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Development and evaluation of a didactic tool with augmented reality for Quechua language learning in preschoolers

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ABSTRACT

It is important to preserve our cultural identity through the preservation of our mother tongue, contributing to its dissemination. Augmented reality (AR) is a great ally of education that provides efficiency, and productivity and increases the interest of students in their academic activities. An AR application was developed for learning Quechua in preschool children, thus improving their learning, satisfaction, and preference compared to traditional teaching. Previously, learning styles were identified for better coverage of the application; the design thinking methodology was applied for the development of the application, then the respective tests were conducted where it was obtained that the children's performance improved by 28.3% more compared to traditional teaching, with an average satisfaction of 89% of the classrooms, and 81% of students' preference. It was concluded that the proposed application considerably favors the written and audiovisual learning of the Quechua language in preschool students.

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1. INTRODUCTION

The preservation of indigenous languages is an extremely important issue as it allows the promotion of a country's culture, understanding the world differently, acquiring new knowledge, and promoting the protection of human rights and the freedom and integration of peoples. In the world, 96% of the nearly 6,700 languages are spoken by approximately 3% of the world's population. According to the UN [1], [2], the indigenous population represents less than 6% of the world's population, yet speaks about 60% of the total number of languages. It is estimated that by the end of this century, 95% of the world's languages could be extinct or severely affected, most of them indigenous languages.

There are currently 48 native languages in Peru: 44 Amazonian and 4 Andean (representing the communication of 55 indigenous peoples), of which 21 are at risk of disappearing [3]. There are different reasons why languages tend to disappear over time, reasons such as integration problems, colonialism, globalization, the few organizations interested in the preservation of these languages, the little or no interest of the inhabitants in maintaining or learning their language of origin, and discrimination [4]. Approximately 15% of the Peruvian population recognizes one of the 48 indigenous languages as their mother tongue [5]. There are currently approximately 3.7 million Quechua speakers, of which 727 thousand are located in Lima. In 2015, the second most spoken language in Peru was Quechua (15.2%), followed by Aymara (1.9%) registering a

decrease of 1.3% in 2017; (0.8%) in other native languages decreasing by 0.3% in 2017; finally English with 0.2% increasing by 0.3% more in 2017 [5], [6]. Since pre-Columbian times Quechua has been one of the main languages of Peru, being part of our identity and culture for hundreds of years, however, Quechua in the schools of the capital (Lima) shows little presence. This is often due to the lack of trained teachers who master the language [3], [7] causing it is not disseminated in educational institutions as it should; in addition, there is a lack of didactic and interactive materials necessary to support the learning of this, replacing the conventional learning system present as the use of spreadsheets and 2D images, where the few sessions dedicated to the teaching of this language are developed; Unlike other languages that have different learning methods and in some cases quite interactive as in the case of English, Quechua still lacks didactic learning methods that promote student interest.

In recent years after the pandemic many of the developed or developing countries have been forced to change teaching methods in schools as traditional teaching methods do not attract students and currently do not generate a great contribution to their learning [8], this change has led to improve the quality and efficiency of education through the use of technology [9], with the primary objective of forming an informed society, a progressive and innovative community that contributes to the development of the country through technology [10], improving the quality of pedagogical resources, showing a positive impact on the performance of students in subjects that are more difficult to understand or that are not of interest to them [11], such as history and promotion of culture [12], language teaching [8], [13]. However, this resource is not yet fully implemented at the basic level of education, it is believed that it can hurt children, despite the existence of studies showing satisfactory results in learning [14]. Numerous researches have been conducted in different fields using augmented reality (AR), and have highlighted the advantages of its implementation [15], highlighting that this technology can perform efficiently in the area of education because it allows users to interact with the real world in a didactic way, helping both teachers and students [16]. Mixing qualities such as the good use of this tool and the dedication of a good teacher give way to a set of virtues capable of transforming the educational experience because information and communication technology (ICT) resources contribute to the didactic processes of learning and collaboration in the educational environment [17].

