Talki: A Mobile Application to Improve English Learning of High School Students in Peru utilizing Virtual Reality and Gamification

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ABSTRACT

Despite the widespread necessity of students to learn English, Peruvian students face challenges that include a lack of motivation, overwhelmed academic expectations, and low socioeconomic status. Therefore, in this paper, a mobile application that employs virtual reality and gamification is proposed to improve English language learning among Peruvian high school students. This research consists of three stages: (1) review, (2) proposal, and (3) validation. In (1), an exhaustive review of teaching techniques, gamification strategies, and virtual reality models applied to English language learning is carried out. In (2), specific guidelines are selected for the implementation of teaching techniques, gamification, and type of virtual reality for the construction of the mobile application, using Google Cardboard virtual reality glasses. Finally, in (3) the validation of the mobile application is reported, in which 58 high school students participated. Data were collected on student performance before and after using the application. The results showed that students increased their performance in the English language by 22%. This percentage was measured by the average of the grades taken at the beginning and at the end of the experiment.

Keywords-English; learning; virtual reality; gamification; education; mobile application; immersion

I. INTRODUCTION

In recent years, English has acquired an undeniable importance due to its role as a global language in areas such as international business, scientific research and communication in the digital era [1]. This relevance is reflected in the desire among individuals to achieve a high-level proficiency in English, motivated by personal, academic and professional aspirations. However, this desire faces several significant challenges. According to the EF English Proficiency Index [2], Peru ranks 51st in English skills, highlighting obstacles such as the lack of motivation among students. This lack can be attributed to multiple factors, including disinterest in the language, a lack of connection between English and individual goals, as well as deficiencies in vocabulary and grammar. In addition, Peru was the country with the lowest number of English teaching hours in secondary schools in Latin America, in 2016 [3].

In order to solve this problem, different studies have been carried out where teaching techniques, methodologies, and gamification techniques have been applied. Four basic techniques used for language teaching have been considered: immersion, gamification, serious games, and flashcards. The immersion technique uses Virtual Reality (VR) to facilitate student learning [4-7]. The applications that make use of this technique seek to immerse the students in a virtual environment where they can interact with real-world situations and conversations in the target language. However, none of these applications are adapted to the Peruvian reality, limited to the practice of foreign languages without considering the needs, resources and opportunities of the local context [8]. Gamification [9] uses game-like elements and dynamics to engage students in learning. The Duolingo application uses this technique to motivate its users [10]. In [11], gamification was used in conjunction with immersion improved educational performance and progress in learning a foreign language. Serious games (games designed with an educational, formative or informative purpose beyond pure entertainment) [12] and flashcards (used to memorize vocabulary or concepts) [13] are less often used techniques

Four methodologies used for language teaching, have been found: flipped learning, Problem-Based Learning (PBL), reading method, and blended learning. Flipped learning methodology [14] focuses on making the material available to students through audiovisual media, allowing them to use it in different spaces outside the school and personalize their learning before the classroom session in which the material is studied in a more practical way. In [14], it was used with the gamification technique, with the aim of improving students' motivation to learn, interaction with teachers and interactions among students. PBL [15, 16] is based on the resolution of problem situations as an engine of learning. In [15], PBL was used together with the immersion technique, through VR, with the objective of increasing the students' capacity for professional exposure to the learning of English as a foreign language. The reading method [17] focuses on the development of reading skills and blended learning [18, 19] combines both online and face-to-face learning to optimize the educational experience. In the gamification category, 7 techniques have been identified: avatar, points, challenges, levels, competition, rewards and leaderboard. The points technique [20] is defined as the assignment of virtual points to users for completing tasks or achieving objectives in a gamified environment. This technique is often used in conjunction with the levels technique [21, 22], which involves the gradual progression of users through different levels of difficulty or achievement, and the avatar technique [21, 23] which allows users to customize virtual representations of themselves in the game environment. The challenges technique [22], involves specific challenges that users must overcome to earn rewards or advance in a game. On the other hand, the competition technique [22], encourages friendly rivalry among users, motivating them to compete for prizes or recognition. The rewards technique [22] refers to virtual incentives given to users for achievements or desirable behaviors Finally, the leaderboard is a virtual incentive system [22, 23] that displays public rankings of users based on their performance in the game. These gamification techniques have been found to be effective in increasing participation levels, encouraging engagement and improving activity outcomes in educational settings. In addition, they are recommended for use in educational settings to improve student performance, focus and satisfaction.

In the last years, educational institutions were pushed to use online technology because of Covid-19. Therefore, a mobile application named *Talki* that uses VR and gamification is proposed to strengthen the process of learning English among high school students in Peru. It is an online tool that can adapt to the Peruvian reality offering multiple levels that can be personalized by the teacher depending on the proficiency of English of every classroom. In this way the application can be used to teach English to both new learners and more experienced students.

