

**UNIVERSITAT  
JAUME·I**

# **FINAL PROJECT OF THE EARLY CHILDHOOD EDUCATION DEGREE**

## **CREATIVE EXPERIENCES OF AUGMENTED REALITY (AR) WITH MOBILE TECHNOLOGY IN EARLY CHILDHOOD EDUCATION.**

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## **Abstract**

### *English*

In our society we are continuously surrounded by Information and Communication Technology (ICT) which is taking a big part of our daily life. These technologies suffer from constant changes due to the fact that human beings discover, create and invent new technological tools. A great example would be augmented reality (AR), which is able to offer us an interactive experience expanding our reality from digital elements. In addition, AR in education gives the opportunity to improve and enhance the skills of students to acquire new learning skills. This requires that teachers are trained for this new technology so present today. Therefore, the main objective of this educational proposal is to design, develop and evaluate a web page of resources to train teachers and thus introduce augmented reality in the early childhood education classrooms.

For its realization, we have started from a search for relevant information on the subject that is addressed. The web portal was designed and created taking into account the information gathered from the theoretical framework and through evaluation instruments, in this case a series of interviews with ICT experts and early childhood teachers. A number of improvements were made, such as adding a repository of relevant augmented reality activities and resources on the same web page.

After collecting the results, they pointed out that the website has a clear structure, that it offers adequate and didactic content. And at the same time, the activities are useful and practical to learn about this technology. In addition, some of the conclusions were that the website gives the possibility to learn freely and that AR is a motivating and very interesting tool to acquire knowledge in the classroom as it is present in our world on a daily basis.

### *Spanish*

En nuestra sociedad estamos rodeados continuamente de las Tecnologías de la Información y Comunicación (TIC) que está ocupando gran parte de nuestra vida cotidiana. Estas tecnologías sufren cambios constantes debido a que el ser humano descubre, crea e inventa herramientas tecnológicas nuevas. Un buen ejemplo es la realidad aumentada (RA), esta es capaz de ofrecernos una experiencia interactiva ampliando nuestra realidad a partir de elementos digitales. Además, la RA en la educación da la oportunidad de mejorar y potenciar las habilidades del alumnado para adquirir nuevas habilidades de aprendizaje. Esto requiere que el personal docente esté formado para esta nueva tecnología tan presente en la actualidad. Por eso, el objetivo

principal de esta propuesta educativa es diseñar, desarrollar y evaluar una página web de recursos para formar a los docentes y así introducir la realidad aumentada en las aulas de educación infantil.

Para su realización, se ha partido de una búsqueda de información relevante en cuanto a la temática que va dirigido. Se diseñó y se creó el portal web teniendo en cuenta la información recogida del marco teórico y mediante instrumentos de evaluación, en este caso una serie de entrevistas a expertos TIC y maestros de infantil. Se puntualizan una serie de mejoras, como añadir un repositorio de actividades y recursos relevantes sobre realidad aumentada en la misma página web.

Después de la recogida de los resultados, estos apuntaban que la página web tiene una estructura clara , que ofrece un contenido adecuado y didáctico . Y a la vez que las actividades son útiles y prácticas para aprender sobre esta tecnología. Además, algunas de las conclusiones fueron que la página web da la posibilidad de formarse libremente y que la RA es una herramienta motivadora y muy interesante para adquirir conocimientos en el aula ya que está diariamente presente en nuestro mundo.

## **Key words**

Augmented Reality, pedagogy, classroom, teachers, training, applications, information and communication technology, skills, learning, early childhood, mobile technology.

### **1. Introduction**

We live in a globalized world where ICT forms an important part of this society as they digitally transform our lives. "The technological revolution in the media, channels and supports of information that is taking place before our eyes can be included in a broader set of changes in the productive structure of our society<sup>1</sup>" (Adell, 2006, p. 6). This digitalization changes the way of knowing, thinking and communicating, providing new opportunities for learning. New technologies are the way to achieve knowledge. "Technologies have a relevant role, not only as the content of training, but also as a meaning to bring this training to its recipients" (Adell, 2006, p.10). Therefore, it is important to use them to train human beings.

Within ICT there are different technologies that surround us today, but in these pages we will focus on one in particular, augmented reality, a tool that is capable of transforming our society. "AR

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<sup>1</sup> All quotations in the document have been translated from the original version into English.

(Augmented Reality) is to add a layer of virtual information superimposed on the existing physical information through a real-time device" (Bellver, 2022).

In order to learn to use ICT, the teacher's digital competence plays an important role in the use of technology both inside and outside the classroom and in guiding students in the use of ICT. "Keeping teachers digital competencies up-to-date, in other words, means that teachers are ready for education in the digital sense and in this sense, they respond to the necessary needs and problems of the students" (Gümüő and Kukul, 2023, p. 2762).

The next paper is a didactic proposal on AR aimed at the teachers to expand their knowledge about the interactive experience of AR through the use of ICT, since it offers us endless opportunities to improve and continue to grow in a world that is constantly changing. "Institutions offering face-to-face training are beginning to use new technologies as a didactic resource and as a tool to make teaching/learning environments more flexible..."(Adell, 2006, p.12). This initiative is free training, "This degree of flexibility will allow many people with family or work obligations to continue their training throughout their lives" (Adell, 2006, p.12). Therefore, the purpose of the research has been to create a web portal so that teachers can be freely trained in augmented reality and can apply it in their early childhood classrooms.

In the following section of this work, the main points of the proposal will be addressed at a theoretical level, from ICT and augmented reality to the importance of teachers training. Next, in the methodology, the objectives, the evaluation instruments used and the people who participated in the process, in this case ICT experts and early childhood teachers, are presented. Next, the resources and activities are described. Finally, the results and conclusions obtained in the research are shown.

