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TEENGLISHAPP- MULTIPLATFORM MOBILE APPLICATION FOR TEACHING ENGLISH LEARNING: A CASE STUDY IN TRUJILLO-PERU

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ABSTRACT

The teaching-learning of the English language in different public and private institutions anywhere in Latin America tends to be weak with respect to the quality of this, monotonous and with little motivation for the students. The research aims to improve the teaching-learning of English in students of 1st year of secondary school in the I.E. Liceo Trujillo, Peru through a Multiplatform Mobile Application which has a server developed in Django Rest Framework with database in MySQL and the Python programming language; the part of the Frontend is developed in Ionic Framework that uses Angular Framework and the TypeScript programming language, developed with the Mobile-D methodology which consists of the following 5 phases: exploration, initiation, production, stabilization and testing of the system.

As a result, the aforementioned process is improved using indicators such as: academic performance, time it takes the student to learn a new group of words and a new topic and satisfaction of the student regarding the English class. It is concluded that having implemented a mobile application improves the teaching-learning process of the English language.

Keywords: mobile-d, multiplatform, mobile, English, teaching-learning, case study.

I. INTRODUCTION

The teaching-learning process of English in the Educational Institutions of Peru has not advanced enough to achieve positive results, it is monotonous and with little motivation for students due to external situations such as the recent pandemic. Portilla (2020) sought in his research

to optimize the usability of mobile devices for learning in the classroom, and achieved it using instant messaging for mass use in audio, text, images and video formats in order to strengthen the learning of English in the Agroindustrial Training Center "La Angostura", Colombia. On the other hand, Romero et al. (2015) highlight the importance of the teaching-learning process of the foreign language because it requires different motivational methodological strategies of a pedagogical and sociological nature, to generate affectivity in the student so that he has basic knowledge and skills to apply the knowledge of the language. Similarly, Alanoca (2019) in his research proposes an Emotional Intelligence program to improve the teaching-learning process of the English language through a communicative approach taking into account the effective development of the student. Olivera (2021) also aimed to determine the regularity in which feedback is used in the teaching-learning process of English in 340 students of the I.E. "José Carlos Mariátegui". Likewise, Neira (2022) mentions the great positive impact generated by using some type of technology for the teaching-learning process of English; for his research he promoted the use of Google Classroom. On the other hand, Bosquez Vera et al. (2022) aimed to design and implement an educational mobile application in order to strengthen the teaching-learning process of English, through a mobile application called STUDENGLISH. Likewise, Ocampo-pazos et al. (2020) conducted research using didactic materials where they applied augmented reality in education for university students of the nursing career in order to improve and strengthen the teaching-learning process. Similarly, Jaramillo Henao et al. (2018) aimed to provide an understanding about the benefits of augmented reality, where they used the teaching-learning process in classrooms and educational centers. In this way, Máñez-Carvajal and Cervera-Mérida (2022) set themselves the objective of developing a mobile application for children with learning difficulties in reading and writing, where it facilitated linguistic development and the reinforcement of some phonological awareness processes. On the other hand, Serrano et al. (2018) aimed to disseminate a circuit simulator, at the Polytechnic University of Sinaloa (UPSin), where he used as an activity the teaching-learning process in simple series and parallel circuits. In addition, he described the implementation and use of the application in the graphical programming language, LABVIEW. The use of mobile applications to improve conceptual learning of different academic topics has a great advantage to reinforce concepts obtained by a tutor or learn new concepts. Learning a second language is one of the most important topics today, as is the English language, which offers possibilities in the academic and professional field. This article results in the development of a mobile application that contributes to the improvement of the teaching-learning process of English in students of 1st year of secondary school in the I.E. Liceo Trujillo directly benefiting the students and parents of said institution. The main objective of this article is to improve the teaching-learning process of the English language through the development of a mobile application aimed at 1st year high school students, with the Mobile-D methodology, at the Liceo Trujillo national school. The research is organized as follows: in section II, key concepts for the understanding of this article are mentioned as Background; section III describes the Research Method used; in section IV, the application of the Mobile-D methodology is presented through a Case Study; in section V, the Results and their Research Discussions are shown; Finally, section VI shows the Conclusions and recommendations on Future Research that can be carried out.