II. MATERIALS AND METHODS

This section presents an approach to build a mobile application to improve English language learning for high school students in Peru by applying VR and gamification. This proposal is aimed at one user: student and is developed in five phases: (1) teaching techniques selection, (2) gamification techniques selection, (3) VR type selection, (4) application procedure design, and (5) mobile application development (Figure 1).

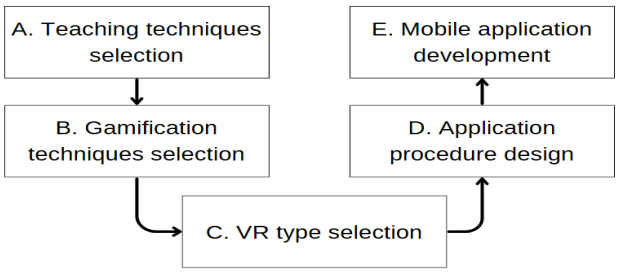


Fig. 1. Representation of the proposed approach.

A. Teaching Techniques Selection

Immersion and gamification were selected as teaching techniques because they have been successful in several studies. In [11], significant improvements were demonstrated in educational performance and progress in foreign language learning by combining both techniques. This strategic choice is based on the promise of providing a comprehensive and rewarding educational experience that encourages participation, increases motivation and optimizes English language learning.

1) Immersion

It is a teaching technique that uses VR to provide students with an authentic experience [4]. The decision to use it is based on its proven effectiveness in creating virtual environments that allow learners to interact with real-world situations and conversations in the target language [24], offering improvement of comprehension and fluency in English. Furthermore, this choice is supported by reference to successful applications such as Mondly VR. [6] and ImmerseMe [7].

2) Gamification

It is known for its ability to motivate students by leveraging game elements and dynamics [9]. In this context, the Duolingo application is mentioned as an example of how gamification can be effective in keeping users engaged in language learning [10]. Gamification is considered especially attractive to students and has been shown to significantly improve the learning process.

B. Gamification Techniques Selection

The mobile application will be composed of the most widely used gamification techniques in the literature: levels [21, 22], points [20], and avatar [21, 23].

1) Levels

The level structure in English teaching methodology stands as an organized framework that plays an essential role in guiding and developing students during their learning process. Table I shows the distribution of the levels in *Talki*, having 3 fundamental areas (vocabulary, speaking, and listening). In its design, these areas are systematically divided into 3 units, each with 3 levels.

TABLE I. DISTRIBUTION OF LEVELS

Area	Units	Levels
Vocabulary	3 per area	3 per area
Speaking	3 per area	3 per area
Listening	3 per area	3 per area

2) Points

These are numerical units obtained by performing some action. In the application, students accumulate points by completing any level, exam, or error correction activity within the application. Table II shows the number of points earned for each activity. For example, for each level you can earn between 5 or 35 points depending on the activity. These points are used to unlock avatars and act as a source of motivation for the students.

TABLE II. POINTS PER ACTIVITY

Activity	Points
Level	20
Exam	35
Errors	5

3) Avatar

The avatar is a visual representation in a game environment. In the application, each student starts with the default avatar (Figure 2) and can purchase different avatars. These can be unlocked using points earned by completing activities. It is suggested that the use of avatars in educational games increases students' motivation to learn [25].

C. VR Type Selection

The benchmarking (Table III) provides a comparative evaluation of various VR devices against key criteria. These devices include a PC with 500 GB hard drive and 8 GB RAM, a smartphone with 128 GB internal memory, 4 GB RAM, 720 p display, and 90 Hz frequency, and a PS4 with 500 GB hard drive, 8 GB RAM, 4 k output, and 60 Hz frequency. These devices will apply to all cases, even if they are not used in some cases. The score assigned to each device reflects its performance in each aspect, where a higher score indicates better performance (Table IV). In the context of our work, the socioeconomic gap is an important area of concern. Therefore, affordability is the most critical factor when choosing VR glasses. In this sense, the clear winner would be Google Cardboard because its price is in the range of 30 to 50 Peruvian nuevos soles.

Fig. 2. Example of default student avatar.

TABLE III. VR LENS CRITERIA SCORE

Criterion	Score			
	0	1	2	3
Affordability	Greater than or equal to 1000 soles	Less than or equal to 1000 soles	Less than or equal to 500 soles	Less than or equal to 100 soles
Storage	Less than 255 GB	256 GB	500 GB	1 TB
Resolution	Less than 1080 p	1080 p	2 k	4 k
Refresh rate	Less than 60 Hz	60 Hz	90 Hz	120 Hz
Memory	Less than 4 GB RAM	4 GB RAM	6 GB RAM	8 GB RAM

