Chapter 6
Augmented Reality in Spain: Heritage Education, Cultural Tourism and Museums

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Abstract This chapter analyses how Spanish institutions, archaeological sites and publishers in the field of formal education are using Augmented Reality (AR) as an educational tool. After a decade since its arrival in the cultural world of Spain, augmented reality has undergone a process of implementation and settlement characterized by being in the background of activities, exhibitions and by apps with such short life cycles that only a few specific studies have been conducted. The use of AR in some Roman sites in Spain, the Sorolla museum in Madrid and the Alhambra in Granada are examples that are analysed in this chapter based on significant educational theories within the field of Heritage Education.

6.1 Introduction

The emergence and consolidation of the digital society in the twenty-first century has meant that the daily lives of citizens and institutions of any kind have been dominated by the systematic use of new technology.

Education, cultural tourism and museum spaces are not alien to the development of contemporary society, so they have turned to technology to generate new proposals adapted to a public accustomed to using mobile devices in their daily routines. In the case of education, this involves taking a new look at the teaching and learning processes, new possibilities to promote interest among students who

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are digital natives communicating with peers and with the world through screens. Augmented reality (AR) fosters active participation in learning and students can become intellectually, creatively, emotionally, socially and physically involved in the process (Ibáñez-Etxeberria et al. 2010). Cultural tourism has not been oblivious to the extraordinary development of Industry 4.0, and has found in it new tools and ways of interacting with the visitor in order to enhance and enrich the attractiveness of heritage sites and increase the market of potential visitors (Bernad 2020). This has meant that more and more tourist places are incorporating AR and virtual reality (VR) experiences in their cultural offer; although it is true that they continue to be a minority and the implementation of this type of technology is still in an initial phase.

During the last decade museums (as well as tourism at-large) have undergone an unprecedented technological revolution that, with greater or lesser success, has allowed them to acquire new resources through which they can extend their cultural content to a greater number of users through attractive and didactic experiences (Ruiz and Bellido 2014). The origins of the implementation of the digital world in museum spaces date back to the mid-1990s with the appearance of the World Wide Web and the creation of the first Web pages (Kargas et al. 2020). This first phase was followed by a second one characterized by the proliferation of social networks 2.0, digital tools used by museums to connect with their audience, without geographical barriers, and, in most cases, without cost. Kargas et al. (2020, p. 118) define the use of social networks by these spaces as "an alternative, faster, low cost and direct (user friendly) way to share content, to announce events and to extend 'potential' visitors' pool". Social networks, in addition to many other applications and digital environments, were favoured by the systematic use of smart mobile devices by the population (Luna et al. 2019). Parallel to the use of social networks by museums, over the last decade, two technologies have been developed (VR and AR), which represent a clear enrichment of the traditional visit to the museum's physical space and, therefore, improve the quality of the learning experience in visitors, participants or users (McGovern et al. 2019).

Among the various types of existing technology, AR is gaining strength within the museum field, although it is true that its use is limited to a small number of museums. Ruiz and Bellido (2014) point out that museums are not creating virtual spaces parallel to physical museums, but rather a virtual enrichment of real spaces is taking place, providing them with accessible digital content through applications and capable electronic devices to access AR. The use of this avant-garde technology allows the generation of new mediations between the visitor and the heritage asset, new forms of interaction and/or reconstruction of the spaces that are a plus to the traditional visit and mediation. Generally, to read these new languages, it is necessary to have only a smartphone, tablet or AR glasses, devices that are economically affordable for a large part of the population, which does not imply, however, that there are certain sectors that continue to be excluded because of the digital divide.

6.2 Research Areas

As Kargas et al. (2020) indicate, current research on virtual and augmented reality has been motivated by the first works published in this field, such as the analysis of interactive technologies in museums (Sparacino et al. 2000) or interactive exhibits using screens with augmented reality (Brown et al. 2003; Bowers et al. 2007). Later studies focus on the comparison between three close technologies: virtual reality, augmented reality and Web3D (Sylaiou et al. 2009; Santamaría and Mendoza 2014) and the development and application of augmented reality in archaeological sites (Angelopoulou et al. 2011; Esclapés et al. 2014; Gutierrez et al. 2015). Current research focuses on the evaluation of heritage education in virtual environments and augmented reality (Kortabitarte et al. 2017; Ibáñez-Etxeberria et al. 2010), and the analysis of the strengths and operational weaknesses of virtual and augmented reality in the field of museums (Loumos et al. 2018).

