

## Reinforcing Reading and Listening Skills Through Augmented Reality in a rural class



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Reforzando las habilidades de lectura y escucha a través de la realidad aumentada en una clase rural

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**Abstract:** This study explored the impact of Augmented Reality (AR) on enhancing reading and listening skills in an English class at a rural school in Cañar, Ecuador. Eighth-grade students, who had been learning via whatsapp and printed worksheets during the pandemic, were introduced to AR-based reading passages. Using a free AR prototype, students used their phone cameras to integrate 3D images into their reading without needing internet access. The reading material, designed by researchers and ICT teachers, included activities to improve listening and phonetic skills. Data from pre-tests, post-tests, and focus groups indicated that AR created an engaging, game-based learning environment and provided students with access to innovative, offline educational content.

**Keywords:** augmented reality, marker, reading, rural school.

**Resumen:** Este estudio exploró el impacto de la Realidad Aumentada (RA) en la mejora de la comprensión lectora y auditiva en una clase de inglés en una escuela rural de Cañar, Ecuador. Estudiantes de octavo grado, quienes habían estado aprendiendo a través de whatsapp y materiales impresos durante la pandemia, fueron introducidos a pasajes de lectura basados en RA. Utilizando un prototipo gratuito de RA, los estudiantes usaron las cámaras de sus teléfonos para integrar imágenes 3D en sus lecturas sin necesidad de conexión a internet. El material de lectura, diseñado por investigadores y docentes de TIC, incluyó actividades para mejorar las habilidades auditivas y fonéticas. Los datos de pruebas previas, posteriores y grupos focales indicaron que la RA creó un entorno de aprendizaje lúdico y accesible, brindando a los estudiantes acceso a contenido educativo innovador sin depender de la conectividad.

**Palabras clave:** collaborative learning; communities of practice; higher education; teacher training.

## 1. INTRODUCTION

Over the past few decades, technology has evolved at an exceptional pace, transforming nearly every aspect of our lives. In the field of education, this evolution has brought about considerable changes, revolutionizing the teaching-learning process. One of the key advancements in educational technology is the development of Augmented Reality, which has opened up new avenues for education, making learning more interactive, engaging, and accessible due to its potential to create immersive and interactive learning experiences.

In the case of education in Ecuador, schools were close during two school years because of the COVID-19 pandemic, which affected small communities with limited accessibility to internet connection for online classes. The national government did not announce the official return to face-to-face classes until March 14, 2022, after the increase in vaccination rates led to a decline in the death rate.

Under this perspective, this paper involves reinforcing rural students' reading and listening skills through a free prototype based on Augmented Reality (AR). This research aims to identify the initial insights of implementing a basic prototype designed for Android users who would interact with this tool in their English language sessions to promote reading skills in the English language. This study seeks to answer the following research questions:

1. To what extent does augmented reality influence the reading process in English language learning?
2. What benefits do the stages of the reading process reinforce with the use of technology?

The participants of this study are enrolled in the Eighth Grade of the Basic Education System (Secondary level), where they have their English classes with an English teacher who was their tutor during the COVID-19 pandemic. During that time, accessing education was challenging in those rural areas due to connectivity. However, the national government implemented certain measures to assist the learning of the English language through a prioritized curriculum that reduced the teaching hours from five to two. Other measures to particularly assist rural education comprised printed worksheets, a TV educational program, and radio educational programs for rural communities.

Implementing this basic prototype of AR through reading passages could have some potential benefits for rural communities and English Language Teaching (ELT) instruction. International studies advocate for the use of AR as a fast-growing and flexible tool to integrate various scenarios into ELT sessions (Ozdemir et al., 2017; Kaliisa et al., 2017; Suleiman Alfalla, 2020). However, the vulnerable situation of rural schools during the COVID-19 pandemic, and their students who mainly depend on their parents' phones to access classes, has made English classes a more challenging reality. Likewise, in this scenario, authorities and parents may perceive AR as limited to entertainment rather than a tool for learning, which could also be an obstacle to implementing future interventions to promote the improvement ELT classes in rural schools. This perception of AR as a potential distraction that impedes the learning process is also shared by other authors (Kukulska-Hulme, 2014; Mansour, 2016).

### The theory behind Augmented Reality

This study used the cognitive theory of multimedia learning (CTML) by Mayer (2009). This author remarks that the brain processes information through two discrete channels: verbal (auditory), which is responsible for processing music, video, and spoken words. The visual (ocular) channel deals with written texts, animation, and moving video images. Words can be processed in two ways: via the ears or the eyes.