II. BACKGROUND

A. Multiplatform Mobile App

Mobile applications in the educational field promote the construction of knowledge through social learning and the exchange of knowledge, generating opportunities for development through practice in the educational environment in an innovative way (Escobar-Reynel et al., 2021). The operating system in mobile devices, also called platform, is responsible for managing the hardware resources on a device, that is, it manages and controls these resources to optimize process management without sacrificing the security and performance of the mobile device (Velásquez et

al., 2019); in the current market the following operating systems for mobile devices predominate: Android and iOS. A cross-platform mobile application is a software that its coding serves different platforms without the need to make large changes to the code; provides the same functionalities in different operating systems and platforms as well as mobile, web and desktop (Castillo-Portales et al., 2022). The term Backend refers to the development layer that contains the programming, specifications and logic of the microservices of the business, it also handles the entire structure of the database, while the Frontend is the development layer that converts the data it receives from the Backend of the graphical interface for the end user (Mamani Rodríguez et al., 2020). Ionic Framework has components written in HTML, CSS and JavaScript, this facilitates the creation of user interfaces with modern and high quality features, provides tools optimized for mobile devices for the creation of interactive and fast applications (Ionic, 2022). Django Rest Framework, is a powerful and flexible toolset to create a web API, has extensive documentation and great community support, uses the Python programming language and is compatible with any database, structured or not (Django, 2022).

B. Learning

Teaching is defined when the teacher guides the student, which includes the search process for problem solving, so that students can achieve knowledge to use and master creative activity (Bellocq et al., 2022). Learning is the meaning and personal value for the beginner when he tries to support and understand himself, he is also able to act and project a future plan that involves personally (Engel & Coll, 2022). The teaching-learning process is composed of two components: personal and non-personal; The personal component is made up of the community, society, the student and the teacher. On the other hand, the non-personal components contain the method, content and evaluation (Ramírez Terán et al., 2022).

III. RESEARCH METHOD

3.1. Solution Development Methodology: Mobile-D

The Mobile-D phases where each phase is highlighted, except for the Initial phase, is shown in Figure 1.

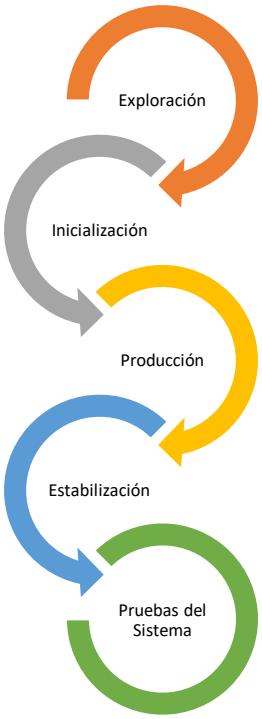


Figure 1. Mobile-D Methodology Phases

a) Exploration: It allows the planning and definition of the basic concepts of the project, as well as the scope, function and that plans other stages.
b) Initialization: Identification of all the resources needed to develop the application.
c) Production: The sub-phases are repeated: plan, work and release until all functions are performed. At this stage, technologies such as Test-Driven-Development (TDD) are used to achieve higher product quality.
d) Stabilization: Product component integration activities are performed to ensure that the entire system is functioning properly.
e) System testing: The goal is to provide a stable and functional version of the system, adapted to customer requirements, if possible the observed errors are corrected.

3.2. Applied Research Method

a) Operationalization of Variables

Table I details the indicators used in the research to be optimized through the Multiplatform Mobile Application.

Table I. Operationalization of variables

Indicator	Index	Unit of Measure
Time to learn a new group of words	[1–16]	Hours
Time to learn a new topic	[1-16]	Hours

Academic Performance	[0-20]	Unit
Student Satisfaction	Strongly agree, Agree, Indifferent, Disagree, Strongly disagree.	Likert scale

b) Research Design

The research design is pure experimental, requiring the participation of two groups.

R Ge XO1

R Gc---O2

Where:

A: Random choice of the elements of the Sample (Ge or Gc).

Ge: Experimental group: Study group to which the stimulus will be applied, that is, the multiplatform mobile application.

Gc: Control group: Study group to which the stimulus will not be applied.

X: Stimulus: Multiplatform Mobile Application.

--: Absence of Stimulus.

The present research compares the control group (Gc) made up of a representative number of the teaching-learning process of English, where the values of the posttest (O2) are obtained, with the experimental group (Ge) to which the stimulus is provided, the multiplatform mobile application (X), to solve the problem, then it is expected that the values of the posttest (O1) will be obtained.

c) Universe and Sample

For the universe, all processes of Teaching-Learning of English were taken in students of 1st year of secondary school of public and private I.E. of Latin America: N = Indeterminate.