TABLE IV. BENCHMARKING VR LENSES

Criteria	Lens			
	HTC Vive Pro 2	Google Cardboard	Oculus Quest 2	PlayStation VR2
Accessibility	0	3	0	0
Storage	2	0	1	2
Resolution	3	0	2	1
Refresh Rate	3	2	2	3
Memory	3	1	2	3
Total	11	6	7	9

D. Application Procedure Design

Figure 3 shows the procedure for using the mobile application. The process starts when the student enters his/her credentials (1). In the next step, the student can enter or omit a section code. Each section has its own set of questions that update the levels (2). Next, the student is directed to the activity menu (3), where several English subject areas can be chosen (4). Then, the student selects his/her preferred activity (5) and

level (6). The student will then proceed to communicate in English according to the chosen area (7). For example, the student might find himself/herself in a classroom where he/she must communicate in English to correctly answer the questions the teacher asks. In addition, the student has a limited number of 3 lives. If he/she answers correctly without losing all the lives, he/she is assigned points (8) and rewards based on the activity. On the other hand, if he/she answers questions incorrectly, he/she loses a life (9). At the end of each activity, the student has the option to participate in new virtual experiences to continue accumulating points or end their session in the application.

E. Mobile Application Development

The architecture of the mobile application is shown in Figure 4, which consists of three layers: clients, backend, and data server. The application has been developed in C# with Unity and is designed to be compatible with Android devices, in addition to being optimized for use with Google Cardboard virtual reality glasses. For the operation of the application, a Rest API deployed in Heroku and developed with Java Spring Boot is used. This API is responsible for communicating with the MySQL data server, which is deployed in Amazon RDS and EC2. The application was given the name *Talki*. The mobile application has four modules designed to maximize the user learning experience.

1) Authentication Module

It is responsible for managing student accounts, providing secure and personalized access to each user (Figure 5).

2) Educational Activities Module

This module offers a variety of educational activities based on VR and gamification. These activities are organized into key thematic areas such as speaking, vocabulary, and listening (Figure 6). Students can choose from a variety of interactive challenges designed to improve their language skills in a practical and exciting way.

3) Level Progression Module

This module tracks student progress as they complete activities and challenges (Figure 7). Students progress through different levels that correspond to increasing difficulty and complexity in the application's activities. Each level presents specific challenges and educational goals, offering a structured progression in language learning.

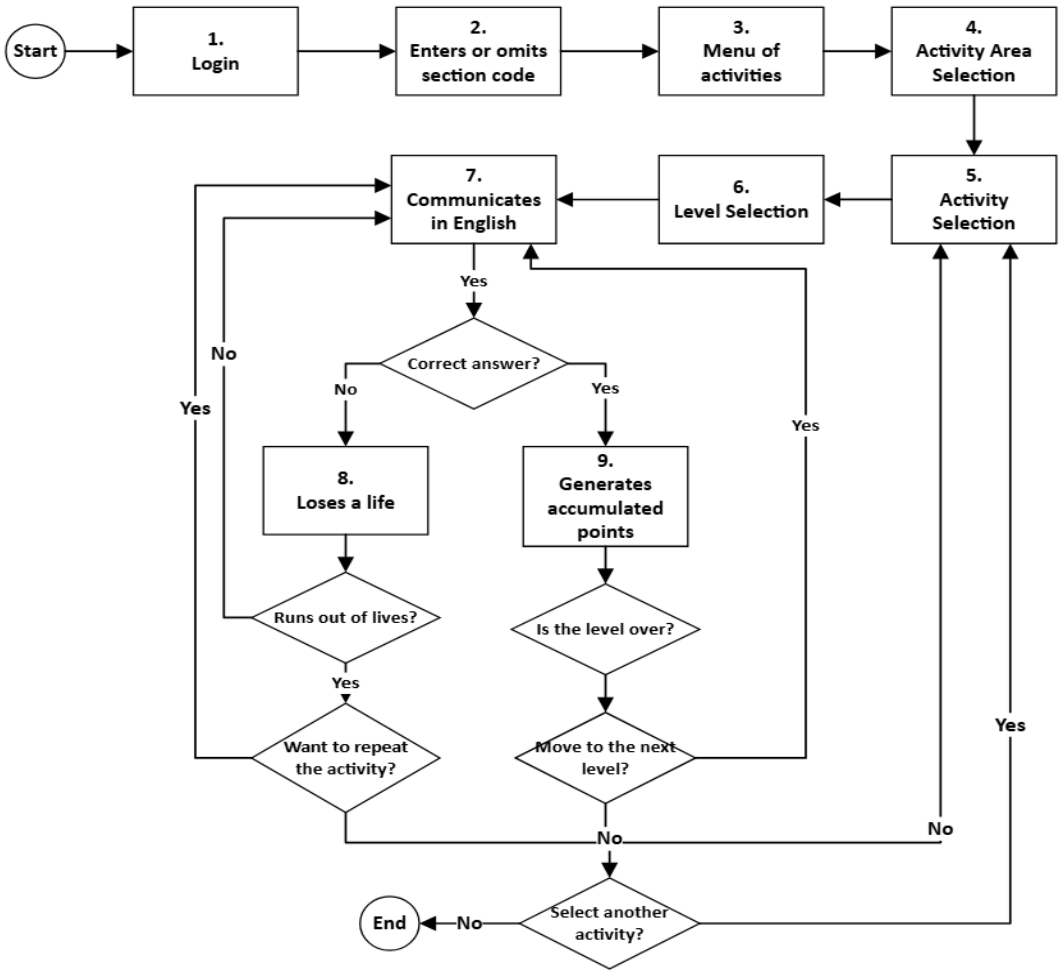


Fig. 3. Mobile application procedure.