In 2020, museums continue their digitization and dissemination process based on three fundamental pillars: virtual reality, augmented reality and social networks. These three pillars are an insight into the interest of museums in meeting some of the objectives established in article 14 of the Faro Convention (Council of Europe 2005) regarding the use of digital technology to improve access to cultural heritage and some of the goals included in the Sustainable Development Goals adopted by the UN General Assembly as a plan of action in the 2030 agenda (UNESCO 2015; UNESCO et al. 2015). The current research aims to respond to these documents, focused on the appreciation of cultural diversity and on redoubling efforts to protect and safeguard the world's cultural and natural heritage.

This chapter analyses the implementation of AR and VR in cultural institutions that host heritage of diverse nature, from which unique practices and experiences that implement AR as an educational tool are collected.

6.3 Augmented Reality in Heritage, Tourism and Education

Heritage education can contribute in various ways to achieving a true awareness of people towards the cultural legacy. Currently, the relational method (Fontal et al. 2015), based on the links between people and assets (Fontal 2003, 2013) is one of the most valued for achieving quality meaningful experiences based on understanding and appreciation of the cultural legacy. In a certain sense, the intensity of the experiences, the emotions and the experience that we have with the patrimonial asset, will determine our link with it and, therefore, reinforce that relationship of understanding, valuation, care and transmission. The trigger in these relationships will predominantly occur through two lines of action, which respond to the main channels of approach of society to heritage environments: Education and Tourism—the fundamental pillars of this study.

The emergence of both tourism and education, as far as heritage is concerned, are almost a simile, since both tourism—a set of human interactions, a social and cultural phenomenon (Department of Economic and Social Affairs 2010)—and education—a social institution that develops the intellectual, moral and affective capacity of people in accordance with the culture and the rules of coexistence (Durkheim 1975; Sarramona 2000)—are the fundamental pillars for the achievement of the primary objective of heritage education and social awareness. Both forms of approach to heritage presuppose a social starting point based on the search for knowledge and enjoyment, which increasingly demands authenticity in experiences (Perea-Medina et al. 2018). For this reason, the context that is analysed in this chapter is a non-formal educative scenario, in particular apps with augmented reality related to tourism and the dissemination of heritage spaces to ascertain the extent to which experiences are enriched by their implementation in the visits. Not only are apps specifically aimed at the school public being studied, but they are also designed to expand cultural experiences, so that they can serve as an interactive complement or accompaniment to the visit, either individually or collectively, and for all ages.

Heritage education, in its most virtual and digitized aspect, turns its teaching–learning strategies towards a more real, subjective experience of heritage, enabling a greater approximation of the legacy to society. This experience is becoming increasingly important due to the incorporation of new technologies (Ibáñez-Etxeberria et al. 2018). A recent study by Ibáñez-Etxeberria et al. (2020) highlights the potentialities of the use of AR and VR in the teaching of heritage, pointing to this as one of the greatest impacts in mediation of assets. However, depending on the categories of heritage with which we are going to work, this potential will have more or less power and a surprising capacity linked to other social factors, such as the desire to know what the past was like. This is closely linked to archaeological heritage, and thus presents a large number of virtual educational initiatives. The archaeological remains and places linked to memory set us a strong challenge, since it implies an arduous task of reconstruction and cognitive interpretation of spaces by the visitor. A pathway of immersion into the spaces of the past is favoured. This enriches the experience and is the key to raising awareness. Archaeological heritage gives us more information about our past but requires a great effort of imagination for those who contemplate it, a practice that, when accompanied by AR or VR, can provide us with a more complete experience of the visit. AR allows us to enlarge the visible part of a vestige (Chang et al. 2014) or to show an entire context around a heritage element (Petrucco and Agostini 2016; Zhang et al. 2018). Likewise, its implementation can include a virtual guide to accompany us during the visit (Chatzidimitris et al. 2013), provide us with information superimposed in the context such as data, anecdotes or video recreations about places of interest (Furata et al. 2012), or propose an interactive game in which the virtual and the real overlap (Angelopoulou et al. 2011; Perra et al. 2019).

