| **RESEARCH ARTICLE**

The Application of Augmented Reality (AR) to Language Learning and its Impact on Student Motivation

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| **ABSTRACT**

The recent emergence of digital authoring tools related to Augmented Reality (AR), such as Zooburst, Roar or Aumentaty, has facilitated the integration of this cutting-edge technology in Education. Consequently, different publications have come out to light about the affordances and limitations of integrating technology AR in the EFL/ESL classroom. Thus, this study seeks to analyze and review the recent trends in AR implementation in the English as a Foreign Language Classroom (EFL) and to present the main projects aimed at teaching English with AR-based projects that have been published in the latest years in WOS and Scopus. Following the methodology, the improvement in the performance of the student in different areas of study has been proved while using AR in EFL teaching.

1. Introduction

The use of Augmented Reality (AR) has experienced a significant increase over the last years in different areas such as architecture, sports events and tourism. The development of low-cost programs and mobile applications has facilitated the use of this technology in more areas, for instance, education. The first mention of AR appeared in 1901 when Frank L. Baum coined the term "character marker" in one of his novels, becoming nearly a century later an important concept in AR. In 1962, Morton Heiling created Sensorama, in which a set of vibrations and additional information was added in order to improve the experience of the users. Later in 1968, Ivan Sutherland created the first display system in which a head-mounted system allowed the user to get further information. However, it was not until the 1990s that Tom Caudell coined the term Augmented Reality. As a result of technological advances and the worldwide use of mobile devices, AR technology has been adopted in the Educational System, and, more precisely, it has been integrated into the teaching of English. Although it was used previously in other fields, AR technology has allowed in-service teachers and students to experience digital and interactive lessons where the real-world environment is mixed with augmented digital created elements. The popularity of AR tools has increased due to diverse causes, for example, the free-downloadable applications such as Roar, Zapworks or Aumentaty, among others. The expansion of AR has been such a success that a great number of international companies have integrated it into their catalogue of applications and games. For instance, IKEA has created an application to display their products in the houses in order to have a better representation, and Nintendo released in 2016 Pokémon Go, which has become the most popular game worldwide that uses AR as the main device of gameplay.

There are only the first steps into the adoption of AR in language teaching, but some research works have been published in the past years. However, a great amount of them focused on examining the impact that AR has on student motivation and engagement. This article aims to review current trends regarding the adoption of AR technology in language learning and its impact on student motivation.

2. Literature Review
2.1 AR Definition
AR is used to describe a set of technological elements that permit the user to have a clear image of the real world while using a device that generates extra graphic information. This means that the real physical world is mixed with other virtual elements. This term was first coined by Tom Caudell (1992); however, the most cited in AR terminology was Ronald T. Azuma in 1997. Azuma described it (1997, p.2) "Augmented Reality (AR) is a variation of Virtual Environments (VE) or Virtual Reality as it is more commonly called". He also affirmed that the difference between Virtual Reality (VR) and AR is that the last one allows the superposition of real elements and virtual while the first one is just a virtual creation. Moreover, he claimed that AR complements the real world with virtual elements instead of removing the real complement as VR does. In 1997 Azuma established the three main features of AR:

1. AR combines the real world with virtual environments, which allows the user to interact with real-world elements with the use of a technological device, providing them with unique experiences.
2. AR should be interactive in real-time, which means that the user has to be able to change the action and have an impact on the created scene, making the experience more realistic.
3. AR should have 3D elements. The information has to be shown from that perspective, giving the user the sensation of belonging to the real world.

Barroso and Cabero (2016) affirmed that some technological elements are needed, such as triggers, tracking and overlays. Triggers are real elements used for the virtual element inclusion in the real environment. There are different types, such as:

1. Marker-based triggers. The users should aim their devices in the direction of the marker established as a trigger. It could be different real elements such as images, text, the object itself or QR codes.
2. Markerless-based triggers. AR could be inserted into the real world in a really sensationist way due to the lack of an outgoing element, as was the case in the last type of markers. This causes a triggering of the augmented elements in the surface set for, and it is attached to the element the user was aiming to. This type of marker is used, in general, by enterprises such as IKEA because it allows you to have a realistic picture of the furniture without seeing the marker on your technological device.
3. Geolocation-based triggers. Using the GPS and the positioning, the triggering could be set in the exact spot. This trigger is used by some AR games, such as Pokémon Go, where the event trigger is in relation to the ubication of the player.