## **2. Theoretical framework**

### *2.1 Information and communication technologies (ICT)*

Nowadays, technology undergoes constant changes, which means it does not stop evolving and offering us new ways each day. Information and Communication Technologies (ICT) are dependable tools for improving our lives and they make us rethink our vision for the future. Due to the advance of ICT, the schools must give an adequate response to provide greater opportunities for both students and teachers, to adapt teaching to their individual needs and for the students to obtain better learning (Das, 2019). ICT are part of our daily life. According to Area and Adell (2021), ICT are a great opportunity for educational change since they allow the implementation of

many of the pedagogical principles such as learning experience and activity, collaboration, etc. In addition, during the covid-19 pandemic, they were essential in providing urgent responses to all the needs that arose during that time in all areas. Moreover, Marimon-Martí et al. (2022) presented technology as a change where we can see the evolution of technology over time and our view of its role in society.

In addition, Adell (2006) exposed “technologies already established over time, the ones we use habitually or since childhood, are so perfectly integrated into our lives, like second nature, that they have become invisible. We use them to such an extent that we are unaware of how they have contributed to changing things” (p. 2). According to Adell (2006), the ICT changed the way to interact, “an example of these new forms of interaction are virtual communities: groups of people who share an interest and use computer networks as a cheap and convenient communication channel between spatially dispersed and temporally unsynchronized individuals. This feature, interactivity, together with delocalization, defines the new information technologies more than any other and has crucial implications in all areas of information technology. crucial implications in all areas of our experience” (Adell, 2006, p. 9).

If we focus on the use of ICT in education we can see that it offers a wide range of learning possibilities from the adaptation to the characteristics of the students, the opportunity it offers for self-learning, different forms of evaluation... to new strategies such as collaborative or hybrid learning (Marimon-Martí et al. 2022). Moreover, the pandemic confinement showed us the big possibilities that ICT can offer to society. The urgent need to give an answer to our limitations because of the situation showed us the importance of ICT in our lives. Digital technologies develop our abilities and also it helps us to make multiple daily activities such as get information, play, work... for improving our lives. “Almost unintentionally, teachers and students, outside of school, began to equip themselves with their own technology, to develop the knowledge and technical skills of its use and to become aware of their need for them to function as citizens of today's society” (Area and Adell, 2021).

ICT has shown us the great possibilities it can offer us through its continuous change. Also it has the power to transform education. Linked to this, the possibilities of ICT are very wide because they open the curiosity, inventories and construction, they improve the quality of education, they give us new tools to improve the learning and they help to achieve new competences, they increase the motivation, they also make the education more accessible... For example, if a child lives in a rural location can learn through distance learning from his home (Das, 2019). According to Adell and Castañeda (2012), schools began to incorporate ICT in their classrooms with the purpose of preparing students for a new information society and teaching them to use them as a

learning tool. In addition, Cabero and Ruiz (2017) exposed the importance of facilitating social and digital inclusion both in education and in society to promote personal development and offer tools and formation for improving their digital competence.

Finally, “The contribution of ICTs to education and society as such is undoubtedly flexibility and adaptability to an increasingly changing environment. While at the outset labor was mainly affected by this process, however, the passage of time has shown that society depends on a technological approach to help it build and acquire knowledge” (Hernández, 2017, p. 345). Also, Adell (2006) emphasizes “the greatest potential of new information technologies in education lies not only in what they will bring to current teaching/learning methods, but also in the fact that they are radically transforming what surrounds schools, i.e. the world. They are changing how we work, how we relate to each other, how we spend our free time and, in short, our ways of perceiving and relating to reality and to ourselves” (p. 15).

Nowadays, we can find different technologies in education around us. According to Lorigo (2005), current technologies include practically the application of digital technologies and telecommunication systems such as computers or digital cameras. We also have tablets and smartphones which belong to the mobile technology and which we will focus on in the following section.

## *2.2 Mobile technology*

The use of mobile technology is being introduced in the schools. According to Camacho and Esteve (2018), mobile technology is a catalyst for change and eliminates barriers by accessing information from anywhere. It generates new opportunities by creating new learning experiences to solve everyday problems. Moreover, the use of mobile devices promotes the search for content among students, the generation of knowledge networks and allows the emergence of creative and innovative educational practices (Camacho and Esteve, 2018, p.162).

Actually, many people use devices for entertainment but they can really be used for educational purposes to provide better learning. For example, in an analysis of Kvale and Bergschöld (2021) exposed the importance of the pedagogical use of the mobile phones and the skills required to make use of them. How the use that the students make of the mobiles phones can make them more competent in the ICT knowing the potentially pedagogical functions that the devices have (Kvale and Bergschöld, 2021). In addition, in the different experiences the children acquired new skills by using the devices and then they discovered and opened doors to new possibilities for constructing knowledge.



In our daily lives, the devices are used for communication, multimedia display, social media... and the attitude towards that is positive because it is easy and attractive for them. Besides, in the different generations there are others opinions about ICT because they didn't have it from the start, so our generations should offer their hand to learn it. It's because of that it's important to be predisposed to learn them and help each other to make this possible (Camacho and Esteve, 2018). The use of the tablets improves classroom climate by enhancing students' motivation and attentiveness. The students said "if you do it with the book, you get confused with anything because it seems boring, but when you do it with the tablet, you learn more because it's more fun" (p. 174). On the other hand, the pupils talked about the punctual technology problems that happened to them. The teachers highlight that the impact of tablets in the learning process improve their transversal competencies such as autonomy, initiative, learn to learn, collaboration, critical spirit and above all, their digital competence. Also the use of mobile technology potentiates the specific competencies with the subjects, the versatility of the tools and the answer to the diversity as an important key for the inclusion (Camacho and Esteve, 2018).

After focusing on the mobile technology we are going to use. Now we will expose the pedagogical tool through which we will learn a diversity of knowledge and enhance our skills in the classroom. I mean augmented reality (AR).

### *2.3 Augmented reality in early childhood learning*

According to Telefónica (2011), AR is a technology that helps to perceive reality with new eyes because information from the real world is complemented by information from the digital world. It is an emerging technology that has given a great impulse in society where real and virtual elements communicate (Cabero and Barroso, 2016). Furthermore for the AR to be carried out we need four essential elements as camera, screen, software or programme and a mechanism linking both face-to-face and virtual information (Castañeda et al., 2014). Also augmented reality triggers or markers QR codes, physical objects and a content server where the virtual information we incorporate is located (Cabero and Barroso, 2016). In addition, this technology offers knowledge more closely related to the world around us (Bower et al., 2014).