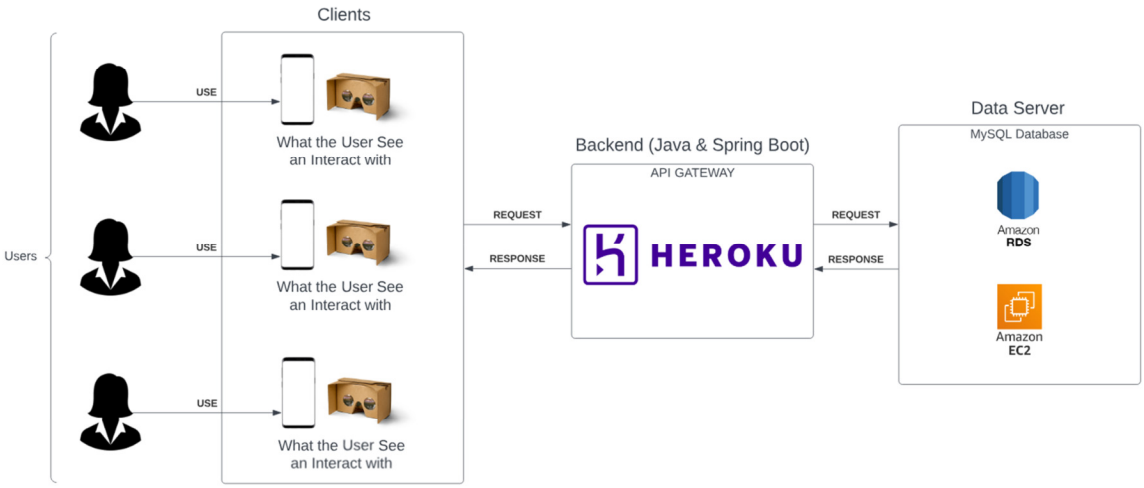


Fig. 4. Physical architecture of the application.

4) Avatar Customization Module

In this module, students can customize their virtual avatars (Figure 8). They can choose from different avatars to create a digital representation of themselves within the learning environment. The avatars are purchased using points accumulated throughout the game, which adds a motivational element for the learners.

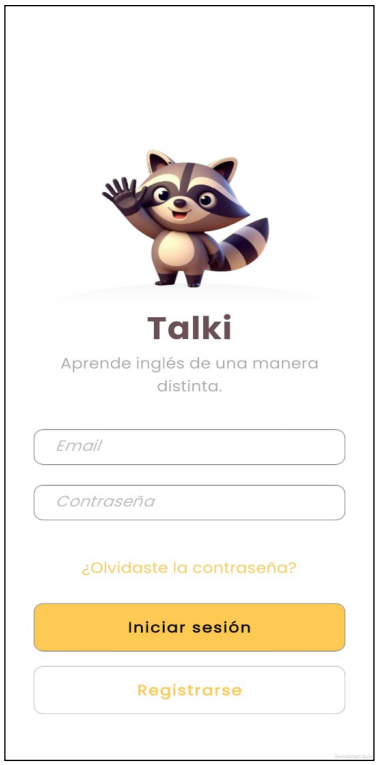
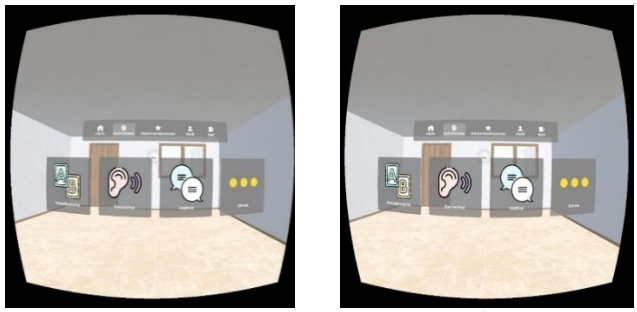


Fig. 5. Login interface.



(a) (b)

Fig. 6. VR view - Activity area menu: (a) left eye, (b) right eye.

Fig. 7. Levels in the vocabulary area.