Mayer (2009) also states that there are certain principles in multimedia learning; however, the one applicable to AR is the Multiple Representation Principle, which processes both channels (verbal and visual) to activate meaningful learning at the same time. As a result, this theory proposes a constructivist perspective where students learn by constructing their knowledge. In other words, students learn by doing in an interactive scenario.

AR combines human and digital interactions (Kapp et al., 2011). This application combines virtual images to create an environment that complements reality instead of replacing it (Chang et al., 2010). Besides, it creates a space where one is part of the data in which the physical and digital worlds are united. AR also comprises sight and sound features far exceeding rigid book images (Bukit & Hassan, 2020). Recent studies indicate promising results that the invention of AR has contributed to different professional fields and, in the case of education, has improved learning outcomes. This statement is also part of the Horizon Reports analysis by Becker et al (2019) that highlights mobile devices' use to close the gap between learning in the classroom and the student environment. Many inexpensive and attractive applications promote and support teaching work. Besides, they allow them to interact more professionally and adaptively with their pupils in their classrooms (Moreno et al., 2016).

### Implementing Augmented Reality in English Language Teaching

Integrating Augmented Reality (AR) into English Language Teaching is an innovative approach with the potential to transform language education significantly. AR seamlessly combines digital elements with the real world, creating an immersive and interactive learning environment for students. In English teaching, AR can enrich language acquisition by providing students with immersive and contextually relevant materials that mirror real-world situations, thereby enhancing

the practicality of language learning. In the educative field, when the AR application is used, students can engage in virtual environments, participate in role-playing scenarios, and interact with digital objects that come to life within their classroom or on their mobile devices (Yelia et al., 2021).

For Khan et al. (2023), augmented reality has garnered attention in education because it enables learners to engage in real-world experiences as part of their learning process. AR involves integrating computer-generated information into the physical environment, creating an interactive learning experience. The integration of AR technology for learning English significantly influences the language acquisition abilities of English as a foreign language (EFL). On the same line, Marrahi-Gómez & Belda-Medina (2022) stated that Augmented Reality has become increasingly prevalent in education at various levels due to the widespread adoption of mobile devices, making its integration into the educational environment straightforward. Additionally, it is believed that mobile devices will be better equipped to support AR content with improved quality efficiently in the future. This foresight is expected to drive further advancements in English learning.

In addition, Punar Özçelik et al. (2022) claimed that Augmented Reality is a remarkable technology whose primary aim is to enhance user interactions with the physical world by incorporating three-dimensional virtual objects within natural environments. This augmentation is not restricted solely to visual elements but extends to auditory components.

These authors also declared that through AR, it would be possible to enhance the quality of education as AR provides learning materials that can be accessed anytime and anywhere. AR offers cost-effective and portable educational resources compared to traditional paper-based textbooks, models, posters, or printed manuals. Moreover, it is essential to consider that the AR does not require any specialized equipment. In today's era, where most adolescents possess smartphones equipped with cameras, AR can be readily utilized. Moreover, Karacan and Akoglu (2021) affirmed that AR increases motivation and academic success in different fields, especially in the development of English as a foreign language. AR in a classroom enhances students' learning progress compared to those who have never been exposed to AR. Students exhibit positive outcomes after using AR when working on the four primary English language skills. Students demonstrated better control over the language. Regarding this, Simonova and Kolesnichenko (2022) expressed that it is essential to highlight that these tools also play a significant role in enhancing students' speaking and listening skills in a foreign language, aiding in acquiring new vocabulary, and fostering collaborative and independent learning activities.

Augmented reality technologies positively impact students' motivation to learn a foreign language, creating a conducive and emotionally engaging atmosphere in the classroom. In this context, implementing AR technology in the classroom functioned as an interactive and enjoyable resource, turning a dull learning environment into an immersive and productive one. For instance, using AR for developing listening and speaking activities could enable students to achieve a solid grasp of English language concepts, and educators could harness AR within the confines of traditional classrooms and in extracurricular settings (Ustun, 2022).

Under the same perspective, Vate-U-Lan (2012) coincides with the previous author by declaring that the potential and popularity of AR facilitate interactions between students and mobile devices, enhancing English acquisition. The fact that AR can be customized for better learning experiences is formidable. Adjusting content and difficulty levels to suit individual student requirements provides exciting opportunities to bridge the gap between traditional teaching methods and the expectations of 21st-century digital-age learners, facilitating a more captivating, immersive, and efficient English language education.