In education, AR offers a great learning experience which supports cognitive development. A well-designed AR app helps in the learning process of the children and also to reflect on the content (Bower et al., 2014). It's important not to confuse augmented reality with virtual reality. Moreover, AR doesn't replace the real world for the virtual world, AR keeps the real world that the user sees by completing with virtual overlay information around us (Hidalgo et al., 2018). The AR

gives us a lot of opportunities for a better experience in our lives. According to Manipour and Cohrssen (2020) enriching learning and enhancing pedagogical quality is possible through the inclusion of augmented reality in the classroom as it expands learning opportunities for preschool children. Moreover, “the inclusion of AR technology as a cutting-edge form of digital technology has the potential to enhance play as the vehicle of active and interactive learning in the context of an informal, play-based curriculum” (Manipour and Cohrssen, 2020, p.6).

There are many different experiences about AR in schools learning the connections between the real and virtual world. The use of AR potentiates the skills of the children in their cognitive development (Palamar et al., 2021). For example, the use of an AR application that only with a device we can see objects in 3D or discover animals scanning a cube through an application where they can discover their habitat and also the students have to take care of them, etc. Other examples of the AR application in the schools can be for example the creation of a physical book of triggers that with the device's camera you scan the pictures which there appears the translation in the language that they are learning, in this case *kichwa*. In this study they highlight the importance of the use of ICT in all teaching and learning processes because it increases interest in the subject and at the same time enhances the level of learning (Hidalgo Ponce et al., 2018).

The introduction of AR in the classrooms is going to transform education because this ICT offers many new pedagogical possibilities of learning for the children. According to Cabero and Barroso (2016), the AR gives new ways for teaching and learning. The students have autonomy and they are the main character of the learning process where pupils make their own discoveries by relating the information presented to them (Cabero and Barroso, 2016). According to these authors, for incorporating AR in the teaching we should design a flexible environment with an educational and dynamic purpose, give answers to the limitations in the context, curricular contents and teachers training in ICT for being able to integrate this technology in the classrooms.

#### *2.4 Teacher training*

Depending on different institutions, such as the European Commission, for making a good use of ICT, it's necessary that teachers have adequate digital competence in teaching. According to The European Digital Competence Framework (2019), “DigComp is about people. The framework does not focus on devices or software but seeks to support confident, critical and responsible use of, and engagement with, digital technology by people. The framework offers a comprehensive description of the knowledge, skills and attitudes that people need in 5 key areas”. In addition, it also highlights that “Digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society”.

Redecker (2020) exposed a study which presents a framework for the development of educators' digital competence in Europe. It aims to help Member States in their efforts to promote the digital competence of their citizens and boost innovation in education. The framework is intended to support national, regional and local efforts in fostering educators' digital competence, by offering a common frame of reference, with a common language and logic". It's called European Framework for the Digital Competence of Educators.

The digital competence of teachers is of great relevance today as it is the fundamental tool for implementing ICT in the classroom. Therefore, Agulló (2018) states that it is necessary to unite the characteristics of digital teaching competence and to train teachers to respond to these current technological changes in order to integrate them in the classroom and improve student learning. Actually, the good thing is that everyone is very interested and willing to learn. Therefore, we should respond to this lack of training to improve the teaching-learning process of students. Moreover, it is not only about teaching through ICT, it's also about knowing and understanding them (Gómez et al., 2018) Above all, it's about knowing our students. I mean to know their characteristics and interests in order to adapt the teaching to their needs from a pedagogical purpose (González et al., 2018). After all, in order to acquire these digital competencies, teacher training is necessary. In our world, ICT are constantly adding new knowledge and modifying information to provide a better life experience for the human being. That is why teachers have to be continuously updated and trained to offer a quality education to their students and integrate ICT in their classrooms. According to Rodríguez et al. (2018), it's important to integrate ICT in the education system but first we should give formation to the teachers because it's a big challenge for them because many teachers didn't receive formation in their careers about it.

Following this, it's essential the teachers' training to respond to children's education. "The teaching-learning process in the classroom, using ICT, requires a set of skills to be developed by the teacher with a view to internalizing a methodology to make the most of technological tools, in which teacher training shall be deemed among the first options prior to facing new educational challenges" (Hernández, 2017, p. 345). Because of that, "teachers, faced with the transformative vision of a society that needs to integrate ICT into the classroom, have seen their role change into that of agents with the ability to generate the necessary skills for a society 'yearning' for technological knowledge and the frequent use thereof in various educational matters" (Hernández, 2017, p.342)

In the end, the formation of our future teachers is necessary because they are going to teach the next generations in the new advances of ICT but the students of early childhood and primary

school are exposed that they need more training in ICT for the application in the classroom (Lorenzo et al., 2018).

As mentioned above, “the pace of change in our society is so rapid that initial training systems cannot meet all the present and future needs of society. We have been aware for years that training must continue throughout life and that retraining and continuing education are key elements in a developed and modern society” (Adell, 2006, p.10).

It's for this reason that “the information society, the necessary mechanisms must be created to ensure that this continuing education reaches the large number of people who, presumably, will need new knowledge, skills and abilities. At this point, new technologies have an important role to play, not only as training content, but also as a means of reaching the target audience” (Adell, 2006, p. 10).

Moreover, Adell (2006) emphasized which ICT are going to be a communication media at the service of training where there are going to take place teaching and learning processes.

“It is a matter of broadening the type of learning experiences of students using media that they will encounter everywhere in their professional lives and that are part of the technological culture that permeates everything” (Adell, 2006 p. 14). According to Adell (2006), “digitization and new electronic media are giving rise to new ways of storing and presenting information” (p.14). Moreover, there are open educational resources (OER) which give us the opportunity to access more information freely.

### *Training materials and open educational resources*

The technological pedagogical content knowledge (TPCK) is a model which helps to understand not only technical knowledge as technology, pedagogy and content. According to Mishra and Koehler (2006), “TPCK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones” (p. 1029). In addition, working on this can be done through training and open resources.