All these possibilities are an asset applicable to tourism, since at present it is also committed to an experiential and emotional tourism applying the same relational theoretical approach (Pérez-Martínez and Motis Dolader 2018). The promotion of

heritage is increasingly based on the integration of narratives and the use of storytelling to move and captivate, as well as to awaken emotions in the visitor, providing a turn in tourism policy to maintain the "fascination for the past", legacy and memory (2018, p. 389). Some authors, such as Vinuesa and Torralba (2018), even speak of a dialectical relationship between territory, heritage and tourism. AR is established in tourism as a platform that provides new opportunities for the development of the sector, again, predominantly focused on virtual tours, preferably of historical places and their promotion. However, common limitations in both sectors are highlighted: arduous, slow and expensive processes of development of both manual and software (Templin and Popielarczyk 2020). Various studies agree that this new technology allows us to digitally preserve culture and favour sustainable development through the promotion of respect and care for heritage (González-Rodríguez et al. 2020; Little et al. 2020; Lv et al. 2020; Templin and Popielarczyk 2020). In addition, they speak of this technology as an asset for attracting tourism, as well as a more comprehensive and sensory learning experience with the integration of multifaceted information that is capable of providing data for a greater understanding of the space or for recreating events and places (Graziano and Privitera 2020).

Whether as a tourist asset or as an educational axis, museums and heritage spaces are at the forefront of new technologies. All these possibilities can be put into practice in situ or through virtual museums, although at the moment the latter is most used (Ibáñez-Etxeberría et al. 2020). This new way of approaching heritage without damaging or polluting it (Chang et al. 2014) allows us to increase motivation, interaction and knowledge of our cultural heritage. However, the integration of AR in culture is proving to be a slow and gradual process of progressive implementations. Each of the new AR applications implies high cost and laborious development to achieve the "magic" combination of the real space and the superposition of digital objects. In the tourism sector, the way of financing may be more pronounced through public–private partnerships, which promote tourism and guarantee the preservation and restoration of cultural assets (Medvedeva et al. 2018). So far, the search for AR-based heritage projects leads us to the conclusion that a high percentage is allocated to the documentation, reconstruction, restoration and dissemination of heritage. However, this gradual increase in AR-related education and tourism provides us with some unique and remarkable initiatives.

6.4 Emerging Practices: Spanish Institutions Committed to AR

The research group ARGOS, dedicated to the didactics of social sciences, is carrying out a continuous task of locating exemplary practices related to virtual environments, edu-communication in network and cutting-edge technologies. Hence, in this chapter, we seek to highlight some institutions that implement AR from their non-formal spaces and influence any of the axes addressed, be it tourism or heritage education.

Among the institutions studied, we found some museums that implement apps with AR to promote a more comprehensive and experiential experience of the visit, as is the case of the Carlos V Museum located in the town of Mojados (Castile and Leon), the first museum in Spain dedicated exclusively to the figure of King Charles V. The museum offers its visitors a free app for mobile devices, which is divided into two types of activities: a question-and-answer game type quiz where the visitor must answer questions about the monarch Carlos V. An AR tool provides access to different images and texts that allow the information received during the visit to be expanded (see Fig. 6.1). QR codes are represented in the form of different shields and these must be scanned with the rear camera of visitors' electronic devices.

Apps are at the forefront of attracting tourists to promote heritage and this is the case in the town of Fuendetodos (Zaragoza), which has its own app to promote the heritage of the area. The app is divided into two sections. The first section consists of a series of challenges to be met through gamification to obtain rewards; challenges related to different activities that can be carried out by visiting the municipality. The second section is dedicated to the various cultural itineraries that can be found in the town by visiting different points of interest during a town tour. It offers QR codes to access different AR content, for example, the painter Francisco de Goya's workshop

Fig. 6.1 A visitor using the app "Museo Carlos V" (Courtesy of Museo Carlos V. https://www.museocarlosv.es/es/interactua-aprende/juego-app-movil)

Fig. 6.2 Promotional image of the app "Fuendetodos" (Courtesy of Heraldo de Aragón. https://www.heraldo.es/noticias/aragon/zaragoza/2018/05/22/una-app-realidad-aumentada-invita-fotografiarse-con-goya-recrear-sus-caprichos-1245305-2261126.html)

(see Fig. 6.2). Finally, AR allows children to recreate in three-dimensioned colouring cards based on the works of Francisco de Goya.