AR together with the creation of new learning experiences in K-12 educational environments has achieved satisfactory results in students [18], helping to improve comprehension visually and interactively in children and young people. The fruits of the use of videos, animations, and didactic activities, together with simple presentations of complex content, are evident, accelerating the learning phase in both physical and virtual classrooms [12], [19]. In China, the importance of second language learning and the great contribution of apps to achieve this goal was highlighted [20], emphasizing the 5 advantages they offer in education, which are: multifunctionality, individuality, accessibility, interactivity, and affordability. Also, a more recent study conducted in Indonesia evaluated the effect of using the Hello English app developed for learning English [21], showing a positive relationship among students who used it for more than 3 months. Additionally, nowadays mobile devices have become indispensable and young children are no strangers to this, even obtaining the support of their parents in terms of their children's learning through the use of applications [22].

Immersing the child from an early age in learning a second language such as Quechua has great benefits as it increases neural connections, thus increasing learning, making the pace of learning more effective, for this reason. It is estimated that between 3 and 12 years of age is the ideal age to involve the child in a second language [23]-[25] highlighting as an important advantage the ease with which the child can naturally adopt more languages since Quechua generates a stimulus that allows the infant's linguistic intelligence to grow favorably [26]. Even better if the use of technology is involved, proof of this is the study conducted in a Chilean article [27], where semantic, phonological, and syntactic aspects were evaluated using AR and the digital whiteboard applied to children, enhancing the understanding of sentences and words, and linguistic segmentation, where favorable results were obtained that demonstrate the understanding of the language learning process in children through ICT, allowing to obtain a greater interest in learning and experimenting by students. Likewise, although research has been conducted to preserve the indigenous languages of the Peruvian Amazon [28], [29], aimed at Spanish-speaking children through the development of mobile applications with basic content as educational tools adapted to their culture; advances in the use of AR are scarce in the educational sector [17].

The objective of this research work was to provide a didactic tool, in this case, an application implemented with AR aimed at preschool children to support the learning of the Quechua language, both at home and with teachers, which aims to train children in learning a second language, as well as to promote children's interest in learning our culture and thus contribute to the preservation of this language. This is done through the development of the topics as a game, making an evaluation obtained from the comparison of satisfaction between traditional teaching and the application. This paper is structured as follows: section 1 introduction; section 2 contains the methodology used for the development of the application, which is explained in its respective phases; section 3 contains the results obtained and the discussion where the percentages obtained from the study are explained. Finally, section 4 contains the conclusions.

2. METHOD

Learning Quechua not only reinforces the cultural integration of children but also serves as a tool to curb racism and discrimination. According to scientific studies of Andean languages, Quechua is grouped into three types (northern, central, and southern), which are characterized by their own phonological and morphological aspects, highlighting the use of southern Quechua in much of the Peruvian territory and neighboring countries such as Bolivia. Therefore, the application to be developed will employ the use of Southern Quechua for teaching preschool children, since it is the most widely used and easy to understand. To give way to creativity in the development of the application, a qualitative and exploratory methodology was used, which allowed the learning of Quechua through the development of games classified by categories according to the learning level, incorporating ICT in preschool education to improve the teaching of Quechua.

2.1. Population and sample

The study was conducted in preschool children, collecting data strategically in the kindergarten "San Ignacio Kínder"- Carabayllo (Lima), in July 2019, in the classrooms of 3 and 4 years old, 5 years old, and 1st-grade primary school. A total of 31 children were sampled from the different grades representing 46.2%, 23.1%, and 30.8% of the population respectively. The performance of the class with the AR application was measured, making a comparison between the class conducted with traditional methods and the class with the implemented application.

2.2. Methodology design and development

Romero *et al*. [30] mentions that the design thinking methodology provides a technologically feasible solution to the needs presented by users through problem analysis, challenge solving based on creativity, multidisciplinarity, and above all teamwork. Figure 1 shows this methodology developed in its five stages: empathize (consists of observation and interviews), define the problem (find the patterns of the problem), think (create the design of the possible solution), prototype (development of the solution) and test (verify the correct functioning of the solution). These phases lead in an orderly manner to the development of the proposed prototype, taking into account innovative design thinking.