According to Redecker (2020), the open educational resources (OER) are “teaching, learning and research materials in any medium, digital or otherwise, that are in the public domain or have been

released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions” (p.91). Nevertheless, an example of OER, Red de Bibliotecas Universitarias y Científicas Españolas (REBIUN) focuses on the knowledge and opportunities of social networks and on the digital competences of self-involvement in social media and digital dissemination, networks and online communities and above all on being aware of the potential of digital technologies in citizen participation. Therefore, we can see how they offer us the basis, the beginning of knowledge about digital technologies in society from open educational resources. Above all, the important thing is to have online replenishment because this way we all enrich ourselves by acquiring new knowledge.

### **3. Methodology**

In this study we used the methodology of educational design research. Plomp and Nieveen (2009) exposed “Educational design research is perceived as the systematic study of designing, developing and evaluating educational interventions, - such as programs, teaching-learning strategies and materials, products and systems - as solutions to such problems, which also aims at advancing our knowledge about the characteristics of these interventions and the processes to design and develop them” (p. 9).

#### *3.1 Objectives*

This section describes the main objective of the study followed by its specific objectives.

##### ➤ General

Design, develop and evaluate a web page of resources to introduce augmented reality in early childhood education to train teachers.

##### ➤ Specifics

**S. 1** Analyze the educational potential of augmented reality.

**S. 2** Design and develop a web page of educational resources for the introduction of augmented reality in early childhood education.

**S. 3** Evaluate the perception of the usefulness of the website through interviews with active teachers.

**S. 4** Evaluate the adequacy of the content and design of the web portal based on interviews with ICT experts.

### 3.2 Context and participants

In this research carried out at Jaume I University during the 2022/2023 academic year have participated two ICT experts and two early childhood teachers, one of them more specialized in ICT.

Moreover, the design is made for teachers of early childhood education in a school context. In this table, you can find the profiles of the different interviewed persons.

Table 1. Profile of participants in the web portal evaluation process

	<i>Profile</i>
<b>ICT expert 1</b>	Specialist in educational technology. Especially in web and multimedia. 20 years working as an ICT expert.
<b>ICT expert 2</b>	Teacher in the pedagogy department in the UJI about digital competence and educational technology. 3 years and before 5 / 6 years as an educational technology research fellow.
<b>Early childhood teacher 1</b>	Early childhood and primary teacher. 28 years working.
<b>Early childhood teacher 2</b>	Early childhood and primary teacher. 29 years working.

### 3.3 Process

This educational proposal has been implemented during the course 2022/2023. At the beginning, I did an extensive search for information on the most important points of the work such as ICT, mobile technology, augmented reality and teacher training. During March, I started to create and develop the web page and started to think about the activities that I can propose for the classroom with AR applications and also I elaborated the questions for the interview with the ICT experts.

Our design has been adapted from the educational design research by Plomp and Nieveen (2009). As mentioned above, it has several phases and we adapted them to our educational design. The

phases exposed according to Plomp and Nieveen (2009) are the preliminary research which are part of this the needs and context analysis, review and development of a framework for the study, secondly prototyping phase which consists in a repetitive design phase with formative evaluation, aimed at improving and refining the intervention in the research and thirdly the assessment phase with also recommendations for improvement of the intervention.

In [attachment 4](#) you can find a picture about the process phases of the educational design research.

### 3.4 Instruments

In this section you will find the instruments we have used to evaluate our augmented reality proposal for teachers. According to Zorrilla et al. (2017) the instrument is a methodological resource that is materialized by means a device or a format (printed or digital) and is used to obtain, record or store the relevant aspects of the study (p. 2).

The main technique used was the interview "technique oriented to obtain oral and personalized information on events experienced and subjective aspects of the informants in relation to the situation under study." (Massot et al., 2004, p. 336). This technique was chosen for knowing the opinion of different persons who are specialized in ICT because they gave relevant information for improving the work.

According to Diaz-Bravo et. al. (2013) the interview is a very useful technical tool in qualitative research to collect data. Moreover, "The interview is one of the instruments whose purpose is to collect data, but due to its flexibility it allows for obtaining more in-depth, detailed information, which even the interviewee and interviewer did not have identified, since it adapts to the context and the characteristics of the interviewee" (p. 166). In addition, "interviews are widely held to be a fundamentally useful way to understand informants' beliefs, experiences and worlds" (Mann, 2016, p.2).

Three different people have been interviewed in educational technology. One expert in educational technology, another an early childhood teacher and a professor of educational technology at the university. I made that for finding out what the design is like and also to be able to improve it through their advice and ideas.

Below you can find the various interview questions for ICT experts and early childhood teachers.

Questions for ICT experts:

- What is your profile? What are you specialized in and how many years have you been working in it?
- Do you consider augmented reality a useful tool for learning?
- Do you think the website has a clear structure?
- Do you think that the content presented is adequate?
- Do you find the proposed applications useful?
- Do you consider the didactic use of the web portal to be appropriate?
- What do you think about the audiovisual material, and do you think it is useful?
- If you had to improve something... What would it be? How would you do it? Suggestions.

Questions for early childhood teachers:

- What is your profile? What are you specialized in and how many years have you been working in it?
- Do you consider augmented reality a useful tool for learning?
- Do you think the website is attractive?
- What do you think of the proposed applications? Do you find them effective and applicable in the classroom?
- Do you think that the audiovisual materials on the web portal are useful and practical?
- Do you think that the proposed activities are appropriate for the infant cycle?
- If you had to improve something... What would it be? How would you do it? Suggestions.

Moreover, three of the four interviews have been audio recorded and can be found at this link [https://drive.google.com/file/d/1HRWlg39TH95fwSuNniD80AvDAJVi9y0F/view?usp=share\\_link](https://drive.google.com/file/d/1HRWlg39TH95fwSuNniD80AvDAJVi9y0F/view?usp=share_link).

The other one has been transcribed and can be found at [attachment 1](#).

To conclude this section, a table is attached with the different phases of the process, the objectives set, the instrument used in each case and the participants in the research.