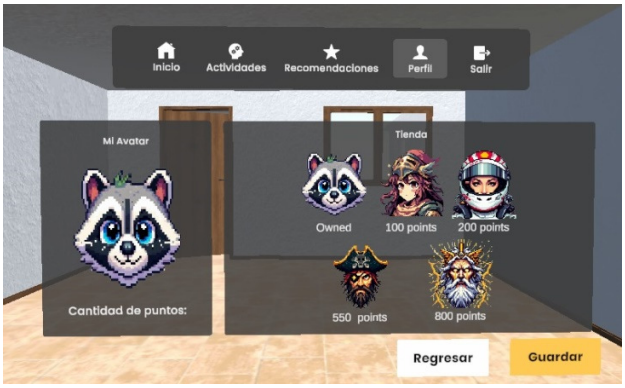


Fig. 8. Avatar selection.

III. EXPERIMENTAL VALIDATION

The experiment was carried out in a school in Peru, with the participation of 58 students distributed in 2 sections of 2nd year of secondary school (30 students in section B and 28 in section D). At first, an initial test of the students was carried out, then the *Talki* application was used for two weeks, and afterward a final test was taken to verify its effectiveness. Two topics were considered for the tests: learning basic vocabulary and learning listening (Table V). Additionally, a satisfaction survey was applied to the students to evaluate the quality of *Talki.*

TABLE V. EXPERIMENT

Experiment	Students	Metrics
Initial test	Section B Section D	Average grade (AG) Min. Grade (MIG) Max. Grade (MAG) Grade Mode (GM) Average Time (AT) Improvement Percentage (IP %)
Use of *Talki* application	Section B Section D	

The IP is calculated by (1):

$$IP = \frac{AG_{FT} - AG_{IT}}{AG_{IT}} \times 100 \quad (1)$$

where AG FT is the grade average of the final test and AG IT is the grade average of the initial test.

Figure 9 illustrates the learning process followed by all sections. The process starts with the traditional teaching given by the teacher to sections B and D (1). Then, the teacher designs the activities and the initial assessment (2), and the students perform the assessment (3). During the next two weeks, students continue to participate in class (4) while the teacher continues to teach her lessons (5). In parallel, the teacher provides the section code so that students can access the activities related to the initially assessed topic (6). Students log into the application and use the section code (7). Using Google Cardboard VR glasses, students perform vocabulary and listening activities (8). At the end of the two weeks, the teacher prepares the final exam (9) and evaluates the students (10).

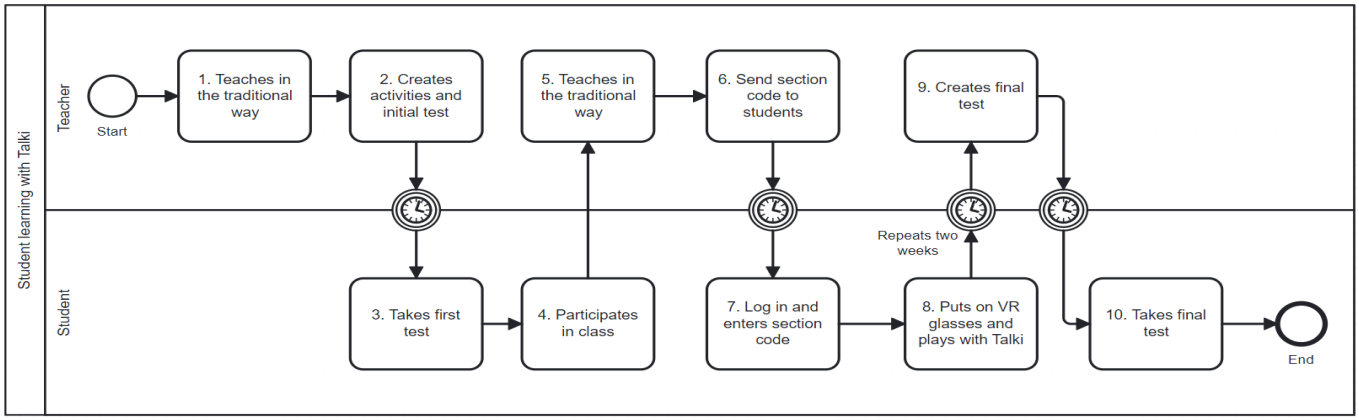


Fig. 9. Process diagram of the application use.

A. Initial Test

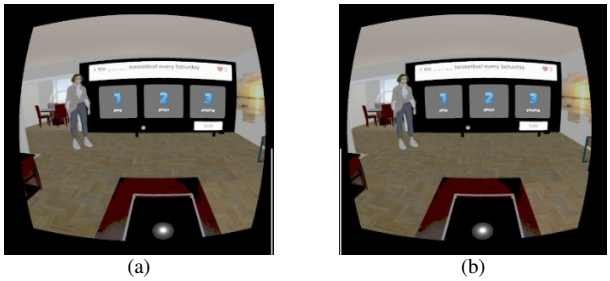
The initial assessment was created by the school's English teacher. The test consisted of 20 questions between the vocabulary and listening topics and each question gave 1 point. The students had studied these topics a week before and developed their homework in a traditional way, which provided them with adequate preparation for the assessment.