For the sample, the processes of Teaching-Learning of English in students of 1st year of secondary school at the I.E. Liceo Trujillo were considered. n=30

d) Data Collection Procedures

In this research the data collection instrument was the observation sheet, the techniques used were direct and indirect observation.

e) Statement of Hypotheses

The following hypotheses were established:

H1: If a multiplatform mobile application is used, developed with the Mobile-D methodology; then it reduces the time to learn a new group of English words in 1st year of secondary school students at the I.E. Liceo Trujillo.

H2: If a multiplatform mobile application is used, developed with the Mobile-D methodology; then decreases the time to learn a new subject of English in students of 1st year of secondary school in the I.E. Liceo Trujillo.

H3: If a multiplatform mobile application is used, developed with the Mobile-D methodology; then increases the academic performance in students with respect to English at the I.E. Liceo Trujillo.

H4: If a multiplatform mobile application is used, developed with the Mobile-D methodology; then raises the student's satisfaction with respect to English at the I.E. Liceo Trujillo.

For the testing of the hypotheses, the following solution was proposed for each of the indicators:

$\mu 1$= Population Mean (H1, H2, H3) for Post-Gc Test.

$\mu 2$= Population Mean (H1, H2, H3) for Gene Posttest.

Where:

$H0 = \mu 1 > \mu 2$

Ha= $\mu 1 \leq \mu 2$

In addition:

$\mu 1$= Population Mean (H4) for Post-Gc Test.

$\mu 2$= Population Mean (H4) for Posttest of Ge.

Where:

H0= $\mu 1 < \mu 2$

Ha= $\mu 1 \geq \mu 2$

Finally, the data normality test, descriptive statistical analysis, and the hypotheses were validated using Student's t-test with specialized Minitab software.

IV. CASE STUDY

In the development of the mobile application, the Mobile-D methodology was applied in a detailed and rigorous manner, which is composed of 5 phases, these are:

4.1. Exploration

a) Project Requirements

Table II. Functional Requirements (RF)

ID	Functional Requirements
RF1	The mobile application must have authentication based on a username and password.
RF2	The application must not allow multiple accesses on different devices with the same user.
RF3	The mobile application must have scores for each exercise and display that data on the main screen.
RF4	The exercises of the mobile application should reinforce topics of greater difficulty and importance for students.
RF5	The exercises of the mobile application must be based on the programming of the English course.
RF6	The user must always know their current progress represented graphically.
RF7	The mobile application must have instructions for its first use.
RF8	The mobile application must notify the user with random words in English with their Spanish translation.

Table III. Non-functional requirements (RNF)

ID	Non-functional requirements
RNF1	The mobile application must be multiplatform.
RNF2	The system must have an interactive interface with the user.
RNF3	The mobile application must feed back the possible mistakes that the student makes.

RNF4	The exercises must be located on the main screen of the mobile application.
RNF5	Shorten texts and prioritize the improvement of visual aspects.
RNF6	The mobile application must have a Backend developed in Django Rest Framework with MySQL database.
RNF7	The Frontend of the mobile application must be developed in the Ionic and Angular framework with the TypeScript programming language.
RNF8	The system must use MySQL as the database manager.
RNF9	The download of the mobile application must be usable from the Google Play store.

b) Project Stakeholders

- Director of the Liceo Trujillo Educational Institution
- Deputy director of the secondary level of the I.E Liceo Trujillo
- Teachers of the subject of the English language
- Parents
- Students

c) Project development tools

- Visual Studio Code
- PostgreSQL
- Adobe XD
- Django Rest Framework
- Ionic Framework
- Angular Framework
- TypeScript
- Python

4.2. Initiation

a) Solution architecture

This section, shown in Figure 2, defines how current architectures (information, technology services, and information systems) should be adjusted.

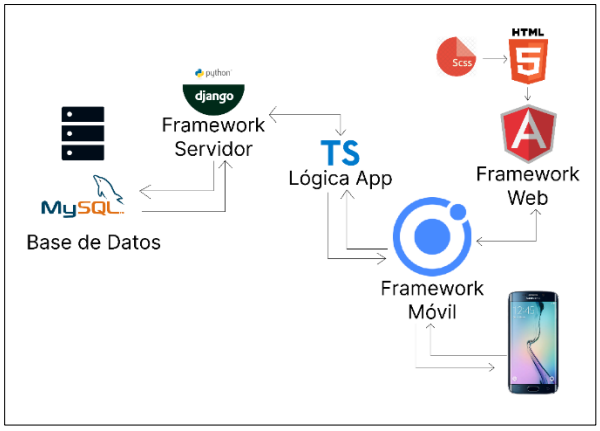


Figure 2. Solution architecture

b) Software architecture

This section, shown in Figure 3, refers to the structure and relationship between the different parts of a software and its visible external properties.