Table 2. Summary table of the process carried out on the educational proposal.

<b>Phase</b>	<b>Specific Objectives</b>	<b>Instrument or strategy</b>	<b>Participant</b>
<i>Preliminary research</i>	S. 1	Revision of the wording	-
<i>Prototyping phase</i>	S. 2	Design and development	-



	S. 3	Interview	ICT experts
	S. 4	Interview	Early childhood teachers

## 4. Description

### 4.1 Resources

The main proposal is the design of an educational website which offers free training on certain augmented reality applications, resources and some recommendations of activities for their class.

This is the web address <https://al383884.wixsite.com/discover-the-reality> where you can see all the tools and all the audiovisual content for learning.

You can find some pictures of the main cover of the website in [attachment 2](#).

### 4.2 Activities

The different activities are for early childhood children. The teachers can adapt them depending on the features of their pupils. Following this, you can find the tables of different activities that you can make in your early childhood classroom with the applications.

You can find the tables of each activity in [attachment 5](#).

## 5. Results

Once the interviews were conducted, the results are as follows.

On one hand, ICT experts think that augmented reality is a useful tool for learning because it is present in many aspects of our daily life. In addition, one of them stands out "Augmented reality is the superimposition of two realities that complements and amplifies information that reality itself can give us. For example, if you have a garden at school and you put a sign that you can focus on with augmented reality, you can perfectly know what plant it is, how much watering it needs ...etc, and all this kind of things that in the end helps to give more information of reality" (ICT expert 2).

Focusing on the web page made, they agree that it has a clear and easy-to-follow structure. However, the ICT expert 2 stated that she was a bit doubtful about the fact that the colors of the web portal headings. "I find that on my computer screen it looks very good but I guess it depends on the classroom's screen, projecting..etc plus, I don't know if the colors are way too much the same and if it would be readable. Maybe there isn't enough contrast" (ICT expert 2).

In the next question, about the content, they agreed that it is appropriate but one of them goes further “As a teacher, if I would like to take your activities as a reference, I would like you to tell me what materials I need, and how much time I need to dedicate... this might help” (ICT expert 2).

Regarding the usefulness of the proposed applications, one of them expressed that a lot of applications have limitations but are sufficient for the level of education at which they are aimed for. “It would be preferable to have some kind of applications that are much more extensive but at the same time do not imply an economic cost. If there is practically nothing on that aspect, it will probably come out in the next few years. As for now, we have to use what we have at hand” (ICT expert 1). The other one thinks that they are useful but they lack more descriptions and information for which teachers need.

Focusing on the use of the web portal, both of them think that it is didactic and useful for teaching and learning. “Perfectly a teacher who was working in an educational center can perfectly enter, use it for the classroom and adapt to their children. “I believe that it is useful and also for those of you who are in training, for classmates, to take advantage of it in your internships or if you work in a summer house, it is perfectly adaptable”. Moreover, she also highlights the several formats of the web page, “I can see a video, a picture, and also a little bit of text...and I think it's helpful to take it on board” (ICT expert 2).

The audiovisual materials, in this case the tutorials are useful, as they are well produced, with good quality and you can follow them easily. For example, one of the ICT experts highlights “I believe that the most important part is that the use of an activity as an example in each application is really helpful to inspire and guide the teachers” (ICT expert 1). Moreover, the other ICT expert specifically outlines that it is useful because there is a generation that accesses the information in this format. “In addition, I think it is a material for which is quite adapted to the possible specific needs of educational support because the video does not go fast ... it is a video that you can follow perfectly, you can pass, delay ... I think it is well produced and the quality seems also good to me” (ICT expert 2).

Some of the improvement tips that they mentioned were that the web page should add a general introduction in the beginning and also materials and time in the proposed activities. In addition, a new supplementary material tab as a repository of activities, articles about augmented reality... where the early childhood teachers can get more information. Besides, the contrast of colors in some titles of the front page and review the performance of one of the videos of the web page.

On the other hand, the early childhood teachers expressed that augmented reality is a new tool in the learning process. Por example, one of them highlights “we should use different tools, keep changing them so that it is always motivating” (Teacher 2). The other interviewee stated that applying augmented reality in all projects makes it more enriching.

Focusing on the website, both of them agreed that it is attractive, the apps are applicable in the classrooms and the activities are adequate and simple. However, one of them exposed that it is necessary that the teacher must be motivated by the applications, know how to control them and to think that the ICT are very useful for education. The teacher also exposed the disadvantages that may arise “Things often don't turn out the way we want them to. My device is missing one thing to install, it's not compatible... You may have, for example, a digital tablet in the classroom that no longer supports the program, the school's internet is not powerful enough to download something to make it work and a video freezes... These are not easy things to use. I think you have to be very motivated to work with these things” (Teacher 2). Instead, the other teacher highlights “I like the three applications that you chose to publish, they are very different and they bring diversity” (Teacher 1).

Regarding the tutorials, both of them agreed that they are useful and practical. For example, one of them points “They were well done, I liked the tutorials as well as the applications and everything” (Teacher 1). The other one has also added “the tutorials are useful and practical but if there were some more examples of how to use it in a classroom with students at that time as it is being done could give more ideas of how to use it, for example in a classroom of children” (Teacher 2). The same person also highlights that “if there were a case study about it this could make it more motivating”.

After that, taking in account the activities, one of them aimed to be simple and without any problems In contrast, the other one expressed “I think I would do it more step by step. An example, that is geared towards a topic but that goes a little more step by step because people who do not master ICT will find it more complicated if it does not go step by step” (Teacher 2).

Finally, each teacher expressed suggestions for some improvements. For example, one of them stated “Well, maybe the only thing I would do... I understand that you are not working and you cannot do it at this moment. But at a given moment, the only thing I would do would be to try to capture the whole process of the activity with photographs. Not only to suggest it but make it done. But of course, obviously you have to do that when you have already done the activity. It would be the only thing to do but I understand that in your situation you can't do it now. If I were in the classroom I would put some images of the activities already done and that would be the only thing I would like to do. The rest I think is fine” (Teacher 1). The other one highlights that the website should have more accessible information and external links where you could see some examples of other persons as teachers using these applications.

