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DESIGN AND IMPLEMENTATION OF A LESSON USING AUGMENTED REALITY TO TEACH SOCIAL SCIENCE IN A PRIMARY CLIL CLASSROOM CONTEXT

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DESIGN AND IMPLEMENTATION OF A LESSON USING AUGMENTED REALITY TO TEACH SOCIAL SCIENCE IN A PRIMARY CLIL CLASSROOM CONTEXT

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El aprendizaje de contenidos en una segunda lengua es un reto para alumnado y profesorado. Las tecnologías de la información y la comunicación, como la Realidad Aumentada (RA), facilitan esta tarea. El objetivo principal del trabajo es evaluar la eficacia de la RA en un contexto de Aprendizaje Integrado de Contenidos y Lenguas (AICLE) en Educación Primaria. Además, se analiza el uso que hace el alumnado de las tecnologías y las opiniones de alumnado y profesorado sobre el uso de la RA como herramienta de enseñanza. Los resultados indican que el alumnado mejoró significativamente en la mayoría de las actividades y que ambos colectivos están a favor del uso de la tecnología en el aula.

Realidad aumentada, AICLE, Ciencias Sociales, Educación Primaria, Tecnología Educativa

Edukiak bigarren hizkuntza baten bidez ikastea erronka handia da ikasleentzat eta irakasleentzat. Informazioaren eta komunikazioaren teknologiek, hala nola errealitate areagotuak (EA), zeregin hori errazten dute. Lan honen helburu nagusia Lehen Hezkuntzako Atzerriko hizkuntzen eta edukien ikasketa integratuaren (CLIL) testuinguruan EAren eraginkortasuna ebaluatzea da. Horrez gain, ikasleek teknologien inguruan egiten duten erabilera eta ikasleek eta irakasleek EA irakaskuntza-tresna gisa erabiltzeari buruz dituzten iritziak aztertu dira. Emaitzek adierazten dute ikasleek hobekuntza nabarmena egin dutela jarduera gehienetan, eta bi taldeak ikasgelan teknologia erabiltzearen alde agertu dira.

Errealitate areagotua, CLIL, Gizarte Zientziak, Lehen Hezkuntza, Hezkuntza-Teknologiak

Learning content through a second language is a challenging task for students and teachers. Information and communication technologies such as Augmented Reality (AR) provide means to facilitate learning. The main goal of this work is to assess the effectiveness of AR to teach Social Science in a Content and Language Integrated Learning (CLIL) context in Primary Education. Additionally, students' use of technologies and students' and teachers' opinions about AR as a teaching tool are analysed. The results indicate that AR fostered learning in most of the activities and that both students and teachers supported the use of technology.

Augmented reality, CLIL, Social Science, Primary Education, Educational technology

Introduction

Learning content through a second language (L2) can be a challenge for learners while teachers are constantly faced with the need to find ways to help pupils learn content. Information and communication technologies (ICT) offer interesting possibilities to reach these objectives. Augmented Reality (AR) technology blends the real world and virtual images and ensures real-time interaction, which has been proved to be effective and attractive for students (Azuma, 1997).

This paper will present a study carried out in a Primary School classroom in Biscay. The main objective is to analyse the effectiveness of AR in a Content and Language Integrated Learning (CLIL) context to evaluate whether AR helps to understand and assimilate vocabulary and grammar used to teach Social Science content. In addition, students' use of the technologies and their views on the use of AR as a teaching tool as well as teachers' views on the use of the technologies will be analysed. To achieve this objective four intervention sessions were designed along with both pre- and post-tests on the students' understanding of content and perception of technology. Lastly, results were quantitatively and qualitatively analyzed.

The results confirm that students showed a significant improvement in most of the activities and that they evaluated the use of the AR application positively. Moreover, teachers were also in favour of using technology in the classroom but claimed that it should be planned and appropriate resources should be assigned.

This paper is structured as follows. Firstly, the theoretical underpinnings of both CLIL and AR will be presented. Secondly, the steps followed to carry out the study will be described. Thirdly, the development of the project will be explained, that is, objectives, the main hypothesis, research design, sample characteristics, tasks for data collection and the procedure of the study. Finally, the main conclusions of the work together with shortcomings and possible changes for future research will be presented.

1. Theoretical framework

1.1. Content and Language Integrated Learning (CLIL)

CLIL is an acronym for Content and Language Integrated Learning. According to Marsh (2002), cited in Coyle (2007), CLIL includes any activity in which a foreign language is used as a tool in the learning and teaching of both content and language. Lyster and Ballinger (2011) provide a more recent definition: "CLIL is an instructional approach in which non-linguistic curricular content such as geography or science is taught to students through the medium of a language that they are currently learning as an additional language" (p. 279). This dual educational approach does not focus on one of them, as they are interrelated (Coyle, Hood & Marsh 2010: 1).

Although the term CLIL seems to be something new, the activities that could be related to CLIL date back to the time of the Akkadians (Pokrivčáková et al., 2015). The Sumerians conquered the Akkadians and used their language (Sumerian) as a means of teaching the Akkadians. In the 20th century, some precursors emerged, such as the immersion programmes in Canada (Lyster, 2018), the Language Across the Curriculum (LAC) movement in London (England) (Parker, 1985) and Content-based Instruction (CBI) in the United States (Brinton et al., 1989). Immersion programmes in Quebec grew out of the need felt by a group of English-speaking parents for their children to become proficient in French, the official language of Quebec. As a result, in kindergarten, children started learning in French alongside French-speaking children (Martínez Adrián, 2011). Although the latter approach involves content and language, the fact that subjects are taught in a second language (French) does not mean that there is explicit second language teaching.