#### Listening as a subskill to boost receptive skills in ELT

Receptive skills are an essential part of English language teaching (ELT), and listening can be a subskill that plays a significant role in developing overall language proficiency, especially in boosting reading. Listening involves responding to language rather than producing it, and it can be focused regularly on aspects, such as identifying sounds and the features of connected speech. For instance, listening to a story while reading the text can improve their comprehension tremendously, which is essential for successful communication in English.

Under this perspective, Kim (2020) remarks that listening to the exact text while reading it along is one type of reading instruction that can ease the reader's cognitive burden by providing the internal voicing needed to scaffold the lower-level reading processes. In other words, listening as a subskill enhances language comprehension and cultivates cultural awareness. Tasks based on listening practice frequently expose students to various opportunities to develop receptive skills.

In this context, listening while reading (LWR) simultaneously is an approach employed in language learning to enhance reading fluency, pay special attention to both auditory and visual channels, and reinforce the connection between spoken and written language. Moreover, it is said that LWR supports readers with lower proficiency in improving their reading abilities, making reading a more enjoyable experience (Verlann & Ortlieb, 2012).

The integration of listening and reading simultaneously helps learners connect written words with their corresponding sounds, reinforcing the relationship between spelling and pronunciation, listening to a text while reading complements comprehension. Since LWR requires learners to listen while reading actively, it helps develop receptive solid skills. This development is crucial for understanding spoken English in real-life situations, such as conversations, lectures, or media. Woodall (2010) stated that word reading, which encompasses comprehension, is achieved by recognizing words at sight or

through phonological recoding. This author mentioned that even when reading words at sight, there is a presence of a phonological trace.

In addition, it is also alluded to Vygotsky's zone of proximal development as a possible explanation for the influence of reading while listening. The role of the audio recording is compared to that of a seasoned and knowledgeable assistant from a sociocultural learning perspective. The smooth reading provided by the audio helps the reader with decoding, enabling them to achieve a higher level of fluency than they would on their own. In the same line, Clinton-Lisell (2023) affirms that incorporating listening into second language learning enhances word recognition abilities in terms of sounds, phonology, spelling, and orthography. Accompanying a reading with audio helps interpret the text and comprehend it better. As a conclusion, the implementation of listening while reading may offer learners the activation of both channels so the brain processes information with more accuracy and better stimulation to respond to language.

## 2. METHODOLOGY

### Context

This study was conducted at a rural school in a town called La Troncal, located in the Cañar Province in Ecuador.

The school operates under the jurisdiction of Zonal Coordination 6, following the organizational structure and responsibilities outlined in the Organic Statute of the Ministry of Education for the Coastal region. The school "Nela Martínez Espinosa" comprises approximately 527 students in general basic education.

### Research approach and method

This quasi-experimental study is a type of research design that aims to evaluate the effects of an intervention or treatment when random assignment is not possible (Creswell, 2012). Quasi-experimental studies rely on non-random assignment where the researcher does not have an authority to choose the sample, which can lead to potential biases.

### Technique and instruments to collect information

This study comprised a questionnaire, and focus groups This study utilized a pre-test, post-test, and focus groups to systematically gather, analyze, and interpret data to answer the research questions. These tools ensured the research's credibility, validity, and reliability. According to De Vaus (2001), in social studies, pre- and post-tests are used to measure students' knowledge, understanding, and skills before and after a specific instructional period or intervention. In this study, the pre- and post-tests were crucial in evaluating the effectiveness of the intervention (augmented reality) on students' reading and listening skills. Additionally, focus groups allowed for the collection of in-depth qualitative data through group interactions among participants. As Billups (2019) notes, focus groups provide a platform for research-driven discussion that centers on the key areas of interest. Participants in this study were able to express their thoughts on how AR impacted their reading and listening skills in ways that might not be captured through pre- and post-tests or other quantitative methods.

This study adhered to ethical principles throughout the research process. Each legal custodian of the participants considered for this study was given an informed consent form to ensure their anonymity and to confirm that the information provided by their child would be solely used for this research.

### Participants

The participants for this study were 30 eight-grade students, who were in their first year of the secondary school level. They participated in a three-week reading session using (AR) technology. Their proficiency levels ranged from A1.1 to A1.2, as these are the basic levels expected for children of their age group.