B. Use of the Talki Application

The experiment, conducted over two weeks, was carried out using the developed application called *Talki*. At the end of the classes, students log into the application and put on the virtual reality glasses to perform the exercises and reinforce learning (according to steps 7 and 8 in Figure 9). These exercises are composed of varied scenarios, as illustrated in Figure 10, where the activity took place in a classroom with a teacher asking questions, and in Figure 11, which showed a home-based environment referring to asynchronous classes. At the end of the 2 weeks, a final test was taken, with the same characteristics as the first one, to verify *Talki's* effectiveness.

(a) (b)

Fig. 10. VR view - level of the listening area. (a) Left eye, (b) right eye.



(a) (b)

Fig. 11. VR view - vocabulary area level. (a) left eye, (b) right eye.

C. Survey Design

At the end of the experiments, the students completed a survey to identify their perception of *Talki*. This survey was made with Microsoft Forms and consisted of 10 closed questions (Table VI), applied with a Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree nor Disagree, 4 = Agree, 5 = Strongly Agree).

TABLE VI. QUESTIONS AT THE END OF THE EXPERIMENT

Category		Question
Usability	1	Was the navigation of the application easy to use?
	2	Were the exercises you performed intuitive (easy to understand)?
Mobile application	3	Did the application improve your English vocabulary?
	4	Did the application improve your listening comprehension?
	5	Would you like to continue using the application in the future to learn English?
Gamification	6	Did you feel more motivated to learn English with the application?
	7	Did using game elements (gamification) enhance your learning experience?
	8	Did the application make the learning process funnier?
VR	9	Did virtual reality (immersion) help to better understand and remember the content of the English lessons?
	10	Did using the virtual reality (immersive) glasses increase your confidence in speaking English after using the app?

IV. RESULTS AND DISCUSSION

A. Initial Test

Figures 12 and 13 present the students' initial grades in sections B and D, respectively. Section D stands out for having slightly higher grades compared to section B. However, in both sections, there is a significant number of failing grades, which is evidence of low initial student performance.

Table VII presents the data obtained from the first test of the students. Initially, it is observed that the average grade for both classrooms is insufficient. This is also observed when visualizing the mode of the grades being 9 points for section B and 12 for section D. In addition, the average time spent in the test is similar for both classrooms, exceeding 30 minutes. On the other hand, a significant dispersion in the grades can be appreciated, especially in section B, where one student obtained the maximum grade whereas another got only 2 points. This suggests that not all students take advantage of the traditional teaching provided by the school in the same way.

TABLE VII. RESULTS OF THE INITIAL TEST

Sections	AG	MIG	MAG	GM	AT
B	10.43	2	20	9	32.98
D	10.07	1	18	12	32.85

B. Use of Talki

Figures 14 and 15 show the students' final grades in sections B and D, respectively, after using the *Talki* application (Figure 16). In both sections most of the grades are passing. However, there are still remarkably low grades, as can be seen in section D, where one student obtained a grade of 2 points.

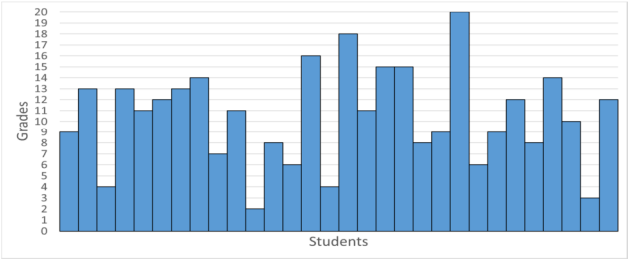


Fig. 12. Results of the initial test - Section B.

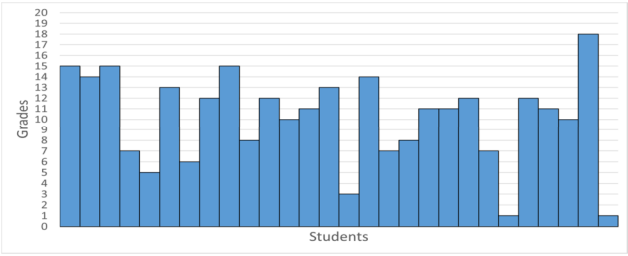


Fig. 13. Results of initial test - Section D.

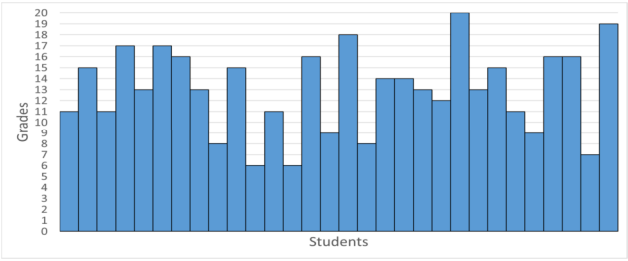


Fig. 14. Results of the final test - Section B.