Despite having recognised characteristics, many authors claim that CLIL programmes have some features that distinguish them from immersion and CBI. These features focus on its objectives, learner and professional profiles, the target language (TL) used as the medium of instruction and the relationship between content and language teaching (Lasagabaster & Sierra, 2010).

In the 1990s, there was talk of the need for higher levels of language proficiency for mobility in the European Union. Specifically, the European Commission's (2005:5) report on foreign language teaching and learning noted that an excellent way to improve foreign language learning would be "to use it for a purpose, so that the language becomes a tool rather than the aim itself." Influenced by these initiatives, at the educational level,

attempts were made to redesign and adapt existing language teaching approaches to achieve that goal (Marsh, 2012).

In the Spanish context, as multilingualism and linguistic diversity appear as one of the main objectives of European policies, CLIL has received increasing attention (Fernández Fontecha, 2009 in Martínez Adrián, 2011). Given that schools already have tight timetables, programmes such as CLIL appear to be the most effective in promoting multilingualism. Many CLIL programmes and initiatives have emerged in the last decade. In the Basque Country, in 1996, a pilot experience began to be conducted to initiate foreign language learning in infant education until the end of compulsory secondary education. These projects are called Early Start to English (Infant Education), INEBI (Primary Education) and BHINEBI (Secondary Education), and they aim to give continuity to foreign language learning. To this end, they integrate content learning into the foreign language classroom, create materials and develop teacher training programmes (Ruiz de Zarobe & Lasagabaster, 2010).

In order to provide a basis for CLIL, Coyle (1999) developed the 4Cs Conceptual Framework, illustrated in Figure 1. This framework focuses on the interrelationship between content (the learning of subject matter), communication (language development), cognition (development of thinking and learning skills) and culture (socialization benefits and identity aspects) (Coyle, 2007).

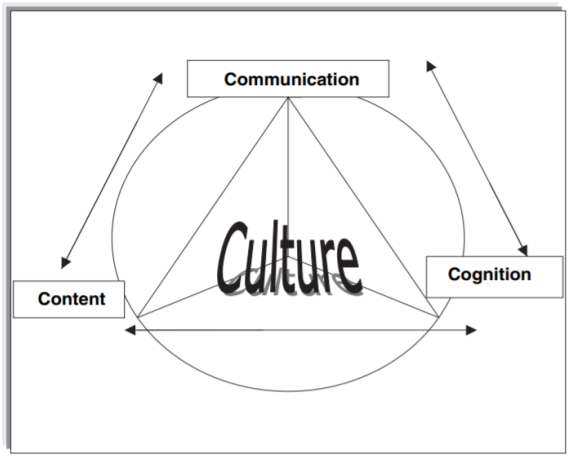


Figure 1. The 4Cs Framework for CLIL (Coyle, 2007)

The literature has documented many benefits of this approach in relation to L2 acquisition, especially in the areas of reading, listening, receptive vocabulary and written and oral fluency (Tedick & Lyster, 2020). Dalton-Puffer (2011) highlights some of these benefits as well. On the one hand, language is used for a purpose, which results in more

meaningful learning and a more authentic communicative act. In fact, according to Coyle (2007), CLIL is a more natural way of acquiring a language as it provides real and meaningful input. On the other hand, a greater amount of exposure to the TL, but also a higher quality of the interactions, different and complementary ones (Escobar Urmeneta, 2019)**,** not only between teacher and learners, but also between learners (Nikula, 2007). As is well known (Long, 1996; Mackey, 2020), interaction facilitates L2 learning because it provides the learner with comprehensible input, possibilities to produce output and to receive feedback from the teacher or his/her peers. Language is addressed in the time normally devoted to the subject, the focus on meaning reduces anxiety and increases learner motivation, and a positive context for content learning is created. However, as Ruiz de Zarobe (2011) states, CLIL research sometimes shows contradictory results, probably because CLIL programmes are heterogeneous in nature and are implemented differently in various settings (Nikula, Dalton-Puffer & Llinares 2013). Improvement in accuracy is not usually reported. For example, Lialikhova (2021) carried out a CLIL intervention project in a class of 27 14–15-year-old pupils in a Norwegian urban school. The project consisted of teaching history through English and lasted six weeks. The aim of the study was to examine the impact of CLIL intervention on pupils' oral language development, which was measured using the Stanford Foreign Language Oral Skills Assessment Matrix (FLOSEM). The results indicated that the short-term CLIL intervention project had a significant impact on the overall oral development of the high and medium achievers, while there were no significant results for the low achievers. The results also indicated that high achievers developed fluency, vocabulary and pronunciation to a large extent, but not so much accuracy. These findings are similar to the ones reported by Segura, Roquet and Pérez-Vidal (2021) in Spain.