Similarly, the town of Alcalá de Henares (Madrid) offers an app for visitors to access a virtual guide by scanning the codes of different points of interest. The AR-based impersonation of "Cardenal Cisneros" acts as a tourist guide offering explanations about the place (see Fig. 6.3). Finally, the app also allows visitors to take a selfie with a 3D reproduction of the character to share the image on Social Media Networks.

As we have mentioned previously, archaeological sites are one of the most profuse categories in the implementation of AR. This is the case of the "Open Air Museum Villa romana de l'Albir" in l'Alfàs del Pi (Alicante), where the Virtual Heritage team of the University of Alicante and the City Council of l'Alfàs del Pi have developed an app available on the iPad in four languages where, due to AR, visitors can access the virtual 3D visualization of the set of hot springs on the site. This allows tourists to visualize the original architecture on the archaeological remains; thus enriching the visit (see Fig. 6.4).

Another example is the "Yacimiento de Villaricos" in Almanzora (Almería), which offers an app for mobile devices that, in addition to giving users information about the hypogeum and the trousseau that it contain, allows a 3D in situ recreation of the Hypogeum of the Phoenician necropolis in two of its historical phases (sixth century B.C. and third century B.C.). This allows visitors a better visualization of the past (see Fig. 6.5).

Finally, the Phoenician archaeological site of Gadir (Cádiz) is a museum site in the heart of the city that shows the evolution of the city, from its beginnings as a

Fig. 6.3 An image of the app "Cisneros GO" (Courtesy of 6Dlab. https://apps.apple.com/es/app/cisneros-go/id1358631720)

Fig. 6.4 A visitor using the app during his visit to Museo al Aire Libre Villa romana de l'Albir (Courtesy of Patrimonio Virtual. https://www.patrimoniovirtual.com/proyecto-albir/)

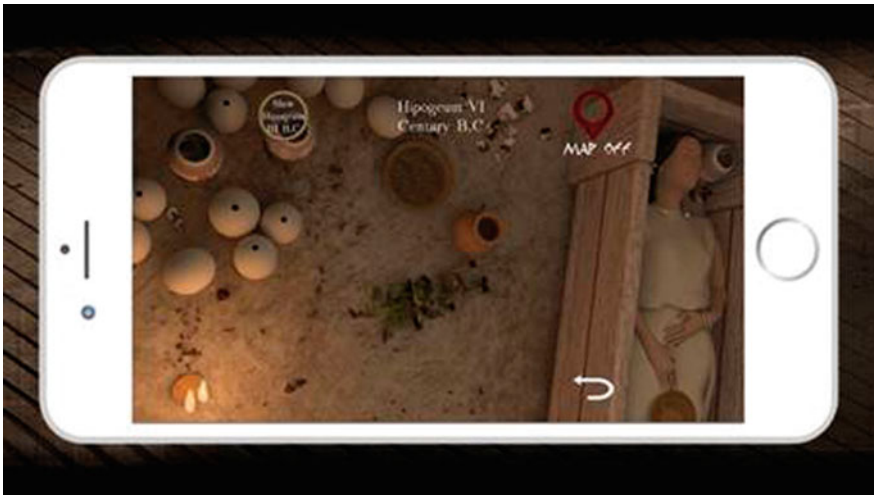

Fig. 6.5 Screenshot of the app "Villaricos Virtual" (Courtesy of App Store https://apps.apple.com/us/app/villaricos-virtual/id1434225495?l=es)

Phoenician settlement to its consolidation as a Roman city, among other features. The Vitelsa Group, in collaboration with the Institute of Promotion, Employment and Training (IFEF) of the Cadiz City Council, prepared the museum plan and a technological project for the implementation of AR. This project placed electronic devices where a 3D reconstruction of the compound archaeological remains can be observed in situ, among other things, by the intersection of two paved streets and eight houses of the ancient Phoenician settlement.