Another element needed in AR technology is tracking. According to Rabbi et al. (2013), this refers to tracking the connection between the world we live in and the virtual space we have created. The result is an AR experience. To make this experience as realistic as possible, AR software too is required to track our surroundings and find points of reference. These points can be created by tracking an image, a surface or an object. There are three types of tracking: 1) tracking based on sensors; 2) tracking based on vision, and 3) hybrid tracking.

The last element is the overlay which is the augmented element that appears in the technological device. Depending on the app, those overlays could differ. However, the most common overlays used in AR apps, such as Zapworks, are images, videos and links.

2.2 AR in Education
Given the latest AR technological advances in many areas and thanks to the functionalities and improvement of technological interfaces, researchers claim that AR has great potential and has numerous benefits. Although there are certain disadvantages, it can provide a new context to education, enhancing its contextualization and effectiveness, as pointed out in several studies (Avila-Garzón et al., 2021; Billinghurst, 2002; Chen, 2017; Cooperstock, 2001; Klopfer et al., 2008; Shelton et al. 2002).

In an educational context, AR has been used as a complement in a preestablished and standard planification, normally based on a traditional methodology (Ávila-Garzón et al., 2021) by implementing text, 3D graphics, video and audio that can be overlaid on the learner's environment in real time. However, there are other elements such as reading materials, textbooks and reading cards that can contain markers or triggers scanned by a device that can support an AR application. Among the main tools we can find:

1. AR-based textbooks. According to Yuen (2011) and Yang (2021), AR books are one of the cornerstones that help bridge the digital world with real environments. This interactive experience seems to please digital native learners. For example, one of the first AR-based papers to appear is a book called "The Future is Wild: The Living Book" (2011).
2. AR Note. According to the studies published by Pasaréti et al. (2011) and later Theodorou et al. (2018), another implementation system that encourages the use of AR in the educational environment is known as "AR Note", a system that allows taking notes in a virtual notebook with the advantage that it can be much more efficient and allows the

introduction of graphics or the search for information in such notes. This encouraged student retention and improved study habits, as shown in the experiment conducted by Pasaréti et al. (2011).

3. AR-based games. According to Pasaréti et al. (2011) and research by Kerr et al. (2020), teachers typically use games to help students with certain concepts. Thanks to the use of AR, games can be based on a real environment but mixed with virtual elements. This allows the creation of new relationships and connections between items in learners. There are two types of AR-based games: board or map-based games and games that link real locations with virtual elements.

Over the years, some improvements in technology have been made thanks to technological progress. Dede (2008) states that educators and researchers are continually developing new teaching methods based on the latest advances, with the aim of making them more accessible to students. AR is a tool that can be found at different levels of education nowadays, thanks to the fact that mobile devices are widely spread, which allows its inclusion in the educational environment in a simple way. Furthermore, industry experts, according to Kerr et al. (2020), have predicted that, as peripherals evolve, they will be able to support AR content more effectively and with better quality, which will lead to further development of AR-based applications and elements in education.

2.3 AR in English Learning

According to Gündoğmuş et al. (2016), in the field of foreign language education, it is necessary to have a natural and educational environment that enhances motivation, interest and encourages learning a foreign language. Therefore, the activities and the environment that needs to be created should attract the student's attention, as well as increase student motivation and confidence, detaching education from negative emotions such as anxiety or fear of failure that often appear in these students.

Moreover, Gündoğmuş et al. (2016) established that the use of AR in teaching English as a foreign language favoured an increase in students' motivation and interest as it added many elements that traditional teaching did not allow in this area of knowledge. This is because the inclusion of AR allows changing the concept of localization, which has led to an improvement in the four main areas of foreign language learning: reading comprehension, listening comprehension, oral production and written production.

In addition, AR can be applied in different ways and in various contexts, in language learning and teaching in general. The overview of the research conducted provides a generalized vision in which the benefits offered by AR in terms of creating an interactive environment in foreign language learning can be observed in a precise and recurrent manner. But a series of disadvantages have also been observed. Some authors have catalogued those advantages as hindering, and although the benefits outweigh the limitations, these are evident in the studies carried out to date. Parmaxi et al. (2020) have classified the benefits in five different sections and the limitations around two dimensions:

1. Benefits:
   a. Improves learner motivation. AR in language teaching is often implemented on a mobile device, which confers an everydayness that cannot be achieved with any other element. Such an effect creates a sense of familiarity in the learner that leads to an increase in their motivation, as they can learn through a familiar element.
   b. Improved representation of abstract concepts. Following the research carried out by Akçayir et al. (2016), Chang et al. (2013) and Lin et al. (2013), one of the advantages of using AR in education, and in language teaching specifically, is that it has the potential to facilitate the understanding of elements considered abstract. In another study, Ibáñez et al. (2014) presented the results of the study where they compared two language teaching tools, AR and web teaching. The evidence obtained suggested that students who had used the first methodology achieved an academic improvement in a more efficient way. In addition, it was found that the improvement could also be clearly observed in the teaching of abstract concepts.
   c. Improved student outcomes. As soon as full or partial integration of AR in language teaching is established, a significant relationship between improved outcomes and AR has been demonstrated. Parmaxi et al. (2013, 2020) and Wang (2018) highlight such a relationship, as well as improved vocabulary teaching effectiveness in students who have been exposed to AR. Higher productivity and success in the items studied have also been shown.
   d. Increases student enjoyment. This benefit is closely related to the interest that the student may show when confronted with a new tool that shares elements with everyday use as it is, for the most part, a mobile device. The comparison with traditional methodology shows, according to several studies (Perry, 2015; Richardson, 2016; Solak et al., 2015; Taskiran, 2019), how its implementation facilitates the user attention required to perform the activity while generating new links by which the student perceives the source of information as something playful and motivational.
   e. Improves learner interaction. This advantage of the application of AR in language teaching shows the potential it has in encouraging student interaction. According to Solak et al. (2015) and Liu et al. (2016), AR amplifies opportunities and enables educational and emotional bonds between students and faculty. In other words, they

become creators of knowledge instead of passive receivers, as is the case with students using a traditional methodology.

2. Limitations:
    a. Technological limitations. As Herpich et al. (2019) stated, this refers to a lack of access to electronic devices by the educational center, a deficient connection to the network, the price of AR programs or the lack of technological knowledge by students, among others.
    b. Pedagogical Limitations. According to Wu et al. (2013), in terms of pedagogical limitations, we can refer to the lack of AR pedagogical models in language education. This refers to the lack of knowledge about the new pedagogical methods oriented towards technology as one of its drawbacks. This could generate a lack of interest on the part of the teaching staff since it requires a considerable investment of time and effort. Among the pedagogical limitations, we can also include the lack of training of the teaching staff in the use of the tool in the classroom, which may lead to a loss of interest due to a lack of knowledge.

3. Objectives and methodology

The present study seeks to analyze and review the recent trends in AR implementation in the English as a Foreign Language Classroom (EFL) and to present the main projects aimed at teaching English with AR-based projects that have been published in the latest years. The study will also examine the impact and the attitudes of the students concerning AR integration. Specifically, the research objectives are:

1. Analyze the latest research on AR-based EFL projects.
2. To examine the principal features of the studies regarding the use of AR-based in EFL teaching.
3. Discuss the future implementation of AR-based projects in the EFL classroom.

For this purpose, a total of seven research works were analyzed. The selection criteria were as follows: a) articles published between 2010 and 2020; b) the language of publication was English; c) the works were published in WOS and Scopus; d) every educational level was considered.

4. Results and Discussion

4.1 Latest AR-based projects

Wu et al. (2013) indicated that since the recent introduction of AR in education and in foreign language teaching, the literature has focused on the development in the use of an initial implementation of AR. The most recent studies focus not only on its development but also on the implementation of certain tools or their feasibility and usefulness in the classroom. Wu et al. (2013) described the early research as simple and with a limited range and focused on curriculum design and implementation in the language classroom. Among the main studies addressing these issues, we highlight the following:

- Lui et al. (2004, 2010) concentrated on teaching English as a foreign language by creating two AR tools called HELLO and MOBILE. Mobile-Based Interactive Learning Environment or MOBILE was created to teach body parts and improve English in elementary school classrooms in Japan by using AR elements on mobile devices.
    Once the experiment was conducted, and the implementation was completed, they concluded that this tool helped students to improve their knowledge. The improvement was evident when a comparison was made with those students who were exposed to the same knowledge but using a more traditional methodology. However, neither the motivation nor the emotional attitudes that could be obtained by using AR as the main tool were studied.
    Subsequently, Lui et al. (2010) created HELLO, an application that used a portable system for teaching English as a foreign language. The research was conducted in Taiwan by using a cell phone and a QR code reader; the student had to follow a map to decipher the different concepts in a university setting. The research showed high satisfaction among the participants based on a series of interviews and case studies.
- Barreira et al. (2012) conducted their studies in an English as a foreign language classroom in an elementary school in Portugal. Their objective was to observe the influence of AR on the learning of lexical items related to fauna. The conclusions obtained in this research were the confirmation of the improvement in the acquisition of such items by students exposed to AR compared to those who used a book to perform the same activity.
- Mahadzir et al. (2013) focused on the study of AR through the use of books with embedded triggers to assess its effect on the motivation and attitudes of EFL learners. By creating a book with triggers, using ZooBurst as an AR tool, students' motivation and attitudes towards the inclusion of this technology in the classroom were analyzed. The experiment was conducted in an elementary school where students used an AR book for one year. In addition, semi-structured interviews were included at the end of the experimental year. Finally, the data obtained showed that the integration of the AR book during the academic year had a very positive effect in many areas. According to Sydorenko et al. (2019, p. 731), those