Several studies have identified problems in CLIL programmes, though. Thus, Bruton (2013) states that the range of CLIL subjects seems to be arbitrary, since what is available, namely what teachers in particular schools can offer, seems to predominate (Gierlinger, 2007). Lyster (2007) mentions that teachers often place too much emphasis on content and too little attention on language. About this, Bruton (2013) comments that in Tan's (2011) study, language was not a problem in mathematics, but it was a problem in sciences that required more participation. That is, if the content subject is complicated or unfamiliar and involves acquiring new concepts, this may be a hindrance rather than a benefit to students' language development (Bruton, 2013). It is indeed difficult to make progress in the subject matter at the same time as in language (Coonan, 2007) but, as

Apsel (2012) argues, the lack of language can be a serious handicap to content development. Some authors (Paran, 2013) have highlighted that CLIL programmes have also been considered elitist, that is, catering to a select few.

One way to facilitate learners' acquisition of content could be the use of technology in the classroom. Although several technological tools are available for that purpose, in the following section we will focus on one of them, namely, Augmented Reality (AR).

1.2. Augmented Reality (AR)

Learning subjects in an L2 can be challenging for students. After all, subjects such as Social Science require students to understand a large number of concepts. Students´ success will therefore partially depend on their knowledge of vocabulary and linguistic structures. Consequently, teachers are constantly faced with the need to find ways of helping students to learn content presented in English, a language that they are still learning (Weisman & Hansen, 2007)**.**

It could then be argued that updating traditional instruction would be necessary for learners to understand the subject matter at the same time as they acquire the L2 (English) skills. Weisman and Hansen (2007) propose, for example, the use of real objects, graphs, pictures or photographs, and Venn diagrams or chains of events.

New technologies are already an essential part of our students' world. Therefore, the use of Information and Communication Technology (ICT) in education seems to be not an option but a need. Fortunately, the various technological resources available today can be considered effective for use in educational settings. In fact, the educational curriculum considers the introduction of new technologies as a resource for learning to be relevant, and digital competences appear as one of the basic skills to be developed (Aguirregoitia et al., 2017).

In this area, Augmented Reality (AR) technology has proved attractive. According to Azuma (1997), AR is defined as a technology in which the real world and virtual images are blended and real-time interaction is guaranteed. AR is not the same as virtual reality (VR) mainly because while the latter immerses the user so that they cannot see the real world around them, AR allows the user to see a real world that is complemented by virtual elements (Kerawalla et al., 2006). Figure 2 illustrates the reality-virtuality continuum proposed by Milgram et al. (1994).

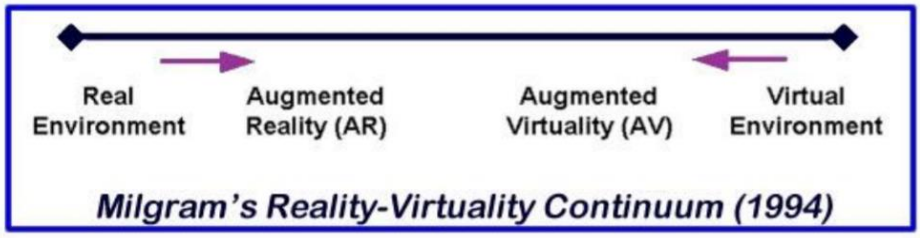


Figure 2. Reality-Virtuality Continuum (Milgram et al, 1994, p. 283)

According to Bistaman et al. (2018), the use of this technology turns an empty space into a rich educational experience. AR allows users to interact with both real and virtual objects, provides experiential learning and increases attention and motivation (Singhal et al., 2012).

Recently, Cabero and Barroso (2016) conducted an analysis of the published works on AR, in which the following benefits of this technology in educational contexts are highlighted: it facilitates the understanding of complex concepts (Joo-Nagata et al., 2017; Laine et al., 2016; Merzlykin et al., 2018); favours the contextualisation of information; allows individualisation and adaptation to different types of intelligence; offers students the possibility to interact by manipulating real objects; favours ubiquitous learning; facilitates the development of a constructivist teaching/learning methodology; favours the development of graphic competences through the perception of spatial content and 3D objects; favours learning by doing (experiential learning); increases motivation (Hung et al., 2017; Merzlykin et al., 2018; Tobar-Muñoz et al., 2017); improves academic results (Wei et al., 2015) and satisfaction (Hsiao et al., 2016; Huang et al., 2016)**;** is flexible, as it can be used at different educational levels and in different disciplines and it can be combined with other teaching methodologies.

In this context, Scrivener (2005) (as cited in Bistaman et al., 2018) states that the main role of the teacher is to help learning take place, that is, to engage students by respecting their pace, providing brief explanations, and encouraging participation and interaction. To this end, Di Serio et al. (2013), consider that educators must take into account this emerging technology to support and enhance their students' learning and at the same time comply with pedagogical practice (Kreijns et al., 2013). In many subjects, it is impossible to gain first-hand experience in the real world. By using the technological approach, according to Bistaman et al. (2018), it is expected that students' creativity and imagination will be fostered and that students will be able to manage their learning according to their pace.