To conclude the interviews, here in this table you can find the relevant information of all the interviews.

Table 3. Relevant responses from interviews with ICT experts and early childhood teachers.

Website	ICT experts	Teachers
Clear structure	✓	
Attractive		✓
Appropriate content	✓	
Utility of the AR apps	✓	
Effective and applicable AR apps in the classroom		✓
Didactic use	✓	
Utility of audiovisual material	✓	✓
Activities suitable for early childhood education		✓
Tips of improvement	<ul style="list-style-type: none"> <li>→ General introduction</li> <li>→ Complementary materials</li> </ul>	<ul style="list-style-type: none"> <li>→ More descriptive, step-by-step activities</li> <li>→ Repository of activities as a new tab</li> </ul>

In [attachment 3](#) you will find two different tables, one from the ICT experts and the other one is from the early childhood teachers with more specific information gathered from the interviews.

## 6. Conclusions

Taking into account and starting from the general objective that we have set out “Design, develop and evaluate a web page of resources to introduce augmented reality to the early childhood education and to train the teachers”. We could observe some different perspectives.

Starting with the specific objective 1, analyzing the educational potential of augmented reality, we have been able to observe that during the search process the augmented reality has an important potential inside our society through the constant evolution of technology. As we have seen in the theoretical framework, the technology AR “is an emerging technology that has given a great impulse in society where real and virtual elements communicate” (Cabero and Barroso, 2016). AR

offers a better experience in our life and also in the process of teaching and learning, enriching learning and enhancing pedagogical quality is possible through the inclusion of augmented reality in the classroom as it expands learning opportunities for preschool children (Manipour and Cohrsen, 2020).

In the next specific objective 2, design and develop a web page of educational resources for the introduction of AR in early childhood education, during the creation of the web page it has been necessary to be directed to the teachers, that the audiovisual materials were adequate and understandable and also that the activities were directed and adapted to the early childhood stage achieving an educational website. It has been a long process, time consuming, entertaining but above all very enriching, making the tutorials and the design of the web page.

Continuing with specific objective 3, evaluate the perception of the usefulness of the website through interviews with active teachers, we have been able to collect a series of data that has given us relevant information to improve our proposal, such as the development and implementation of the activities in a classroom and examples of other teachers' activities on augmented reality.

About the last specific objective 4, evaluate the adequacy of the content and design of the portal web based on interviews with ICT experts, we have collected information for improving the website where the results collected helped to improve certain aspects of the website to provide a better learning experience for teachers who want to learn about augmented reality in the future.

On the one hand, some of the limitations that I have encountered during the course of the work have been the time in some parts of the work. For example, the theoretical framework requires reading a lot for contrasting information between authors which means spending more time and the editing of the videos needed a lot of time too. But above all, we have only been able to evaluate it once with the experts and teachers.

On the other hand, towards future lines of improvement, we could do more than one validation, interviews with more ICT experts and early childhood teachers, take the activity examples to the classroom and add pictures of them on the web page, add a new window as a repository of activities, external links of interest on augmented reality...where they can find more information and resources. In addition, we would try to improve and expand our educational proposal on augmented reality for a possible master's research in the future.

Finally, during the course of the educational proposal, I have learned more about the application of augmented reality and the relevance it has in society. However, there are always things to learn, some knowledge that I think I may be missing would be to go deeper into augmented reality, I mean its creation as for example to make models 3D to offer a more personalized education. Also

to know more applications in the classroom through ICT ... and be continuously updated with augmented reality to provide current resources and quality teaching to teachers so they can train students properly.

Above all, I have learned about how educational proposals through the web can improve education. I believe that we live in a world where time plays an important role and therefore I offer through the web portal that freedom to learn without schedules, offering teachers the resources they need at their fingertips in one place and also that direct communication to resolve doubts or to help them in what they need. Giving the teachers a place to learn freely, without ties and with resources about augmented reality at their fingertips to apply in their classrooms.

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## 8. Attachments

### ★ Attachment 1. Interview early childhood teacher 1

- ¿Cuál es su perfil? ¿En qué estás especializado y cuántos años llevas trabajando en ello?

*Soy maestra de educación infantil y también maestra de primaria pero no he ejercido nunca de primaria, siempre he ejercido de educación infantil y este será mi curso veintiocho de maestra de educación infantil. En infantil somos especialistas de infantil, tenemos que darlo todo, no somos especialistas en... Lo damos absolutamente todo, no es como en primaria que puedes decir soy de primaria y además especialista en inglés, música... No, yo soy de infantil entonces lo damos todo, con lo cual tenemos que estar especializadas en todo.*

- ¿Consideras que la realidad aumentada es una herramienta útil para aprender?

*Considero que es una herramienta más. No creo que sea imprescindible pero sí que es verdad que dentro de que hay que trabajar con los peques de infantil el tema de la competencia digital. Creo que es una buena herramienta para utilizarla también pero no algo imprescindible. Un poco lo que me pasa con todo el tema de las tecnologías, que es una herramienta más, igual que utilizas las tecnologías puedes utilizar pelotas y aros. Me gusta, creo que poner una pincelada de realidad aumentada en todos los proyectos que se hacen es enriquecedor.*

- ¿Piensas que la página web es atractiva?

*Si, pero para adultos. Es sencilla, es muy sencilla. Además, tienes arriba las pestañas para poder acceder fácil a las tres aplicaciones y luego datos sobre ti. Y para lo que querías... doy por hecho que lo que querías era crear una página web en la que vinieran un poco los tutoriales y explicar tres propuestas de realidad aumentada. Evidentemente, cuando utilizas WIX o un Genially hay diseños super espectaculares, pero a mi me ha parecido suficiente. A veces menos es más. No necesita más, me pareció suficiente.*

- ¿Qué opinas de las aplicaciones propuestas? ¿Te parecen efectivas y aplicables en el aula?