areas were "perceptual arousal, inquiry arousal, variability, goal orientation, motive matching, familiarity, familiarity, learning requirements, success opportunities, personal control, intrinsic reinforcement, extrinsic rewards, and equity."

- Solak et al. (2015) were interested in the influence that the use of AR could have on the motivation level of students in a beginner-level English class in Turkey. The results obtained established that, despite the existence of other secondary objectives such as attitudes, beliefs and the learner's self-perception about their learning, a positive correlation was obtained between the level of motivation and academic success. The study concluded that materials that include AR in the academic curriculum have a positive influence on students who use this tool in the learning of lexical items. Regarding motivation, it was established that students who use AR create an emotional bond with the materials studied, resulting in a significant improvement in motivation.
- Fan et al. (2020) conducted a study of AR implementation in the English as a foreign language classroom in a rural area of China. Their study included both students and teachers; they worked with an application called AR PhonoBlocks with the aim of learning the English alphabet, both its writing and pronunciation. Their work focused not only on the acquisition of such a notion but also aimed to observe the interactions and motivations of students and faculty in the inclusion of the AR tool in a rural foreign language learning environment. The results obtained in this study showed an improvement in the concepts presented and communication between the teacher and the students, as well as significant progress in the motivation experienced by the group of students who carried out the activity.
- On the other hand, the objective of Tsai (2020) was to examine the differences that exist in the teaching of English vocabulary by comparing students using a traditional methodology and AR tools. The study aimed to analyze the intrinsic motivation of the materials of both methodologies. Thus, 42 elementary school students participated in this experiment in an ESL classroom in Taiwan. Vocabulary tests, questionnaires and structured interviews were used to collect data. The research results showed that intrinsic motivation for the materials was higher in the experimental group than in the control group, which used a more traditional methodology. In addition, the qualitative data identified the opportunities that the students had experienced and the obstacles to implementing AR in a traditional teaching setting. In terms of vocabulary results, the data showed a significant improvement in the experimental group, thus demonstrating that the use of AR in the experimental group was more beneficial for knowledge acquisition than the use of a more traditional methodology.
- Yilmaz et al. (2022) conducted an experiment in which they explored the English vocabulary learning in a pre-school child by using AR as a principal learning tool. They aimed to discover whether the pre-school children's vocabulary, regarding their retention levels, could improve through the use of AR technology. Quantitative results showed how the retention improved, and the qualitative results indicated that the attitude toward the AR materials, in general, was really positive.

Most of these studies focus on the analysis of motivation and the differences between the use of AR tools and the use of the traditional methodology. Their results indicated that the use of AR technology not only significantly increases motivation and positive attitudes but also improves the learning process.

4.2 Main features in AR-based projects in the EFL Classroom

Here we have to distinguish between the target language they have studied and the context in which the research has taken place in order to see if there are some preferences among the researchers. There are several studies showing which languages are the most studied for AR inclusion, as well as many other differences in experiments in recent years. In order to create a picture of the main characteristics of these researches, we will focus on the studies conducted by Zhang (2018) and Parmaxi et al. (2020), considering the following classification:

- Studies according to the target language.
- Studies according to the level of the language level.
- Studies were conducted at different educational levels.
- Studies about different areas and skills in language teaching.

In order to examine those features, Parmaxi et al. (2020) conducted a study analyzing 140 articles in English published in SCOPUS between 2014 and 2019, with the aim of observing the similarities and differences between them. The authors state that, apart from the predominant language in which the studies are written, there is a wide variety of target languages with respect to the importance of AR in their curriculum. Its objectives also included observing whether there was any improvement between the research group and the control group. The studies analyzed show that the two predominant languages are English and Chinese, and some articles on Spanish as a target language, such as those by Ibáñez et al. (2011, 2014). AR has also been used to complement education with sign language as it has the potential to use markers and create an education where its visual character of it is increased. Similarly, there are which have received less attention, such as Greek, Russian or Arabic. According to Parmaxi et al. (2020), this shows that there are still other languages in which an exhaustive study of the benefits and drawbacks of teaching these foreign languages through the implementation of AR can be carried out.