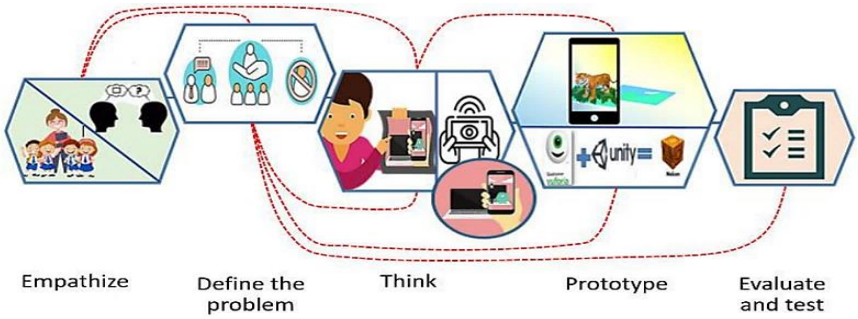


Figure 1. Development of the project according to the design thinking methodology [31]

2.2.1. Phase understanding and observing

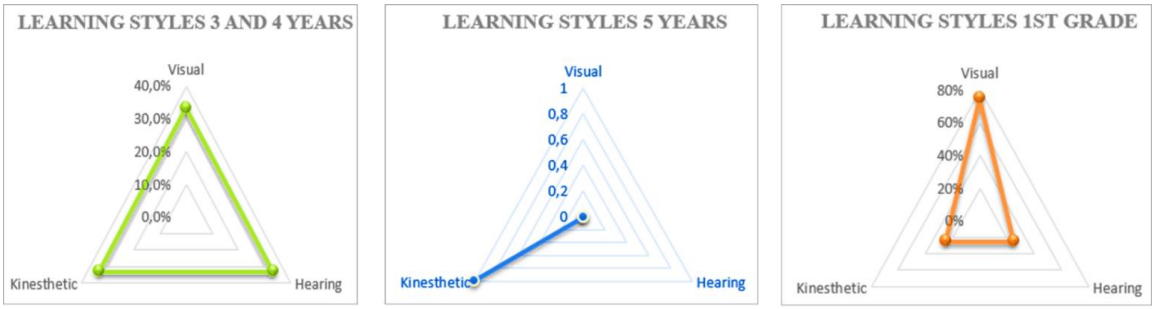
It consists of discovering people (empathizing). This included observation, interview, and conversation with the people involved to identify their needs, for which a learning styles test was conducted with the preschool children; subsequently, satisfaction with the traditional teaching method was evaluated with teachers and students using questionnaires. At this stage, how the Quechua classes were developed, the materials implemented and the dynamics used by the teachers were observed, see Figure 2.

Learning styles study test, to carry out this stage, it was necessary to conduct a study of learning styles in children aged 3-5 years, and 1st grade of the kindergarten "San Ignacio Kinder", see Figure 3. neurolinguistic programming or NLP [32] was used, in which it is established that people perceive reality through the five senses, according to the person, some senses are used more than others. This leads to the distinction of people who stand out for being more visual, more auditory, more kinesthetic, or in between, depending on which is the one they use more in their daily life.

The results of the test showed that in the 3 and 4-year-old classrooms, the 3 learning styles predominate, see Figure 3(a); in the 5-year-old classroom, the kinesthetic area predominates, see Figure 3(b); finally, in the 1st-grade classroom, visual learning predominates, see Figure 3(c). This study was conducted to

identify the most predominant learning areas in the 4 grades to adapt the application to the children's learning styles. The application includes two learning styles, auditory and visual.

Figure 2. Traditional kindergarten education



(a) (b) (c)

Figure 3. Results of the learning styles test applied in (a) 3 and 4-year-old classroom, (b) 5-year-old classroom, and (c) first-grade primary classroom

Interviews were important to obtain a clear vision of the problems to be addressed, for which scheduled meetings and questionnaires for students and teachers were necessary. Due to the complexity that answering the surveys may entail for the children, the help of their teachers was necessary for their respective orientation. The children's ratings from 1 to 5 were taken into account, using eye-catching images with facial expressions for greater understanding.