Several studies have shown that AR is actually beneficial for learning. Kerawalla et al. (2006) conducted a study with a total of 133 Year 5 children (10 years old) and their teachers from five primary schools in London. The aim of the study was to compare teachers' use of AR with the use of traditional teaching materials. For this purpose, several classroom sessions were conducted and interviews were held with the teachers. The study showed that AR helped 10-year-olds understand how the Earth and the Sun interact in a three-dimensional space to create day and night. Küçük et al. (2014) conducted a study with 122 fifth graders from 5 different secondary schools in Erzurum, Turkey. The aim was to investigate whether there was a relationship between students' attitudes and cognitive load levels as a function of their performance levels and whether there was a relationship between these variables. To this end, AR applications were designed and implemented for English courses. This study revealed that students who used AR applications in English language learning had a high level of achievement, showed a positive attitude towards technology and used little effort in the process. In addition, they intended to use these applications in the future, were satisfied and had a low level of anxiety when using the technology.

In the Spanish context, some studies have been conducted already. For example, Cozar-Gutiérrez and Sáez-López (2017) carried out a project using AR as a resource based on a project methodology. It was carried out in a rural school, specifically in the Colegio Rural Agrupado (C.R.A) Laguna de Pétrola, in the province of Albacete. It was designed for pupils in 4th, 5th and 6th grades of Primary Education. The project was part of the Social Sciences area and within the framework of the didactic unit entitled "Iberians, Celts and Cetiberians". After the intervention, the authors highlighted some benefits, the most notable being motivation, which led to improvements in learning. In addition, they stated that the use of technological resources allows for dynamics and interactions in the classroom centred on the student, who must seek information about the different figures and maintain an active attitude. The study also highlighted other benefits in the integration of AR: interest, curiosity, satisfaction, active approaches, comprehensive thinking, critical thinking and collaborative learning.

More recently Toledo-Morales and Sánchez-García (2018) carried out a study with 10–11-year-old 49 5th grade students in Seville. Using a longitudinal design (the study was carried out in one whole academic year), the authors had an experimental group, which used AR tools, and a control group, which followed traditional teaching methods. The aim of this study was to analyse whether the use of AR influenced

knowledge acquisition and learning, to compare students' grades before and after the use of AR, and to explore students' perceptions of AR. In order to do so, the following procedure was used: (i) a pre-test phase (prior knowledge), (ii) a learning phase (the session of the selected topic, which was explained in a traditional manner to the control group and using AR with the experimental group), (iii) post-test phase (assessment of knowledge in both groups), (iv) perception on the use of AR and (v) interview phase with AR students and teachers. The topic "The Representation of the Earth" was chosen in collaboration with the teachers because it was part of the syllabus of the subject. Ad hoc content was created using the AR software *Aumentaty Author*. In the classroom, these contents were visualised by pairs of students using 15 tablets. The results showed that, after the use of AR, the experimental group performed better. As for the students' perceptions, they considered that the use of AR facilitated their learning and understanding of the content and that the sessions were less boring and more interesting. However, there is still a dearth of studies that adequately present and analyse the educational potential and possibilities of AR technology in Primary Education (Fotaris et al., 2017).

2 Methodology

The main aim of this study is to analyse the possibilities of AR and evaluate its impact on content learning in Primary Education, specifically, in the sixth year of Primary Education. As explained in the theoretical framework briefly reviewed above, research on the use of AR in Primary Education is scarce and, therefore, this study aims to be a small contribution to the field.

In order to achieve my goal, I followed several steps:

- First of all, I looked for a school that implemented the CLIL methodology and was willing to collaborate. The school where I studied, B.V.M Irlandesas Leioa, fulfilled these requirements so I contacted them to explain my project.
- I chose the topic for the didactic unit: "Economic sectors". This topic is part of the syllabus for the sixth grade of Primary Education and was also appropriate for the use of AR. I selected the contents of the unit on the basis of the minimum that the students should acquire once the sessions were over. On the one hand, the vocabulary of the activities in the primary sector, the secondary sector and

the tertiary sector. On the other hand, the grammar to be used during the sessions, that is, the present simple and the generic, definite and indefinite articles.

- I designed the didactic unit. In doing so, I took into account the minimum contents to be acquired. I designed different activities with different marker interactions (that is, a smaller or larger number of markers in each activity) and different types of multimedia (videos, photos, 3D objects and audios).
- Prior to the actual implementation, I gave tests to both teachers and students. The teachers' questionnaire focused on their opinion about technologies. The students' questionnaires assessed, on the one hand, their use of technologies and, on the other hand, their prior knowledge of vocabulary and grammar related to the topic to be dealt with.
- Then, I implemented the didactic unit using AR. The material was used in four sessions of approximately half an hour each in an intact classroom. Before starting the sessions, I provided a brief explanation to the whole group about the use of AR: what markers are, what they are used for in the activities and what to do to solve the activities through the AR application. As for the sessions, I divided the classroom into two groups and, separately, I took them out to another classroom so that I could pay closer attention to their performance.
- Finally, I gave post-tests to students. The students' questionnaires were, on the one hand, an evaluation of vocabulary and grammar knowledge to assess whether or not there had been any improvement and, on the other hand, a questionnaire on their opinion about the use of AR.

3 Development of the project

3.1 Objectives

The main aim of this paper is to analyse the effectiveness of AR in a CLIL context in Social Science, that is, to find out whether AR helps to understand and assimilate vocabulary, grammar and content knowledge and provides support for understanding the contents of a Social Science unit. In addition, I will analyse the students' use of technologies and their opinions on the use of AR as a teaching tool. Moreover, I will gather the teachers' opinions on the use of technologies. In order to reach this goal, I have analysed both quantitative and qualitative data.