Zhang (2018) analyzed the different works published in SCOPUS between the years 2013 and 2018 in relation to the teaching of a foreign language through the implementation of AR. It included a total of ten articles on different levels: six of those studies were framed at a beginner level of students, one in intermediate and advanced and, finally, two works were conducted in a class with a pre-intermediate level. Following his study, Zhang (2018) concluded that it is easier to implement AR at lower language levels as the tool allows the creation of concepts that are difficult to implement at higher levels.

On the other hand, Parmaxi et al. (2020) examined different work settings and classified them according to the educational context of the student. They studied the centers where each of the experiments had been conducted. Most of the studies took place in a university environment (39%), while elementary education (35%) was the second position. This shows that research was mostly carried out in an environment where teaching is the main subject, as would be the case of the university environment; and on the other hand, also in an elementary educational environment, such as primary education, where the foreign language learner has a beginner level in general. This confirms previous research carried out by Zhang (2018).

Zhang (2018) also established a classification of AR research as a tool to facilitate foreign language teaching. It was determined that most of the experiments focused on teaching vocabulary, writing, communicative skills, or student motivation.

4.3 AR implementation

Regarding the implementation of the AR-based projects in the EFL classroom, Area-Moreira et al. (2016) state that different governmental programs have been implemented in the educational field during the last three decades. The objective was to facilitate the inclusion of new technologies in the classroom. Balanskat et al. (2006) concluded in a study that the use of new technologies was utilized by teachers as a form of compliment without replacing or significantly altering existing teaching principles and methods. The use of technology as a complement or extension and not as a transformation of knowledge has been explained in several works following Puentedura's SAMR model (2006).

Similarly, Ocaña (2013), Vergara-Ríos et al. (2015) and Zamora-Franco et al. (2018) established that these new technologies possess a unique and novel appeal, "the novelty factor", but this effect alone may not generate learning or enhance it. It needs to be integrated into new learning models. In order to solve the challenge of integration, according to Adell et al. (2013), the educator must adapt electronic tools or devices to the correct educational context with the aim of avoiding such a problem since new technologies such as AR can "take advantage of all their communicative, informative, collaborative, interactive, creative and innovative potential within the framework of a new learning culture" (Adell et al. 2013, p. 30).

The integration of AR in language teaching is an emerging topic often criticized for not being enclosed in any pre-existing theoretical framework, and, as mentioned above, it may not generate knowledge by the mere fact of using this tool. However, different authors have shown that the implementation of AR in the language education field can be considered from certain theories such as Constructivism or Situational language learning since "all learning takes place within a specific context, and the quality of the learning is a result of interactions among the people, places, objects, objects, processes, and culture within and relative to that given context" (Dunleavy & Dede, 2014, p. 736).

5. Conclusion

The present study is based on a review of the impact of AR in English language learning in which some affordances and limitations have been taken into account. These results are based on a comparative method through which several works published in WOS and SCOPUS have been analyzed.

Regarding the latest research on AR-based projects in EFL, we find evidence to conclude that a majority of studies report an improvement in the student performance regarding the use of the AR as an educational tool in various aspects of the learning process, such as motivation and engagement. However, some inconveniences have been reported, but they do not outnumber the advantages pointed out in the different studies.

The great majority of the studies focus on the effects of the implementation of AR technology in learning English, while English and Chinese have been the most studied languages regarding the adoption of AR technology. Moreover, a great number of studies have been carried out in higher education institutions such as universities, followed by other centers dedicated to Pre-school education.

Finally, some advantages and disadvantages of the implementation have been pointed out; For example, the improvement in the performance of the student in different areas of study, such as vocabulary or grammar and motivation, while using AR in the EFL

teaching. However, researchers have also highlighted some limitations, such as the adaptation of the new technological devices into the educational system.

Future research can expand the range of papers by using different repositories outside WOS and Scopus. In addition, as seen in this paper, most researchers have focused their work on the impact of AR on the motivation of EFL learners, but there are many aspects that can be the subject of research, for example, the acceptance by teachers or legal guardians of the use of new technologies in the classroom. Also, the advantages that have been summarised in this research could be applied in order to create didactic materials strictly related to the inclusion of AR in the EFL classroom.

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