knowledge of the UOC's faculty about the benefits, costs and educational applications of AR

Questions	Not at all %(n)	Slightly %(n)	Somewhat %(n)	Enough %(n)	Quite %(n)	Extremely %(n)
AR benefits	13.3 (2)	6.7 (1)	53.3 (8)	13.3 (2)	13.3 (2)	0 (0)
AR costs	13.3 (2)	20 (3)	40 (6)	26.7 (4)	0 (0)	0 (0)
Applications	13.3 (2)	66.7 (10)	0 (0)	20 (3)	0 (0)	0 (0)

A concern over the need for faculty development in learning how to use AR technology in online education emerged in this study. The majority of the participants exposed that they needed training in AR technologies to know how to incorporate it into the UOC's educational model. They also expressed interest in implementing AR technologies in their courses and indicated good availability in get involved in future training activities. To address these perceived challenges, we plan to offer training opportunities and Open Educational Resources (OER) about the topic for the UOC faculty.

Results point towards that the implementation of AR into the UOC educational model would be beneficial for the institution and would have a positive impact on student's motivation. This suggests that the adoption of AR learning and teaching strategies could be attractive for online students and, by extension, can provide some help in reducing the elevated number of dropout rates in online educational programs. In future, we will conduct new research studies to evaluate the impact of AR on the number of dropouts at the UOC.

In general, the faculty considered that the implementation of AR within the UOC's educational model is feasible and appropriate. Specifically, their responses showed that the most appropriate AR-technology for our eLearning environment is geolocation-based AR and, in a lesser extent, AR marker-type. Faculty highlighted the potential of geolocation to enhance contextual information, foster everywhere, everytime learning, conduct role playing activities and promote be active and explore the real world. Regarding the use of markers, faculty stressed its potential to facilitate the understanding of complex and abstract phenomena.

Finally, regarding the recommended instructional and learning approaches, there was consensus in consider that AR has a great potential to engage UOC students in more authentic activities by promoting game-based learning and discovery-based learning. Participants also perceived that the implementation of AR can increase collaborative learning and student-centred learning. Table 3 highlights the answers to close questions. The results were confirmed with qualitative analysis from the open-ended questions, which stressed the relevance of collaboration, game-based learning and discovery-based learning. In a wider sense, this approach is similar to those used by Squire and Klopfer (2007), who developed a variety of mobile AR-educational games for face-to-face K-12 education. Now, the challenge (and the main innovation) is to adapt these educational strategies and implement it within an online higher education environment.

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Table 3: Recommended instructional and learning designs for implementing AR within the UOC

Questions	Not at all %(n)	Slightly %(n)	Somewhat %(n)	Enough %(n)	Quite %(n)	Extremely %(n)
Authentic Learning	0 (0)	6.7 (1)	26.7 (4)	33.3 (5)	33.3 (5)	0 (0)
Learning complex concepts	0 (0)	13.3 (2)	26.7 (4)	20 (3)	26.7 (4)	13.3 (2)
Collaborative Learning	0 (0)	13.3 (2)	26.7 (4)	26.7 (4)	33.3 (5)	0 (0)
Game-based learning	0 (0)	0 (0)	6.7 (1)	20 (3)	53.3 (8)	20 (3)
Discovery-based learning	0 (0)	0 (0)	13.3 (2)	20 (3)	33.3 (5)	33.3 (5)
Sense of belonging	0 (0)	13.3 (2)	33.3 (5)	40 (6)	13.3 (2)	0 (0)

The results obtained in the present study will guide the development of the next phases of the project, in which we will design, develop, implement and evaluate AR learning and teaching strategies within the UOC's educational context. In particular, we plan to use geolocation-based AR though the use of wearable technologies to promote discover-based learning, enhance collaboration processes and engage students in authentic learning activities.

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