In addition to the examples mentioned above, we would like to examine some particularly striking cases, both for their success in terms of their dissemination and use and especially for their edu-communicative proposals.

6.4.1 Bilbilis: An AR Immersion into a Roman Site

The archaeological site of Bílbilis, located in the municipality of Calatayud (Zaragoza), was a site of Celtiberian origin (from the first century B.C.), which, due to the fertility of the lands and its important workshops, became a rich settlement which declined around the beginning of the second century and was abandoned in the late fourth or early fifth century A.D. Due to its richness, a free app "Augusta Bílbilis Guide" was developed to offer visitors a much more holistic experience of the place; to enhance their knowledge and enjoyment. This application, which offers its content in Spanish and English, was developed for ADRI Calatayud-Aranda by the company Prames S.A. The contents of the app were prepared by

Manuel Martín Bueno, Pilar Rivero and Carlos Saénz, specialists in history, archaeology, heritage education and didactics of the social sciences. The photographs and plans were provided by the Bílbilis excavation team and the modelling in 3D by the Advanced Graphic Computing Group (GIGA). In addition, the wide range of educational resources was completed by the virtual reconstructions carried out by the URBS research group and the GIGA of the University of Zaragoza, through the Government of Aragón project "Roman Heritage of Aragon: didactic application of images synthetics digital" (2007–2009) coordinated by Manuel Martín Bueno.

Through this app, users have access to: an archaeological itinerary, the history of the excavations, explanations of the main points of interest and the 3D reconstruction of different maps and buildings due to the use of Augmented Reality (see Fig. 6.6). The AR module activates the rear camera of the mobile device, offering a real image of the place that the device allows by combining with three-dimensional recreations, thus offering the user a mixed reality experience in real time. In this way, the images recreated in 3D appear incorporated into the different spaces of the site, adapting them according to the position and distance of the visitor to the archaeological remains.

In addition, in 2021, Bílbilis plans to enhance its AR resources with a new application called "Aragon Open Air Museum", a development from the University of Zaragoza with financing from the Government of Aragon and European Union (ERDF "building Europe from Aragon"). This app includes AR projected on archaeological remains. This initiative seeks to facilitate the understanding of the archaeological remains, which are often difficult to understand without prior archaeological knowledge. Compared to the usual virtual reconstruction, the placing of the digital model on the archaeological remains allows spontaneous association of each element with its reconstruction, so affording a much simpler interpretation process.

The app will allow users to add contents, comments and set customized routes that can be shared with other users. This constitutes an advance within the social

Fig. 6.6 Codes for using the app "Guía de Augusta Bílbilis" during the visit (Courtesy of Museo de Calatayud. https://museodecalatayud.blogspot.com/)

network or web 2.0 and is in line with the Sustainable Development Goals in terms of promoting participatory communities (Rivero et al. 2020b). This consequently promotes the creation of patrimonial cyber communities that grant the historical rest archaeological and symbolic-identity values (Rivero et al. 2018, 2020a).

6.4.2 *Los Millares: AR Applied to a Copper Age Settlement*

Continuing with the line of dissemination of archaeological heritage, we highlight the case of "Los Millares", an archaeological site from the European Chalcolithic, which was approximately occupied between 3200 and 2200 B.C. The site is made up of a town with four lines of concentric walls, a necropolis of collective tombs, comprising some 80 graves of different ceremonial structures distributed in small groups, and a set of 13 forts that complete a powerful defensive system which controlled the settlement and its surrounding territory. Like the previous example, this site has an application launched by the Ministry of Culture of the Junta de Andalucía and sponsored by Michelin, which allows, due to the use of AR, the interpretation of the archaeological remains preserved at the site. It is a visual recovery of the site made from an extensive documentation process complemented with more than 1,500 photographs that have made possible the virtual modelling of the three burial mounds located in the itinerary of the visit and of the first line of the town wall.

To access the AR, visitors stand in front of the information panels along the route through the archaeological site (see Fig. 6.7). This tool is an outstanding complement to the proposed educational itinerary and combines well with the materials offered at the site's interpretation centre.