3.2 Hypothesis

The main hypothesis entertained in this study is the following: the use of AR will have a positive impact on the learning of the content chosen. Moreover, students will benefit from the ludic component and autonomous learning. Therefore, they will evaluate the experience positively.

3.3 Research Design

This section presents the specific steps followed throughout the process of creating the AR sessions, along with a brief explanation of each step. In addition, for some steps, additional information is provided regarding duration and date. Table 1 (*see Appendix 1*) features each of these steps.

First of all, as mentioned above, I looked for a school that implemented the CLIL methodology and was willing to collaborate. The school was B.V.M Irlandesas Leioa. As they agreed, I looked for a topic that was included in their syllabus and that was appropriate for the use of AR: Economic sectors. I chose the content to include in my didactic unit and started to design the activities, specifying their aim, level and resources needed for each one of them.

Once designed, I had to prepare them in the *Augmented Class* application. For each activity, I had to add 1, 2, 3 or 4 markers, cards containing information (*see Appendix 2.1*). Once the markers were created, the audio, video, image or 3D object was added (*see Appendix 2.2*), depending on what each activity required. Each set of markers, when scanned, would give different information. If they were separate, for example, each would contain an explanation. If they were together, an audio congratulating the students for the completion of the activity would be heard (*see Appendix 2.3*).

In addition, I prepared the questionnaire on technology to be administered to teachers (*see Appendix 3*) and the pre- and post-tests to be administered to students. The items in the teachers' questionnaire were adapted from Abrami and Sclater (n.d.). On the one hand, the students' pre-tests would be on technology and content. The items in the pre-test on technology (*see Appendix 5*) were adapted from Sato et al. (2020). The test on technology contained statements on the type and frequency of use of different technologies: computer, tablet, smartphone and, if known, AR. For each statement, students had 4 options: Definitely no (D No), No, Yes and Definitely yes (D Yes) (*see Appendix 6*). The content test (*see Appendix 8*) included different activities related to the three economic

sectors, in order to assess their knowledge prior to my sessions. I designed the items in the pre-test on content.

On the other hand, the post-tests were also about technology (*see Appendix 13*), but this time only about AR (for feedback on the AR experience), and about content (*see Appendix 8*). The items in the post-test on technology were adapted from Harfield (2014). The first one contained statements about AR and their experience with it, to which they could respond with 4 different answers: Definitely No (D No), No, Yes and Definitely yes (D Yes) (*see Appendix 14*), as in the pre-test. I designed the items in the post-test on content. The content test was the same as the pre-test, to check if there was any improvement in knowledge after the sessions. Students' responses to both the content pre- and post-test were transferred to an Excel spreadsheet (*see Appendix 9*).

We had planned that the students would use the school's tablets to do the activities in the sessions but the AR application was not compatible with the brand of their tablets (Apple). Therefore, different Android tablets had to be collected to carry out the sessions. Consequently, it could not be ensured that all the tablets worked equally well. In fact, there were some problems with their speed. Nevertheless, all the activities were completed. On the other hand, due to time constraints, instead of doing one session per day (4 days in total), two sessions per day had to be planned (2 days). It could be said that it was an intensive intervention, since in a regular situation it would have been done over more days. Finally, in this study, the pre-test, that is, the students' prior knowledge, was not assessed when designing the sessions.

3.4 Characteristics of the Sample

The didactic unit was implemented in the B.V.M Irlandesas Leioa school, a multilingual, Catholic, charter school, specifically, in one sixth-grade classroom. In this school there are two models: A and B. In this case, model A offers some subjects in English through the CLIL methodology. In other words, students learn the target language (English in this case) in common subject classes such as Social Sciences. At the socio-cultural level, the school does not show great diversity, as most of the students are from the area (Leioa, Getxo, Bilbao, etc.). At the socio-economic level, it could be said that the children' families belong to a medium-high socioeconomic status. In terms of language, in general, Spanish is used as a means of communication. English is the language that is mainly reinforced at school, through exchange programmes with other countries, preparation for official Cambridge exams from the sixth year of Primary Education

onwards, etc. Basque, on the other hand, in this model, is only taught as a subject. Consequently, pupils do not seem to be motivated or have any interest in this language.

The classroom selected for the research consisted of 24 pupils, 14 girls and 10 boys. Although some students were 12 years old, most were still 11 years old when the intervention took place. Concerning English, in general, they had a high proficiency level for their age (A2) and a great motivation towards learning the language.

3.5 Tasks for Data Collection

In order to collect the necessary data, firstly, a questionnaire (*see Appendix 3*) was given to teachers on their opinion of the use of technology in the classroom. In the case of students, a pre-test on the use of technology (*see Appendix 5*) and another one on the chosen contents (*see Appendix 8*) were administered. Once the tests had been completed, the planned activities were carried out with the students during four sessions. These were previously planned in Table 5 (*see Appendix 16*) detailing the different objectives of the activities, the materials (*see Appendix 17*) to carry them out and the number of markers used. In addition, the timing of the sessions can be found in Appendix 6. Finally, a post-test was given to the students on the use of AR in the classroom (*see Appendix 13*) and another one on the chosen contents (*see Appendix 8*).