### Material Design

The researchers initially used a printed version of an evaluation worksheet as a pre-test and post-test to measure the accuracy of the reading and listening skills. This instrument consisted of a reading passage that comprised the three stages of reading: pre-reading, while reading, and post-reading. The criteria in this evaluation were vocabulary and prediction as pre-reading tasks; the main idea was a while reading task and scanning and listening were part of the post-reading tasks. The post-reading criteria evaluated the reading skills and listening as a sub-skill. In addition, the researchers designed the other printed worksheets with the same criteria in the three stages. All these activities aimed students to acquire vocabulary, improve, check comprehension, and enrich their pronunciation. The pre-reading consisted of the key vocabulary of the reading passage through a matching task and some predictions as to what the text was about. The while reading section had the audio version of the reading passage so that students could also listen to the story while reading. Lastly, the post-reading section converged some true-false statements and short open answers to check comprehension of details. Ultimately, the

listening section, also included in the last reading stage, consisted of one task where students discriminated among initial, middle, or final sounds of the words selected for that activity. Other English language teachers collaborated with their voices for the tracks' production to use for the listening section.

The researchers chose the reading passages cautiously for the design of the worksheets. They were created by one of the researchers of this project while others were taken from public domain websites with open-source reading passages. Right after the selection of the reading passages, the edition process started. The edition consisted of revising the vocabulary words or phrases from each reading that may not be suitable for the proficiency level. Vocabulary acquisition is a relevant aspect for school-age learners so that they ensure vocabulary acquisition (Valentini, Ricketts, Pye, & Houston-Price, 2017). The final edition of the passages showed they were shortened to make them more familiar to the participants. The researchers included a box with information related the passage below each reading passage including the Lexile, word number, and text type. Lexile is a measure of a student's reading ability. Lexile serves two functions during reading. First, it measures the difficulty of the text, and second, Lexile measures the student's level of reading proficiency (Elmore, 2016). This measure provides important information for both, teachers and students: to teachers, because this information helps choosing suitable texts for children. Also, to students, because they know their range of reading ability and they will be able to find appropriate texts by themselves. The purpose of including this box with the information related to Lexile was to show the level of complexity starting from basic to more complex reading passages to read, so that students could be aware of the amount of information they were acquiring through the reading passages.

The second moment was when the ICT (Information and Communication Technology) research teachers designed the AR's prototype using the software UNITY 3D. This software is a powerful game development engine that develops 3D experiences and some of the most popular video games in the world through Vuforia to identify images and objects. The prototype was created for Android operating systems up to version 5, and the weight was 60 MB. The researchers worked in partnership with the ICT research teachers by designing the AR markers, which are icons that UNITY 3D could recognize. Marker-based AR works by scanning an image, provoking an augmented experience: objects, texts, animations, or sounds when needed to appear on the device.

Then the ICT research teachers created the 3D animations to combine with the markers. After piloting the animations with the AR markers, the ICT team adjusted the position, size, quality, and texts of the markers to effectively associate the images with the content created in the worksheet. Once the adjustments were completed, the ICT research teachers could upload the 3D animations in the prototype to complement the reading process with AR. These AR markers comprised additional features created by the researchers to complement the reading process with audio listening, images, and games to use during the reading sessions. At the end of the design, the reading passages were supported by augmented reality using AR markers included in the printed version of the worksheets.

Before the implementation in class, the participants installed the AR prototype in their phones to use their cameras to point at the AR markers included in each task of the worksheets. The participants were requested to free some storage in their phones to guarantee better functioning before downloading and installing for better use of the AR prototype. Once the students were in class for the first implementation, they received the first worksheets with the reading passages and encouraged to point at the AR markers through using their phones. The AR markers allowed the learners to have different audiovisual features during the reading and provided immediate feedback on the answers selected. The pre-reading stage introduced the key vocabulary of the reading passage through a matching task and some predictions about the text. The while reading section comprised the audio version of the reading passage so that students could also listen to the story while reading. The post-reading section converged some true-false statements and short open answers to check comprehension of details. Ultimately, the listening section included one task at the end of the reading passage, so students could discriminate among initial, middle, or final sounds of the words selected for this activity that were also part of the reading passage.