2.2.2. Phase finding patterns

It consists of defining the problem derived from the study carried out in the first phase, interviews, and current events. In this sense, it was identified that factors such as discrimination, the lack of Quechua-speaking teachers who teach the language, and the predominance of non-didactic materials in the classroom, are some of the reasons why the diffusion of Quechua is not achieved. Likewise, according to the study of learning styles, it was identified that preschool students are inclined to audio-visual learning.

2.2.3. The design phase of the possible solutions

It consists of proposing design principles. This research proposed the development of a mobile application that provides support for learning the Quechua language through augmented reality, achieving a didactic interaction that allows greater understanding in preschool children. For this purpose, technological tools (software) and the design of the project architecture was used, which allows a structural understanding of the operation of the proposed application.

Tools for the development of the application it was necessary to make use of certain computer tools, which made possible the execution of the mobile application with AR as a tool for learning the Quechua language in preschool children, which was programmed with the C# language. These were unity 3D, the Vuforia software development kit (SDK), Android SDK, Firebase, and the 3D models to be projected, being the most important and most useful to achieve the development of the final prototype of the application. Application architecture, Figure 4 shows the basic scheme of the development of the AR application and its relationship with the other components.

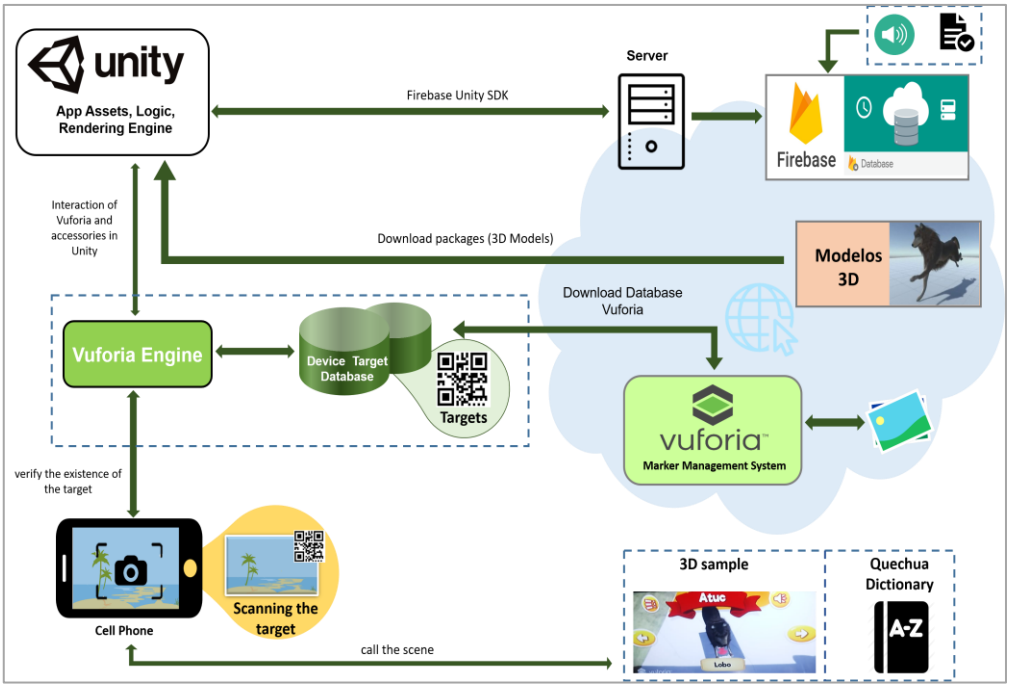


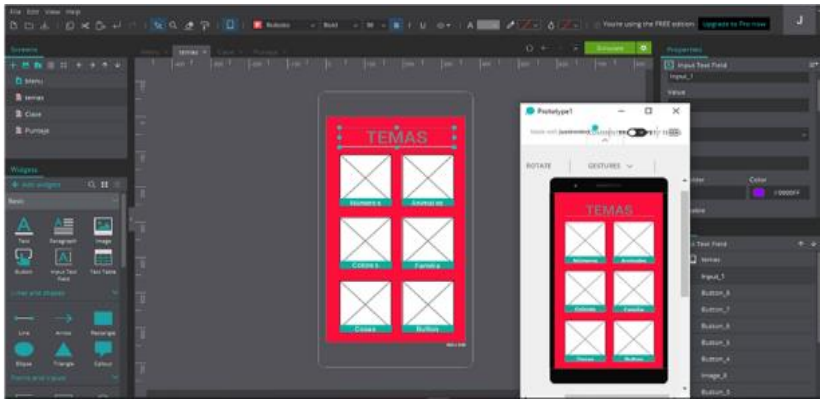
Figure 4. The architecture of the developed application

Under this architecture, see Figure 4, the process began when the images, which served as QR codes, were loaded into the Vuforia database for subsequent management. Then we proceeded to integrate the database exported from Vuforia through its web page and add it to the project created in Unity (previously the Vuforia engine was installed and enabled), for the loading of the set of prefabricated objects to the project. The application interfaces were created using the canvas and the functionalities were increased. New scenes were created to call the 3D models previously downloaded and added to the project tree, to work together with the target (image uploaded to Vuforia), configuring and programming the functionalities of the buttons to call the