3.6 Procedure

On the first day at the school, the students took the two pre-tests, the technology and the content test. Once they finished, I divided the class into two groups: Group A and Group B, trying not to separate the students from the cooperative groups already established in the classroom. Once divided, I took Group A to a separate classroom. There, I asked them if they knew what AR was, and, in general, they had not heard of it. Therefore, I explained what it was all about and introduced them to the application and the basic concepts they should know. In order to do so, I preprared a *Canva* presentation (*see Appendix 18*). Afterwards, I did the same with Group B.

The next day at school, as the groups had already been created, the only thing left to do was to make the pairs and trios, in order to distribute the tablets. I started with Group A, explaining the first activity of the first session. As there were different rhythms, each group needed more or less time to complete the activity. Therefore, intending to respect their rhythms, I told them that when they finished the activity, they should call me so that I could explain the next one. In addition, while they were completing the activities, I was

able to walk around the groups to check that they were doing them correctly and, if they had any doubts, I solved them. Finally, we were able to complete the activities of the first and second sessions. The same procedure was used with Group B.

The following day, again, I started with Group A. First of all, we conducted the third session as a group. In this way, I made sure that each of the students felt involved and that the contents were understood and the doubts were solved. Once this session was completed, we carried out the fourth and last session, in which the students had to create their projects with the tablet (*see Appendix 19*) . Once finished, I carried out both sessions also with Group B.

Finally, one day later, the students carried out the two post-tests, the test on technology (in this case, about AR) and the test on content. Table 1 features each of these steps**.**

Table 1: Implementation timeline

Implementation	30/03/2022	Pre-test on technology	10min
		Pre-test on content	30min
		Group 1: Application explanation	10min
		Group 2: Application explanation	10min
	04/04/2022	Group 1: Session 1	30min
		Group 1: Session 2	30min
		Group 2: Session 1	30min
		Group 2: Session 2	30min
	06/04/2022	Group 1: Session 3	30min
		Group 1: Session 4	20min
		Group 2: Session 3	30min
		Group 2: Session 4	20min
	07/04/2022	Post-test on technology	10min
		Post-test on content	30min

3.7 Assessment Techniques

In this case, there were two assessment procedures. On the one hand, paper-and-pencil pre- and post-tests, that is, regular tests as we know them, structured, formal and conducted under controlled conditions. On the other hand, informal observation has been carried out on the learning process. For the former, the data were introduced into an excel spreadsheet and the corresponding statistical analyses were carried out using the SPSS statistical software (IBM Corp, 2016).

3.8 Results: Interpretation of the Data Collected

This section reports our findings. On the one hand, quantitatively through the various achievement tests and questionnaires about the use of technology and, on the other hand, qualitatively.

3.8.1 Teachers' Perceptions about the Use of Technology in the Classroom

Teachers completed a questionnaire on the use of technology in the classroom (*see Appendix 3*). The participants were four women and one man, with different years of experience, most of whom favour a methodology where there is a fair balance between teacher-centred and learner-centred activities. Their classrooms are made up of between 26-30 pupils and the language of instruction, in most cases, is English and, to a lesser extent, Basque.

The results show that teachers consider technology to be a valuable instructional tool that increases academic performance and promotes pupil collaboration (*see Appendix 4*). They consider the use of technology to be effective because they believe they can implement it successfully, and it makes them feel more competent as educators and enhances their professional development, as well as giving them the opportunity to be facilitators of learning rather than providers of information. However, they state that it is only successful if there is adequate teacher training in how to use it for learning. In relation to students, they consider that it is an effective tool for students of all abilities, that it helps to accommodate their personal learning styles, that it motivates them to become more involved in learning activities and that it promotes the development of interpersonal skills. Finally, they do not consider that the use of technology increases the amount of stress and anxiety experienced by students, nor does it make classroom management more difficult. Appendix 4 features more information.

3.8.2 Students' Use of Technology

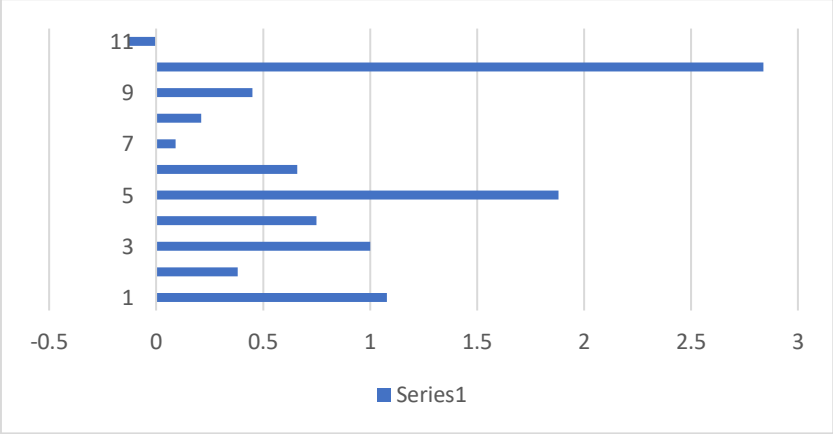
Prior to the sessions, students completed a questionnaire on their use of technology, namely computer, tablet, smartphone and AR (if known) (*see Appendix 5*). Appendix 7 contains graphs depicting the percentages of student responses to this questionnaire. They are pie charts and each slice describes the percentage assigned to each answer. The following lines present the most relevant information.