The English teachers' research team had permission during the three-week reading session to guide the group and help students interact with the AR based activities designed for this purpose. Desks arrangements allowed small groups to set up, which provided collaboration and support during the different AR based reading and listening activities. The researchers used a printed evaluation worksheet as pre-test and post-test to measure the efficacy of the reading and listening skills. The overall data were analysed using ANOVA. Also, the research involved the conceptual systematization of students' insights into the AR prototype used in the reading session. This was assessed by conducting a focus group at the end of the three-week reading session.

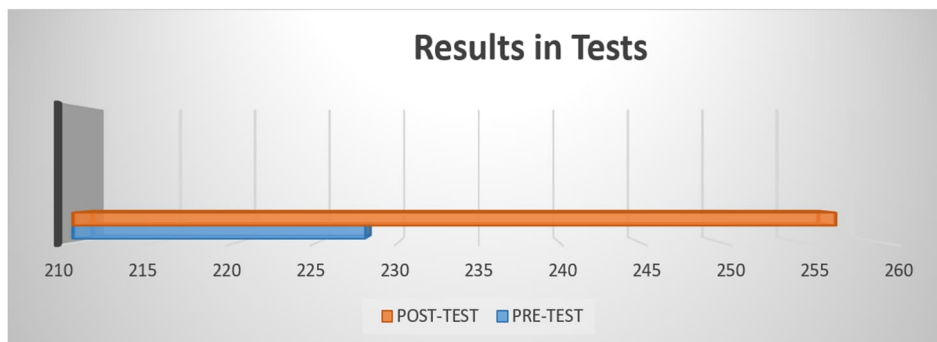
Table 1  
*Results obtained from the Pre-test and Post-test*

Anova Single Factor			
Groups	Sum	Average	Variance
Pretest	228	7,6	4,800
Posttest	257	8,6	2,254

ANOVA					
Source of Variation	df	MS	F	P-value	F-crit
Between Groups	1	14,02	3,97	0,0509	4,0069
Within Groups	58	3,53			
Total	59				

Figure 1  
*Comparison of the Pre-test and Post-test scores*



Note: Elaborated by Castillo, Malo & Mariscal (2023)

The results in Table 1 showed a comparison of the pre-test and post-test based on the data obtained. The outcomes obtained through the analysis of ANOVA showed a slight positive effect, visible in the P-value (0,05) with an average of 7.6 in the pre-test to 8.6 in the post-test. This effect showed the increase in the number of marks in the post-test after implementing AR in the reading sessions. As stated above, implementing AR in different stages of the reading process and the listening tasks allowed learners to feel more confident and receptive when using the language in different contexts.

The Table 1 displayed the comparisons of the pre-test and post-test scores which were analyzed based on the tasks designed and included in each section of the worksheets. Regarding the pre-reading stage, the participants showed visible improvement in the posttest, especially in the criteria key vocabulary. However, the prediction criteria remained the same value. These results showed that the use of images and sounds as AR markers did help participants interact with new vocabulary and identify their meaning with more accuracy. On the other hand, the results in the while reading stage implied positive changes in the evaluations after the three-week reading sessions with AR; consequently, students showed more progress identifying the main idea of the text. In this specific case, the assistance of the AR marker with the listening while reading (LWR) approach did enhance participants to stay on track and infer the main idea of the text with more confidence. Finally, the last criteria, scanning and listening, included as the post reading stage, showed that participants did not improve significantly, especially in the scanning criteria, where they dealt with different tasks. On the contrary, the listening tasks indicated better performance which meant participants felt more motivated to practice sound discrimination and identify them during the activity. Even though this last stage converged reading as a main skill and listening as a sub skill, the participants showed they could interact with different scanning tasks such as true/false facts, matching, gap filling, and question-and-answer activities to check comprehension of details. Likewise, the listening section required sound discrimination in three-word series through dictation of words that the participants heard through the AR markers.