scenes. A new database was created in Firebase where the Quechua words and audio are stored. The 3D models were assigned to different scenes together with the target and the target was ordered in sequence, programming the call of the words in Quechua together with the audio of the pronunciation. For the rendering of the application, it was necessary to use the mobile device as a receiver of the developed environment to achieve the interaction with the AR.

2.2.4. Prototyping phase of the models

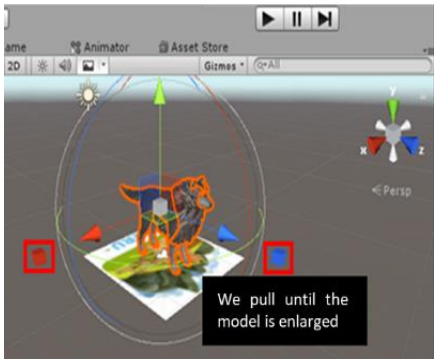
Figure 5 shows the stages of the application development from its inception starting with the application sketch. The first sketch of the application was made in Justinmind Prototyper, see Figure 5(a), which was planned before starting to make the application itself. Subsequently, the respective interfaces were developed in Unity, shown in Figure 5(b) and Figure 5(c), where the models were implemented and their functionalities were programmed using Visual Code.

Figure 6 shows the different interfaces of the application such as the menu in Figure 6(a), the interface that interacts with Vuforia for the reading of images and subsequent projection of the 3D models on them shown in Figure 6(b), as well as the storage of the dictionary of words and the audios of the models according to the chosen topic, using Firebase. Figure 6(c) where the knowledge learned is reinforced with an evaluation. Finally, in Figure 6(d), the score was obtained from the assessment. Phase evaluate and test, shown in Figure 7, the evolution of factors such as the satisfaction of the students in class with the subject to be developed and their interaction with the application, the behavior of the preschool student in front of the technological tool, and the behavior of the preschool student in front of the technological tool were observed. Finally, students and teachers were evaluated with questionnaires.



(a)

(b)



(c)

Figure 5. Development of prototypes in the (a) design phase, (b) development phase, and (c) execution phase

(a)

(b)

(c)

(d)

Figure 6. Application interfaces in (a) menu items (b) augmented reality (c) evaluation, and (d) evaluation result

2.2.5. Phase evaluate and test

Shown in Figure 7, the evolution of factors such as the satisfaction of the students in class with the subject to be developed and their interaction with the application, the behavior of the preschool student in front of the technological tool, and the behavior of the preschool student in front of the technological tool were observed. Finally, students and teachers were evaluated with questionnaires.