The pre-test about technology consisted of 24 questions about students' use of different technologies, which were divided into four blocks: Computer, tablet,

smartphones and AR. This test shows that, in general, students use all the technologies mentioned for different purposes. However, they were not familiar with AR. Regarding the first block (*Computer*), the results show that students do not use the computer every day, as they use the tablet (which I will discuss below), and, when they do, it is for educational purposes, to browse the Internet and to watch videos. As for the second block (*Tablet*), the results show that, except for 8% of the class, the rest uses the tablet. They use it for education, as they work with it at school, and also for playing games, browsing the Internet and watching videos. The third block (*Smartphones*) deals with smartphones. In this case, the results show that most of the students use them, in general, to contact friends and to browse the Internet. The fourth and last block (*AR*) aimed to find out if the students knew about AR and, if so, if they knew or had used any AR application. In this case, practically none of the students knew what it was.

3.8.3 Learning Outcomes

Graph 1 illustrates the difference between pre- and post-tests means for each of the activities that the students completed (*see Appendix 8*). However, more detailed information is detailed below the figure.



Graph 1. Improvement between the pre- and post- tests

Table 2 (*see Appendix 10*) provides the sample means and standard deviations for each of the items in the pre- and post-tests on content, as well as the maximum and minimum scores obtained by the students in each item. In some activities, namely Activity 3 (mean 3.33/4), Activity 7 (mean 2.83/3), Activity 8 (mean 3.67/4) and Activity 11 (mean 3.63/4), the means were high already in the pre-test, indicating that those were perhaps easy items (something I will discuss in more detail later in this section). In the rest of the pre-test activities, the means were not too high, that is, the items, before the

sessions, were not as easy for them, especially in activities 5 (mean 4.25/8) and 10 (mean 2.79/6).

Table 3 (*see Appendix 11*) provides a comparison of the mean pre- and post-scores for each of the activities where, except for Activity 11 where mean post-scores were slightly lower that mean pre-scores (something I will discuss in more detail later in this section), mean post-scores were consistently higher than mean pre-scores for each of the activities. In order to test for statistical significance between pre- and post- tests on content scores, a paired t-test for dependent samples was used (Hogg & Tanis, 1988). Results for these statistical comparisons will be provided in Table 4 (*see Appendix 12*).

In addition, robust alternatives based on the Wilcoxon's signed rank test (Conover, 1980; Hogg & Tanis, 1988) reached the same conclusions. The Wilcoxon signed rank test is a nonparametric robust alternative to the paired t-tests above, and the resulting p-values for each of the tests. Table 3 (*see Appendix 11*) includes the mean differences, standard deviations, 95% confidence intervals, test statistic values for the paired t-tests, degrees of freedom for the student's t distribution, and resulting p-values for each of the tests. The null hypothesis being tested was that there was no difference between the mean post- and the mean pre-scores, against the alternative hypothesis that mean post-scores were higher than mean pre-scores. At the 5% significance level, differences were not statistically significant (that is, the confidence interval included the value zero or the p-value was larger than the established significance level, 0.05) for activities 7, 8 and 11 (something I will discuss in more detail later in this section). Moreover, for activity 11, mean pre-scores were slightly higher that mean post-scores. For the remaining activities (that is, activities 1, 2, 3, 4, 5, 6, 9 and 10), we can conclude that mean post-scores were statistically higher than mean pre-scores (that is, the confidence interval did not include the value zero and both the lower and upper values were positive or the p-value was smaller than the established significance level, 0.05). That is, in 8 out of 11 questions results were significantly better only with four sessions.

Activities where the test statistic value (that is, *t*) is higher than 2 show a relevant improvement. In the activities mentioned above (Activities 1, 2, 5, 6 and 10) *t* is higher than 3, which indicates that the improvement is really noticeable. In order to interpret the results using confidence intervals, we can state that, with a 95% of confidence, for example, mean post-scores for activity 1 are between 0.602 and 1.564 points higher than

mean pre-scores. Similarly, mean post-scores for activities 2, 5, 6 and 10 are higher than mean pre-scores. Table 4 (*see Appendix 12*) also provides information regarding these improvements.

The activities which showed the highest improvement were the ones on vocabulary and content. Exercises 1 and 6 were focused on vocabulary and content as learners had to identify the activities belonging to the sector in question and, in order to do so, recognise the words. Exercise 5 also involved both content and vocabulary knowledge, that is, students had to know the vocabulary related to the topic to correctly classify the different raw and manufactured materials in their respective economic activity. Exercise 2 was a comprehension activity, involving both content and grammar. Finally, Exercise 10 involved reflecting on the content received and being able to place different images in order, as well as identifying which sector each one belonged to. The great improvement in these five exercises also reflects the improvement in content knowledge, vocabulary and understanding of grammar after the various sessions carried out.