### 3. RESULTS AND DISCUSSION

The researchers conducted a focus group at the end of the three-week session. The five participants randomly selected to participate answered questions related to find valuable insights of the reading intervention determined a positive attitude toward using AR. The questions focused on perceptions of using devices for learning, the reading passages, listening tasks, and feedback. Regarding the use of devices, the participants manifested that they are not allowed to use mobile phones in classes as there are no academic tasks where they could use them for educational purposes. As a matter of fact, this study was implemented through the formal communication between the school and the parents who allowed the participants to bring their phones to school. AR markers were a new experience for the students, who showed their natural curiosity in using the phones to visualize the AR markers and interact with the reading passage during the activities. One participant mentioned

the accessible images through the AR markers helped him related the words to use during the prediction tasks in the pre-reading stage: *"I can learn English with the images in the first tasks"*

The participants also mentioned that the reading parts were friendly to follow. They liked how they complemented the reading tasks in the three stages with the AR markers to reinforce key words, make predictions (pre-reading) and confirm their answers at the end of the task (post-reading) with tasks related to spelling, word order, or filling gaps of information. Moreover, they confirmed that one of the most attractive features used in the AR markers was related to the use of audio readings. This experience let them hear a voice off while reading the passages. One of the participants confirmed that this process was friendly enough to stay on the reading task by reading and listening: *"I could hear what I was trying to read"*

The two last questions concerning listening skills also provided positive insights regarding vowel sound discrimination and feedback. A participant commented this task helped them differentiate the sounds they heard and practiced identifying them in the words given. Another participant called this activity a *"fun game"* to learn the sounds in English. In this sense, it was visible the possibility of hearing other voices pronouncing English language words through the AR markers provoking and stimuli to react and guess the right sound while identifying the phonetic symbols in the task. These positive perceptions complemented the insights about the feedback provided by the AR. Students could check whether their answers were correct or not by getting immediate feedback in their phones. Messages like *"That's correct!"*, or *"Incorrect"* after trying to match the sounds with the correct vowel sound or word permitted the participants to hear again and interact when their answers were incorrect. A participant remarked that she had to try again after relating the phonetic symbol included in the worksheet and the sounds heard in the words displayed in her phone through the AR markers. Overall feedback regarding listening and immediate feedback allowed the researchers found the relevance of reinforcing listening as a sub skill in a reading task. Moreover, these two aspects may have yet to be implemented in these rural schools, where the limitation of using technology due to the lack of technological resources impedes the implementation of tasks to reinforce the receptive skills of the English language.

Mason and Krashen (1994) argue that reading empowers listening and speaking skills and improves these receptive skills. As an example of this statement, the pre-reading section of the reading passages included in this study comprised key vocabulary and prediction as pre-reading strategies to help infer the main idea of the reading task. The gain in this stage allowed students to identify the key terms needed for the reading passage while guessing the context of the situation through inference. One of the benefits of implementing AR in this pre-reading stage was that AR images were used to match the key vocabulary of each reading passage. The immediate feedback given by the AR prototype increased the motivation for reading the central passage and fostered a valuable game-based learning environment.

AR also helped identify the text's central idea through images and the audio version of the reading passage. The author Beniko Mason (2010), whose academic contributions promote audio readings, remarks that those learners who experience listening to stories while reading are better to develop their listening skills. In the case of this study, the AR markers included the audio of each of the reading passages. The implementation of the audio readings promoted both receptive skills simultaneously, enabled learners to guess words in context, and stayed on the reading without being interrupted. Moreover, this task gave participants the opportunity to practice their listening skills at their palm of their hands without depending on their teacher.

Overall feedback was a relevant asset in the results of this study. The implementation of feedback in the design of the worksheets helped confirm the right or wrong answer promoted students to interact with the AR markers through their devices to guess the correct word, image, or vowel sound to complete each task and receive immediate feedback. These stimuli encouraged students to try the task again if they failed at the first attempt. The feedback messages that the researchers included at the end of each task were *"You did it"* or *"Try again"*

It is also valid to consider the context of this study since rural areas have limited access to technology or internet connectivity in low-income communities in developing countries like Ecuador. Even though the website provided by the Ecuadorian Ministry of Education comprises different teaching and learning resources, the real implementation of the English Language program in rural areas depends on the available material the rural teachers have beforehand. Consequently, access and practice of reading and listening skills may be affected due to the lack of technological resources.

#### Contribution to Scientific Knowledge

This study advances scientific understanding by demonstrating how technology and in this case Augmented Reality (AR) enhances reading and listening skills in rural educational settings. It provides practical insights into the implementation of AR technology to support language learning, highlighting its potential to transform traditional pedagogical approaches. This research underscores the importance of adapting teaching methods by integrating AR into the curriculum to leverage emerging technologies, offering a novel perspective on how AR can engage students and improve educational outcomes. The findings emphasize the need for continued exploration and adaptation of AR tools to address the specific challenges faced by rural schools, showcasing the critical role of innovation in educational scenarios.