6.4.3 *Sorolla Museum: The Use of AR to Understand Pictorial Works*

Another category within the non-formal settings is the Sorolla Museum. This museum, located in what was the residence and studio of the painter Joaquín Sorolla in Madrid, was created at the request of the artist's widow: Clotilde García del Castillo. In 1925 she made a will donating all her assets to the state to found a museum in memory of the painter. In 1932 the museum was inaugurated with Joaquín Sorolla García as director, the artist's only son, who bequeathed new funds to the museum, completing the collection with the purchase of more works by the painter. The free app for mobile devices "Museo Sorolla AR" is conceived as a pioneering project and in 2018 became the first free download cultural app (project led by the companies 6DLAB and ARS Viva).

This app allows users to discover details of the artist's work by pointing the rear camera of their electronic device at some of the works on display. The app integrates

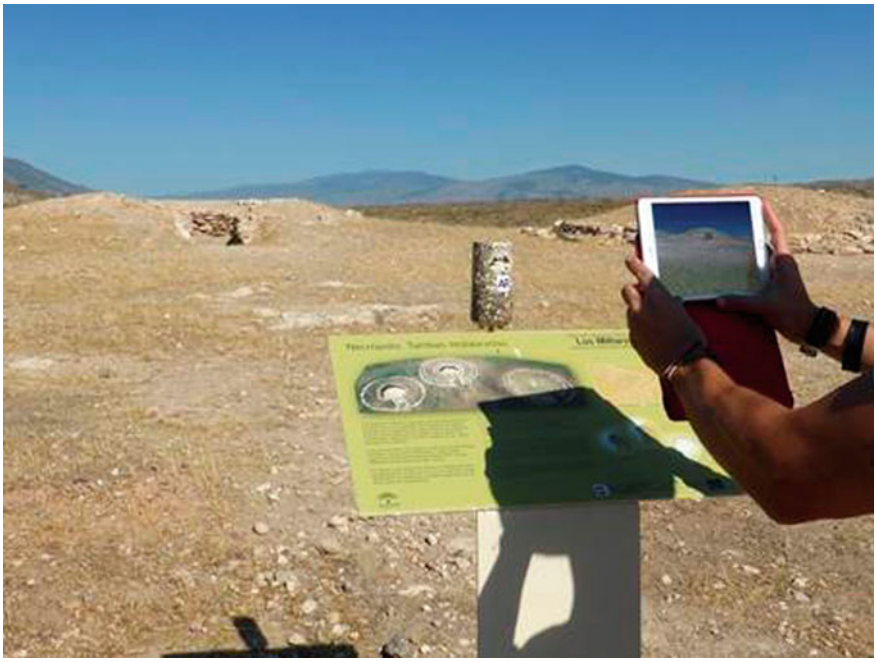

Fig. 6.7 A visitor using the app "Los Millares" (Courtesy of Junta de Andalucía. https://www.juntadeandalucia.es/cultura/aaiicc/millares-virtual)

videos of actors characterized as the painter himself and other characters that appear in the painting set to explain some significant data of the works (see Fig. 6.8). With this video and image overlay obtained on the device screen, visitors can access a greater amount of information about the artist's paintings in an attractive, dynamic and unique way, thus replacing the cartouches attached to the wall that holds the works. This app takes one more step in terms of accessibility for all audiences. Specifically, the resource has been incorporated into its website so that it can be experienced from home or the classroom, or elsewhere, by focusing the mobile device on the photographs of the works hosted on the official website of the museum; taking the viewer directly to the visualization of the videos.

Finally, as in some of the previous examples, the implementation of AR in the museum also allows users to take a selfie with the painter Joaquín Sorolla and his wife Clotilde García del Castillo, a feature that various institutions already promote and that encourages users to share the image obtained on social networks, as so enhancing their use.