*La de Halo AR me parece buenísima. Durante mucho tiempo maestros que utilizábamos aplicaciones de realidad aumentada, utilizábamos una que se llama Aurasma que desapareció y nos quedamos sin poder usar una aplicación fácil para poder crear tu propia realidad aumentada, utilizando tu tanto el marcador como el que se iba a reflejar. Esta apareció después y a mi me parece fundamental para poder crear tu realidad aumentada, me parece buenísima.*

*El Merge Explorer, yo no utilizo en concreto el Merge Explorer, yo es que tengo el cubo original, tiene más jugo. Tienes que aprender a poner tu realidad aumentada en cada lado y eso ya es más complicado, requiere un nivel de conocimiento tecnológico más importante pero también es verdad que simplemente comprando el cubo, que no es caro, es suficiente. Hay bastantes aplicaciones, lo que hablábamos antes, de poder poner una pincelada de*

*realidad aumentada teniendo un cubo en la mano, eso para los pequeños es como poder agarrar algo en lo que va aparecer la realidad aumentada. A mi me gustó mucho cuando me lo compré hace un par de años, antes de la pandemia, y me gustó mucho tener ese cubo. Entonces esas dos las conocía y las dos me gustan mucho.*

*Y la tercera que has propuesto no la conocía y me ha parecido muy interesante. No como introductoria ni como nada sino como aplicación en sí. No la he probado, no me ha dado tiempo, me la he descargado. Tal como la vi, la compré, que luego desaparecen. Me parece que con el precio que tiene. Con lo que me costó, la tengo que probar pero creo que si lo que hay es directamente lo que has enseñado en el tutorial, es decir, que tal como se proyecta, se enfoca con la aplicación el dibujo y cobra vida, me parece buenísimo para infantil. Me gustó, me gustó mucho, las tres me han gustado mucho.*

- Con la de Merge Explorer, tienen la realidad aumentada en sus manos.

*La de Halo AR te permite que tu crees lo que te dé la gana como maestro. El Merge Cube lo bueno es que ellos lo tienen en la mano y el otro que niños de infantil hagan un dibujo y cobra vida... A ver es que eso es pura magia para ellos. Lo que me gusta es que has elegido tres muy diferentes. Habrías tenido opción de haber puesto, por ejemplo Quiver o muchas de estas que directamente te den las láminas y me gusta que de la elección que has dado, en ninguna de ellas imprimes láminas de la propia aplicación. Son muy distintas. Me gustan las tres que has puesto.*

- ¿Crees que los materiales audiovisuales presentes en el portal web son útiles y prácticos?

*Si, me parece que está bien. Y los tutoriales están bien hechos. Yo cuando tengo que hacer algun video normalmente hago un montaje del video y luego pongo el sonido aparte. Lo suelo hacer con iMovie y no me complico. Intento buscar algo que no me haga perder mucho tiempo. Estaban bien hechos, a mi me han gustado tanto los tutoriales como las aplicaciones y todo.*

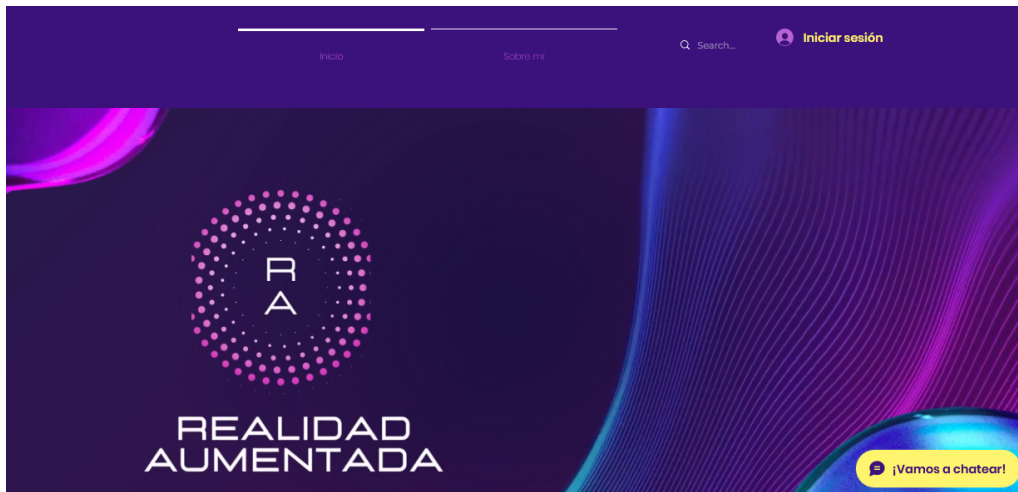
- ¿Piensas que las actividades propuestas son adecuadas para el ciclo de infantil?

*Si, son sencillas y no he visto mayor problema. Voy a recuperarlas, más que nada porque no me acuerdo. Creo que pusiste en Halo AR un ejemplo de hacer una gymkana, esa estaba bien. Evidentemente, el Merge Cube es coger la aplicación y probarla. Lo que hablábamos, en Infantil, no merece la pena complicarlo demasiado. Y la otra, si me parece que las tres son sencillas.*

- Si tuvieras que mejorar alguna cosa... ¿Qué sería? ¿Cómo lo harías? Sugerencias.

*Pues mira, a lo mejor la única cosa que haría... Entiendo que tu no estas trabajando y no lo puedes hacer. En un momento determinado, lo único que haría sería intentar plasmar en fotografías la actividad ya hecha. No solo sugerirla sino ponerla hecha. Pero claro, evidentemente eso lo tienes que hacer cuando ya hayas realizado la actividad. Sería la única cosa pero entiendo que en tu situación no lo puedes hacer. Si yo estuviera en el aula pondría imágenes de la actividad ya hecha y lo único. El resto creo que está muy bien.*

★ **Attachment 2.** Portal web entrance photos



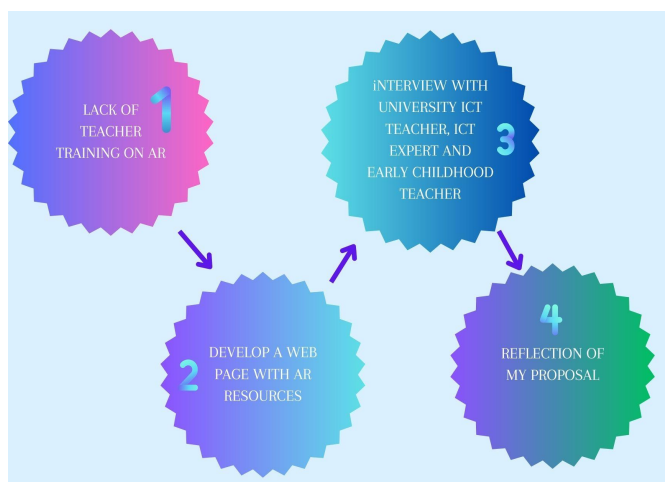
★ **Attachment 3.** Description about the answers in the interviews to early childhood teachers and ICT experts.