## Limitations

This study presented a main limitation. The use of mobile phones was not widely accepted by the participants' parents who showed certain reluctance to mobile learning. Therefore, this aspect should be considered when dealing with parental permission in further interventions.

## 4. CONCLUSIONS

The following conclusions are detailed based on the two research questions considered for this study:

### 1. *To what extent does augmented reality influence the reading process in English language learning?*

The content presented in the worksheets showed slight improvements in the prediction criteria included in the pre-reading phase and the scanning criteria designed in the post-reading phase. Students could more accurately connect the pictures and the stories they read. In this way, the pre-reading phase could better help students understand the content they are about to read and improve their interest in learning. Also, scanning offered a variety of activities that helped consolidate what was read. As a result, the application of AR helped students improve their reading skills.

Reading materials used with AR were designed to boost student engagement. With the multimedia elements of AR, those kinaesthetic participants managed the information with ease. In addition, the stories and activities were aligned to the students' interests, so students enjoyed interacting in situations that required the activation of their perceptual abilities. Although listening was a subskill in this study, students' improvement was not significant even though they did feel motivated to find the appropriate sounds during the activity.

These outcomes showed that AR allowed teachers to design diverse linguistic aspects into activities so that students could develop their reading and listening skills while practicing vocabulary and pronunciation. As a matter of fact, teachers should create their reading tasks and select local and popular stories to increase learners' cultural background. The reading habits in the rural schools considered for this study are low, and the results could have been more affected by the COVID-19 pandemic. Traditional reading activities do not show an immediate positive effect in engaging rural students' reading and listening skills.

An essential factor that affects the acquisition of reading and listening skills is the lack of teaching resources. Access to listening audio tracks and technology affect the immersion within the English language. The visible fact that limitation in resources in rural areas impedes the proper instruction. Listening in class may depend on whether the English language teacher uses English in class or brings digital resources so students could reinforce the other skills. Another relevant factor is related to the unconscious bias notable in parents and certain stakeholders who show reluctance in technology, especially related to using cell phones in class for educational purposes. In this sense, the bias relies on beliefs concerning mere play without a purpose. Further teaching practices related to implementing AR in an English class could be directed to demystify play as only having fun.

### 2. *What benefits do the stages of the reading process reinforce with the use of technology?*

The design of the reading passages into the reading stages allowed learners notice the whole process of introducing key vocabulary, prediction to clarify the context to later move on to get the main idea of the story given so the practice could be done by the AR markers. The release of the responsibility for learning was more visible due to the immediate feedback given after each task, so students could use the prototype in and outside the physical class.

A potential benefit of using AR in receptive skills is the promotion of extensive reading. Other reading passages can be selected and adapted to the students' reading proficiency level so that the stages of the reading process can be designed to be game based. This reading process can also include listening tasks to promote the familiarization within the sounds in English. In this sense, boosting the receptive skills could be also done extensively so the parents of these students could also see phones as a needed tool to achieve progress in the language.

English teachers should use technology in the classroom to promote the assimilation of the receptive skills of the English language. However, it is recommended to strengthen teamwork and team building with ICT designers so that more English teachers feel encouraged to develop AR-based activities and use them in their classes. The prototype brings digital content to life that overlaps with print content, allowing students to spontaneously interact with the language in a more flexible and independent environment. Thus, the different objects created different images, graphics, and discourses as scaffolding to support students' reading comprehension.

Although AR ran with accuracy in most situations, some students found it difficult to quickly interact with the AR prototype. The researchers found that some devices could not properly focus digital content using the camera. Therefore, students performed several trials before their cameras detected and activated the augmented content. Therefore, future updates of augmented reality applications should consider the size of the markers and the aspect ratio of student camera screens. The implementation of free prototypes based on augmented reality could assist the English language teaching – learning process in remote areas. However, the lack of technology implementation inside the classroom without using connectivity is part of a long-term project without the support of the national government to support the teaching-learning process of English as a foreign language. Without this support, the reading and listening skills gap between rural and urban schools may be more visible in the upcoming years

#### Conflicts of Interest:

The authors declare that they have no conflicts of interest.

#### Authors' Contribution:

Castillo Noriega, M. A.: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing

Malo Toledo, C. F.: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Validation, Writing – original draft, Writing – review & editing

Mariscal Touzard, L. I.: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing

Informed Consent: The researchers established communication with the participants' parents who provided their informed consent for the conduct of the study

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