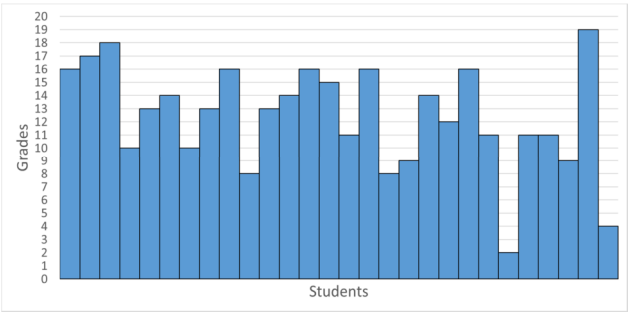


Fig. 15. Results of the final test - Section D.

Fig. 16. Students using *Talki*.

Table VIII shows the results of the final test. The average grade of both sections was passing; however, they indicate moderate academic performance. Likewise, a significant difference is visualized in the minimum and maximum grades, suggesting a greater dispersion in the performance of the students in section D compared to section B. Although there is not a large difference in the average grades, a difference of just over 4 minutes in the average time spent on the test can be seen.

TABLE VIII. FINAL TEST RESULTS

Sections	AG	MIG	MAG	GM	AT
B	12.97	6	20	11	24.38
D	12.36	2	19	16	28.58

Figures 17 and 18 present line graphs comparing the individual students' grades from sections B and D in two assessments. In the initial assessment, in both section B and section D, 16 students passed. In the final assessment, section B increased to 23 passing students, whereas section D had 20 passing students.

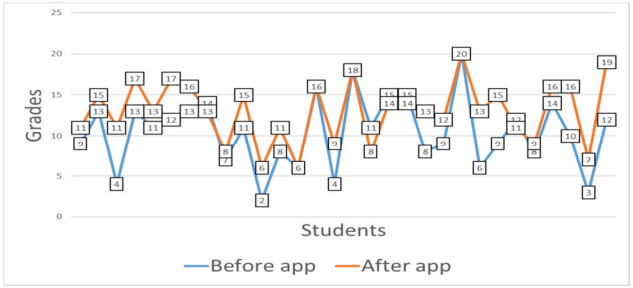


Fig. 17. Comparison of initial vs. final grades - Section B.

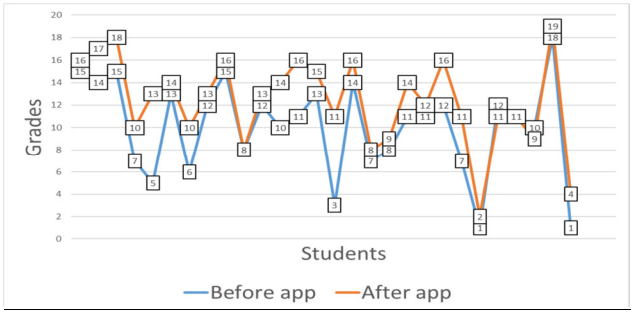


Fig. 18. Comparison of initial vs. final grades - Section D.

Table IX shows the initial and final grades. At the beginning, the average grade for both sections was failing, but after two weeks of using *Talki*, the grades improved to a passing average. In addition, times, which initially exceeded 30 minutes, decreased by more than 8 minutes in section B and by more than 4 minutes in section D. A particularly significant finding from the experimentation is the IP, where both classrooms showed an improvement of more than 22%.

These results highlight that students made remarkable progress in their language skills in a short period of time, highlighting the value and effectiveness of this application as an educational resource.

Figure 19 shows the results of the student questionnaire, grouped by usability, gamification, mobile application, and VR.

TABLE IX. INITIAL VS. FINAL RESULT COMPARISON

Sections	AG EI	AG EF	AT EI	AT EF	IP %
B	10.43	12.97	32.98	24.38	24.35
D	10.07	12.36	32.85	28.58	22.74