	ICT expert 1	ICT expert 2
INTRO: AR as a learning tool	✓ Present in many aspects of daily life.	✓
Clear structure of website	✓	✓ easy to follow. <u>Advice:</u> More color contrast in the home titles and above me.
Adequate content	✓	✓ some activities more developed than others. <u>Advice:</u> Add material and duration

		in the activities.
Utility of the applications	✓ They have their limitations but are sufficient for the educational level at which they are aimed.	✓ For both teachers and students in training. Useful because it is available in several formats (image, video, text...)
Appropriate didactic use of the web portal	✓	✓
Useful audiovisual material	✓ Emphasizes the use of a teacher activity to inspire and guide the teacher.	✓ You can follow the videos perfectly. Well produced and good quality.
Suggestions	Add a general introduction. Add a section of complementary material to learn more.	Add duration, materials... to the activities. Check the performance of a video. New tab for activity repository (articles, external links to sites of interest...)

	Teacher 1	Teacher 2
INTRO: AR as a learning tool	✓ It is one more tool.	✓ It is one more tool. Vary the tools so that it is always motivating for the students.
Attractive website	✓ Add RA to all the projects is enriching.	✓ but for the teachers who think that ICT are useful for the learning.
Effective and applicable classroom activities	✓	✓ For teachers who are motivated and controlled by these applications.
Useful and practical audiovisual material	✓ Well done.	✓ <u>Advice</u> : Add a case study.
Activities suitable for early childhood	✓ Also simple.	✓ More step by step. <u>Advice</u> : Activity directed towards a specific topic.
Suggestions	→ To capture in photographs the activity already done in the classroom.	→ New tab with external links to other teachers' examples of activities carried out with these applications. → Actividades more step by step.

★ **Attachment 4.** The process about the phases of my educational design research.



**Attachment 5.** Tables of activities

<b>Halo AR</b>	
<i>A historic journey: The lost dinosaur egg</i>	
Objectives	Contents
<ul style="list-style-type: none"> <li>● Promote the ICT skills</li> <li>● Potentiate the digital competence</li> <li>● Enhance motivation</li> <li>● Acquire knowledge about dinosaurs through new technologies.</li> </ul>	<p>We will work on the contents of writings in the Decree 38/2008, of March 18, of the Council, which establishes the curriculum of the second cycle of Early Childhood Education in the Valencian Community.</p> <ul style="list-style-type: none"> <li>★ Digital competence</li> <li>★ Initiation in the use of mobile technology as communication elements.</li> <li>★ Approach to the ICT tool of augmented reality.</li> <li>★ Coordination and control of fine and gross motor skills.</li> <li>★ Dynamic and static control of one's own body and objects and its valuation in the functional development of daily activities and in specific and general games.</li> <li>★ Experimentation and discovery of the general characteristics of prehistoric animals.</li> <li>★ Enjoyment when performing activities in contact with nature.</li> </ul>
Description	

The activity consists of an adventurous journey where they are going to search for different clues with the goal of finding the lost dinosaur egg that we will introduce through a story where they will have to scan them with the application.

During this journey they will discover the dinosaurs, how they live and how they feed. In the end, if they follow the clues together and pass the different tests that are proposed to them, they will get all the pieces to reach the lost egg and give their child to the mother dinosaur.

### Merge Cube Explorer

#### *Discover extinct animals*

Objectives	Contents
<ul style="list-style-type: none"> <li>● Promote the ICT skills</li> <li>● Potentiate the digital competence</li> <li>● Enhance motivation</li> <li>● Acquire knowledge about extinct animals through new technologies.</li> </ul>	<p>We will work on the contents of writings in the Decree 38/2008, of March 18, of the Council, which establishes the curriculum of the second cycle of Early Childhood Education in the Valencian Community.</p> <ul style="list-style-type: none"> <li>★ Digital competence.</li> <li>★ Initiation in the use of mobile technology as an element of communication.</li> <li>★ Approach to the ICT tool of augmented reality.</li> <li>★ Coordination and control of fine and gross motor skills.</li> <li>★ Knowledge of the general characteristics of extinct living beings.</li> </ul>

#### Description

For groups, they will make their merge cube. After that, each group will investigate one different extinct animal. For example, the characteristics of the mammoth, its body parts, where they lived...Finally, they are going to scan that animal with the cube through the application of Merge Explorer.

The amazing experience of having an animal of augmented reality in their own hand.

## Rakugaki AR

*A living tale: Little stories with living characters*

### Objectives

### Contents

- Promote the ICT skills
- Potentiate the digital competence
- Enhance motivation
- Encourage plastic expression through the use of an augmented reality application.

We will work on the contents of writings in the Decree 38/2008, of March 18, of the Council, which establishes the curriculum of the second cycle of Early Childhood Education in the Valencian Community.

- ★ Digital competence
- ★ Initiation in the use of mobile technology as an element of communication.
- ★ Approach to the ICT tool of augmented reality.
- ★ The discovery of plastic language as a means of communication and representation.
- ★ Interest, respect and appreciation for their own and others' plastic elaborations.

### Description

In this activity, the pupils are going to draw the character that they want. After that, they will scan and record them for making a tale with all the original creations that they did. Finally, we can add to them an audio and put them together creating our tale.

In addition, we can use the application just to make magic with the simple fact that their drawings came to life.