Figure 7. Interaction between the application and the student

3. RESULTS AND DISCUSSION

After filling out the questionnaires, the following results were obtained about the application made with augmented reality technology, regarding written and audiovisual comprehension of the Quechua language in students of 3rd, 4th, 5th, and 1st grade of primary school. The study of the results was carried out before implementing the application in the classroom and after implementing the application, the questionnaire consisted of 10 questions using the Likert scale (from 1 to 5) as a research method to know the level of agreement and disagreement of the children regarding the topic. Figure 8 shows the average comparative graph of all classrooms according to the study.

According to the tests performed (Figure 9), it was found that the level of satisfaction of the children before the application is 72% in the 3 and 4-year-old classroom, 78% in the 5-year-old classroom, and 79% in the 1st-grade classroom. While the level of children's satisfaction after the application is 89% in the 3 and 4-year-old classrooms, 82.7% in the 5-year-old classroom, and 88% in the 1st-grade classroom. It can be seen that the levels increased significantly compared to previous levels.

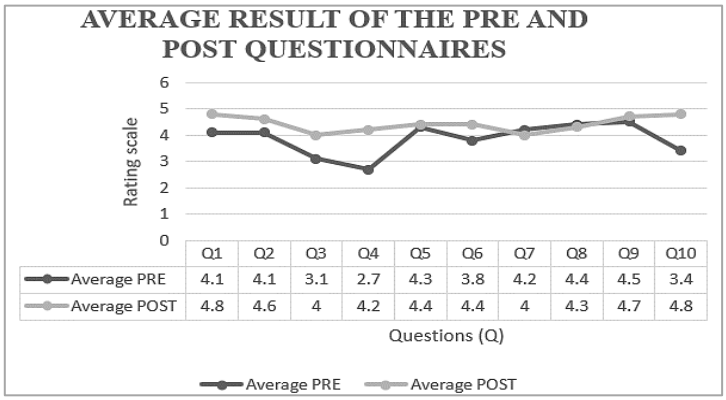


Figure 8. Comparison of the average result of the pre and post questionnaires

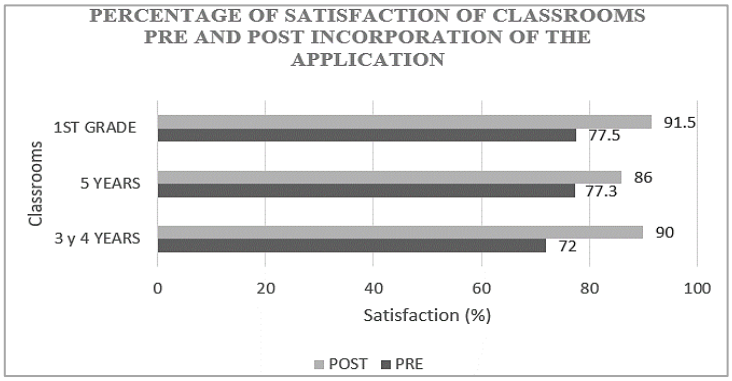


Figure 9. Percentage of satisfaction pre and post in classrooms

It was possible to identify an increase in the level of satisfaction in the classrooms evaluated, which gives to understand that the use of a technology tool within a child study environment provides favorable results, regarding the experience provided to students, which improves the dynamics of learning, motivating students to learn in a fun way. Regarding the academic performance of the students, it was carried out together with the teachers in charge, since they were the ones who evaluated and compared the score and academic performance of the students in comparison with the traditional one, using questionnaires. According to the teachers' surveys, the results obtained in comparison with traditional teaching were as follows.