However, it is also important to reflect on what has been previously observed in other activities, namely exercises 3, 7, 8 and 11, which showed good results already at the beginning. Therefore, in some of them, slight or no improvement from pre-test to post-test was observed. Exercise 3 consisted in writing the name of the economic activity to which the definition corresponded. In this case, some were very simple and others could be found in the first activity, in which the names of several primary sector activities were written. Exercise 7 consisted in matching the economic activities with their description. This could be guessed from knowing some of the words in the definition. In Exercise 8 students had to link the raw material with the manufactured material. It contained neither vocabulary nor grammar, the students simply had to use logic to link the two materials. Finally, Exercise 11 consisted in writing the number of the sector to which each activity in the different pictures belonged. In this case, we can only speculate that they did not read or understand the instructions well. In general, instead of writing the number of the sector to which the activity in the picture belonged, they put the pictures in "order". So, by pure chance, the results in the pre-test were higher than the results in the post-test.

3.8.4 Students' Perceptions about the Use of AR

The post-test on technology (*see Appendix 13*) consisted of different questions related to AR, taking into account different factors: Engagement, attention and interest

(Block 1), Usability (Block 2), Emotional attachment (Block 3), Focus of attention (Block 4) and Presence (Block 5). This post-test was aimed at evaluating the students' experience with AR, as it was something new for them. Overall, the results (*see Appendix 15*) of this post-test were very positive. Although the students said that they did not feel they were the protagonist of the activity, perhaps this is because most of them did not revolve around themselves and their interests.

As for the first block, the AR application that was used caught their attention, the topic of the activity made them want to know more about it, they liked the design and appearance of the AR application, they wanted to spend time in completing the activity successfully, and the vast majority definitely did not think that participating in the activities was a waste of their time. As for the second block, they found the application easy to use, felt confident using it and felt that they could use it to search for the information they needed. Regarding the third block, the results show that students were impatient in terms of completing the activities successfully and that they were excited to feel part of the activities and responsible for them. As for the focus of attention, addressed in the fourth block, the results show that if students were interrupted, they looked forward to returning to the activity, they were more focused on the activity than on any external distraction. Moreover, they felt that time passed by quickly during the sessions. Finally, as far as implication is concerned, a large number of pupils say that they did not feel that they were the protagonist during the activities. Even so, they found the activities authentic and something they could experience rather than just do.

In addition, students were given the opportunity to express their opinion in writing at the end of the test. Figure 3 shows that learners enjoyed the sessions conducted with the app, and the overall experience.

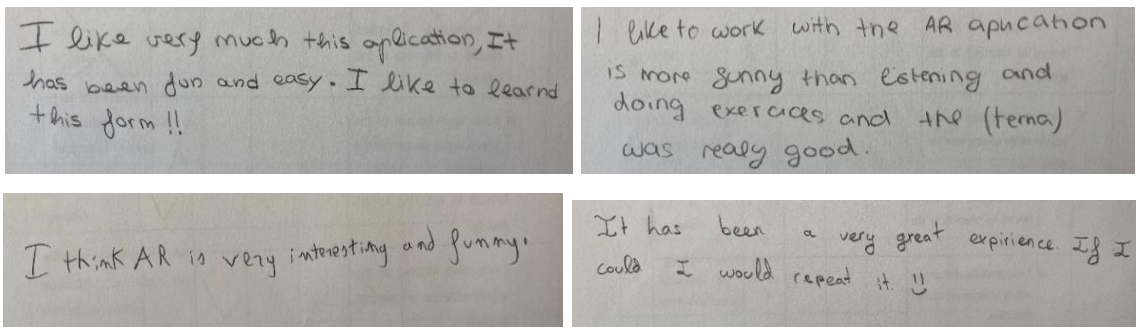


Figure 3. Comments written by students

4. Conclusions

The main objective of this work was to analyse the possibilities of AR to teach Social Science in English in a Primary Education classroom and to evaluate its impact on the comprehension of the content and on the learning of vocabulary and grammar. The most relevant conclusions of this research are that in most activities students performed better in the post-test than in the pre-test and, therefore, we could claim that even a brief intervention of four sessions has had a positive impact on their knowledge and attitude. On the other hand, we also analysed the use of technology by students and their opinion on AR after carrying out the sessions. The application has been positively evaluated: it caught their attention, it was easy to use, they felt excited to be part of the activities and considered that time passed by quickly during the sessions. Moreover, teachers' views on new technologies in the classroom are important for a succesful experience. In this case, teachers stated that the use of technology in the classroom can be of real benefit both for them and their students but it must be properly planned and resourced.

This study also had shortcomings that should be acknowledged. It was a single lesson carried out in a few sessions and with only one group of students. Moreover, as mentioned above, there were some unexpected technical and organisational aspects that could finally be solved. This issue should clearly be considered in further research and tailor-made post-tests taking into account both the students' prior content knowledge and level of English should be designed. This will make the learning more relevant and meaningful for them. All in all, the results should be interpreted with caution because the scope is narrow, but the outlook is indeed positive, as students have not only used the application, but have had the opportunity to create their own content with it.

5. Professional ethics and data protection

In accordance with professional ethics, basic rights and the Universal Declaration of Human Rights were respected. Moreover, the active subject and his/her rights were considered, as well as their freedom and autonomy. In addition, the data collected will be kept confidential together with all the information directly or indirectly related to the data gathering procedure. When sharing information, it will always be for the benefit of the person, the group or the community; following ethical principles and legal regulations, information will be guaranteed to the person concerned. Finally, the language used was inclusive and respectful of the groups represented in the work.

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