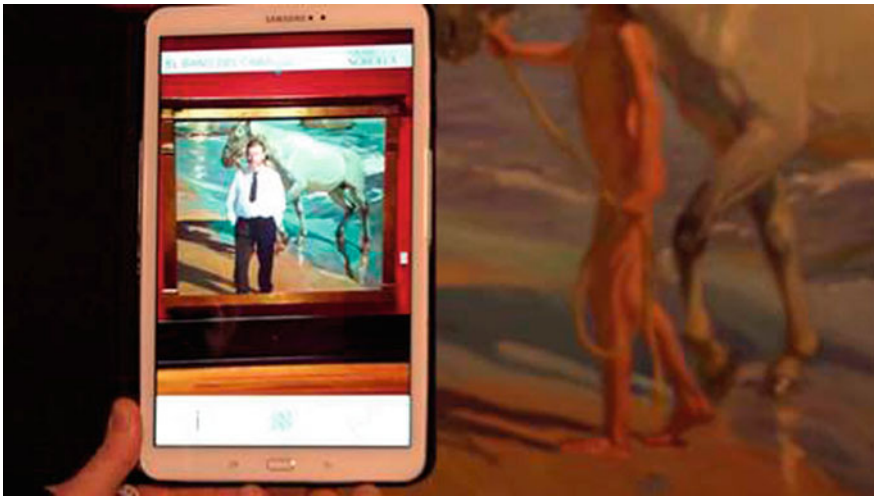

Fig. 6.8 A visitor using the app "Museo Sorolla AR" (Courtesy of Jesús Jiménez. https://www.rtve.es/noticias/20180314/sorolla-guia-visitantes-su-museo-gracias-realidad-aumentada/1695701.shtml)

6.4.4 The Alhambra: The Use of AR in a Children's Audio Guide

Not a museum, but as one of the jewels of Hispano-Muslim Andalusian art in Spain, this monumental complex offers the app "La Alhambra, Castillo Rojo". It is a project financed by the Junta de Andalucía through the IDEA agency and put into practice by the tourist group Granavisión. It is presented as a motivating and gamification-based children's audio guide that invites you to visit the Alhambra in Granada through different features that integrate AR, games, audios and different challenges that users must overcome. This project, available in four languages, combines the free download of both the application and some content with other exclusive paid content to be unlocked during the visit.

In "La Alhambra. El Castillo Rojo", users must retrieve some hidden keys to ensure that the Alhambra does not disappear. To do this, they must look for the keys hidden around the monumental enclosure while interacting with different characters who will guide and explain not only characteristics of the rooms, but also part of the history of the area. The app provides information on the different rooms that make up the enclave, offering information adapted to children, which must be discovered through the codes distributed by the different rooms (see Fig. 6.9). These codes allow users to view on their electronic devices the explanations of four different characters (King Boabdil, Queen Morayma, the military Yusuf and King Carlos V) through photographs, stories, drawings and audios conceived for and adapted to children. Once again, the application allows selfies, in the end, with the characters that have accompanied the visitors.

Fig. 6.9 Visit using the app "La Alhambra. Castillo Rojo" (Courtesy of Alhambra on line. https://www.alhambraonline.org/audioguia-infantil-alhambra-castillo-rojo)

6.5 Conclusions

It is no coincidence that after almost ten years of experience, we have barely been able to collect cases where the implementation of AR has experienced a journey in time significant enough to allow us to analyse aspects such as the evolution in the use of AR as an educational tool or the perception of it by the public.

After observing the use of AR in Spain in the tourist, cultural and educational fields, it appears that the few specific, existing initiatives have either not developed into applications for electronic devices which last beyond a beta test, are already unusable today, or have not materialized due to a lack of funds.

A "magic formula" that would guarantee the success and durability of an AR application does not exist. Only if the content is sufficiently interesting and attractive, the parties involved in the financing, development and promotion of an AR app can manage to get good results.

Future research should investigate the student's perception of AR and its educational use in both formal and non-formal education. Initial technological problems such as excess battery consumption of the mobile device or the need to be connected to the Wi-Fi network in order not to consume excessive data are less and less significant due to the generalization of flat rates or the improvement of electronic devices. Now is the moment for public and private institutions to encourage and promote the use of AR for educational purposes.

In conclusion, public and private institutions should promote and enhance the use of AR for educational purposes. The design of heritage interpretation applications, from our point of view, should be in accordance with the concerns of our time and, consequently, be linked to the Sustainable Development Goals in at least two basic aspects: first, goal number 4 "education of quality", with applications designed from a didactic approach; and second, the creation of participatory communities, through applications to take advantage of the potential of web 2.0 or social web, in line with the promotion of heritage communities already included in the Faro Convention (Council of Europe 2005).

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