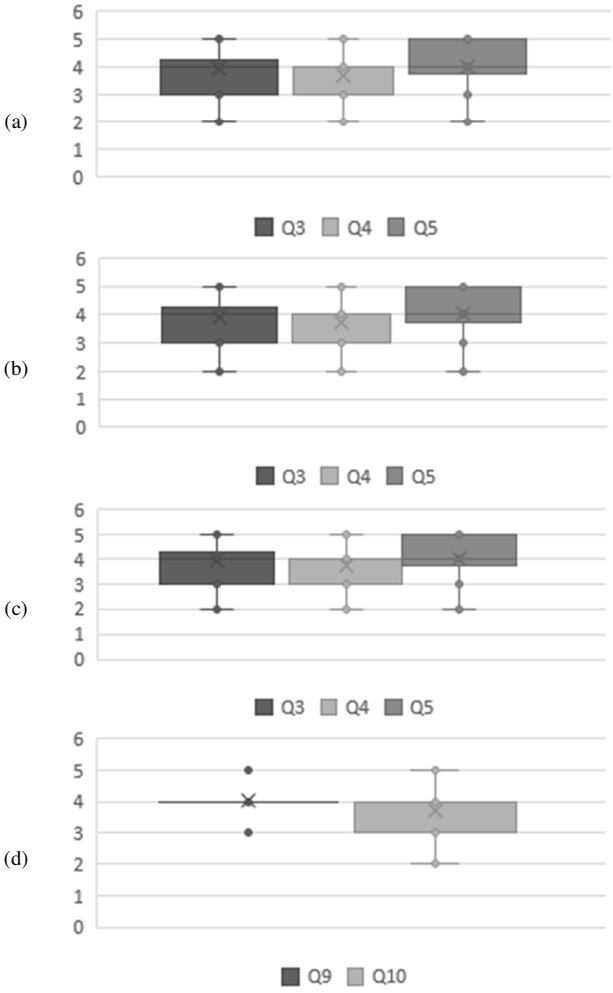


Fig. 19. Survey results: (a) Usability, (b) Gamification, (c) Mobile Application, (d) VR.

Regarding the usability of the system, Figure 19(a) shows that in question Q1, 50% of the students gave a rating between 3 ("neither agree nor disagree") and 4 ("agree"). And in question Q2, 50% of students gave a rating between 4 ("agree") and 5 ("strongly agree").

Regarding the mobile application, in Figure 19(b) it is evident that, in question Q3, 50% of the students have given a rating between 3 ("Neither agree nor disagree") and 4 ("Agree"). In question Q4, 50% of the students gave a score between 3 ("Neither agree nor disagree") and 4 ("Agree"). In question Q5, 50% of the students gave a score between 4 ("Agree") and 5 ("Strongly agree").

Regarding the gamification of the system, Figure 19(c) shows that in the three questions Q6, Q7, Q8, 50% of the students gave a score between 4 ("agree") and 5 ("strongly agree").

Regarding the VR of the application, Figure 19(d) shows that in question Q9 there are extreme ratings of 3 ("Neither agree nor disagree") and 5 ("strongly agree"). Whereas in question Q5 50% of the students have given a rating between 3 ("Neither agree nor disagree") and 4 ("agree").

C. Comparison with Similar Works

Table X shows a comparison between *Talki* and other applications designed for teaching foreign languages. The attributes take in consideration are gamification, VR, and accessibility. Accessibility will be considered by the cost of the application plus the glasses, if the cost is less than 30 dollars then it will be considered as an accessible application to the public. Table X shows the results of the comparison. Only *Talki* focuses on the three most important attributes, providing a good product for a minimum price and adapting to the Peruvian reality.

TABLE X. COMPARISON WITH SIMILAR WORKS

Attributes / Works	Gamification	VR	Accessibility
Talki	x	x	x
MondlyVR [11]		x	
Duolingo [6]	x		x
InmerseMe [12]		x	

V. CONCLUSION

In this study, a mobile application named *Talki* was developed for learning English for high school students in Peru. It used immersive teaching techniques with virtual reality and gamification, using Google Cardboard virtual reality glasses. The application was developed based on 3 gamification techniques (levels, points and avatar) to provide a comprehensive and motivating experience for students.

To validate the application, 2 experiments were carried out with 58 students divided into 2 sections (B and D) in a school in Peru. The first experiment consisted of giving an initial test to the students to validate their current level in the English language. The second experiment consisted of students using *Talki* for 2 weeks and then taking a final test. Section B showed an AG on the initial assessment of 10.43 and an AG on the final assessment of 12.97, resulting in an IP of 24.35%, and section D showed an AG on the initial assessment of 10.07 and an AG on the final assessment of 12.36, resulting in a IP of 22.74%, revealing an academic increase with respect to the English course. These results demonstrate the effectiveness of *Talki* as a tool for improving English proficiency.

In addition, a survey was conducted to identify the student perception of the mobile application. In the analysis of *Talki's* usability, most of the students found the navigation of the application and the exercises intuitive. As for the mobile application, students perceived an improvement in their English vocabulary and listening comprehension, and showed a favorable disposition to continue using the app in the future. The gamification was well received, as most students felt more motivated and found the game elements enhanced their learning experience making the process funnier. Finally, in virtual reality, ratings varied more widely. A significant portion of students found that virtual reality helped them to better understand and remember content, as well as increase their confidence in speaking English. These results suggest that implementing technologies such as virtual reality and gamification in educational applications can have a positive impact on student motivation and learning.

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