Figure 10 shows the estimated percentage of traditional teaching as a tool for learning the Quechua language according to the teachers, who are in charge of directing the classes and implementing methodological strategies such as songs and images. Figure 11 shows the result of the estimated percentage of the application as a tool for learning the Quechua language according to the teachers, which shows a considerable percentage increase of approximately 28.3% compared to the previous result. Figure 12 shows the percentage of preference for the application, divided by classrooms, where in the 3 and 4-year-old classrooms there is a percentage of 100%, which shows that the children of these two grades prefer to learn with the application; in the 5-year-old classroom, the lowest preference was 66.7%, which can be deduced that they could work with the application as a complement to their classes; and finally, in the 1st-grade classroom, 75%.

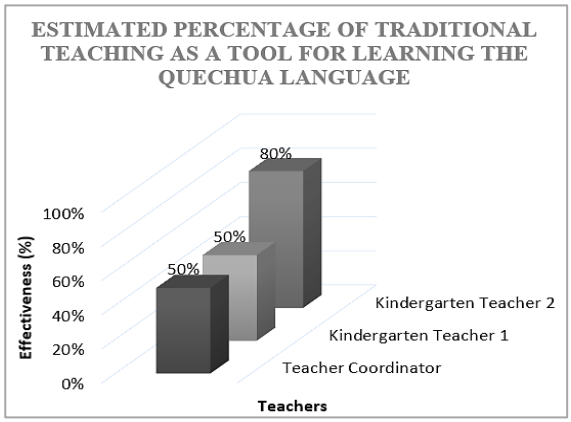


Figure 10. Estimated percentage of teachers regarding traditional teaching as a means of learning Quechua

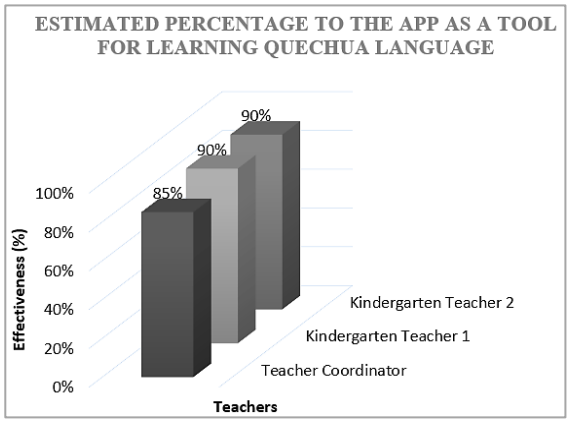


Figure 11. Estimated percentage of teachers regarding the implementation of the app as a learning tool for Quechua

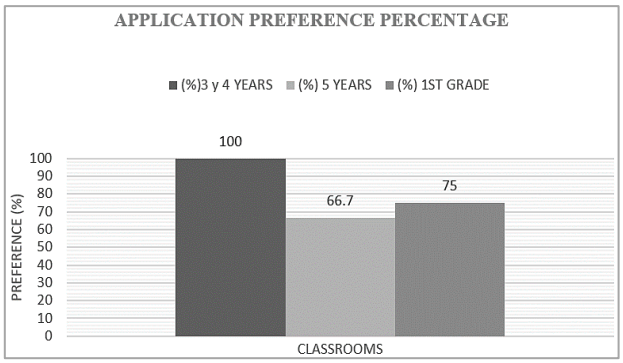


Figure 12. Percentage of preference to the application according to the classrooms of 3, 4, 5, and 1st grade

4. CONCLUSION

The first results of the prototype presented with AR implemented in the kindergarten have proven to be very productive. The levels of satisfaction, preference, and learning are above 80%. The developed application involves grammar and audio-visual material and therefore complies with the main methods of language teaching for children which are highlighted in these points. It has been demonstrated that teaching as a game contributes to the teaching of the infant, influencing considerably the written and audio-visual comprehension of the Quechua language in students of ages 3, 4, 5, and 1st, as well as in the improvement of their performance in 28.3% more compared to traditional teaching. In addition, the questions asked at the end

of each topic contribute to strengthening their knowledge. As future work, we should consider conducting an in-depth study on the time students spend to finish answering the questionnaire for each topic and the grades obtained by the students with the application for each semester. It is hoped that the application will serve as a complement in the classroom, especially in schools that have opted to promote the teaching of our native language.

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