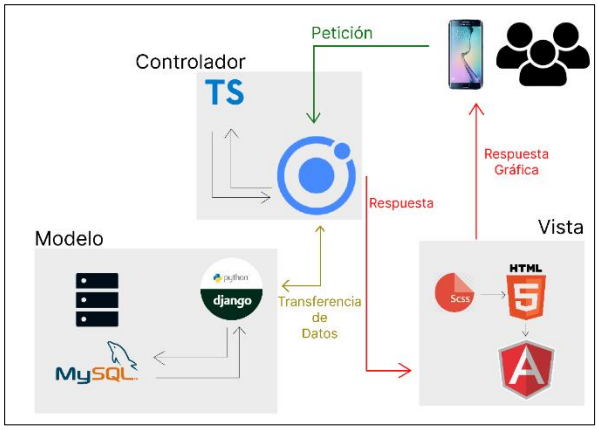


Figure 3. Software architecture

c) Use Case Model

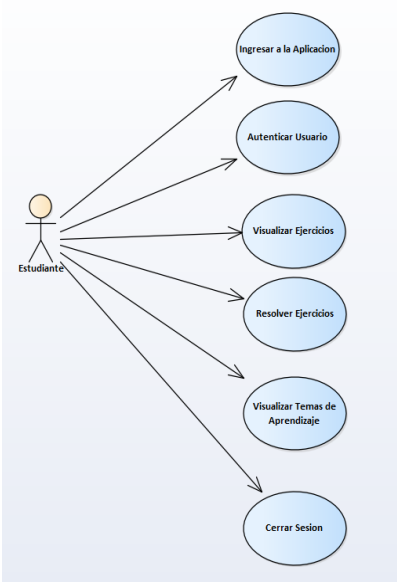


Figure 4. Use Case Model

d) Sequence diagram

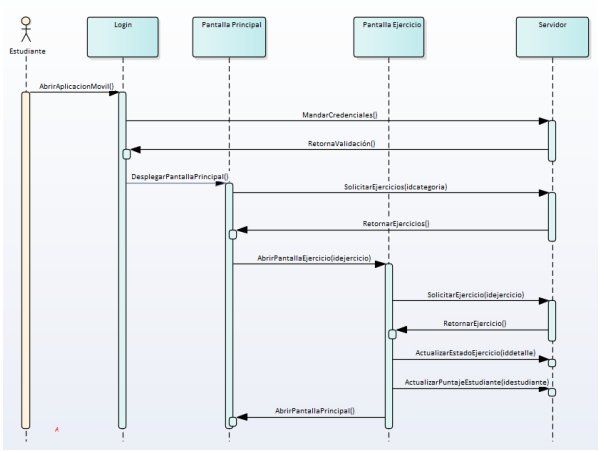


Figure 5. Sequence-exercise diagram

e) Database design

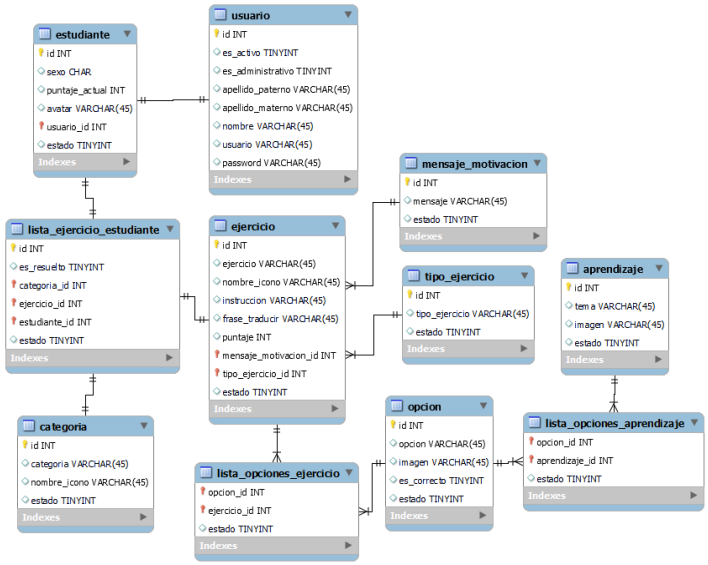


Figure 6. Physical database diagram

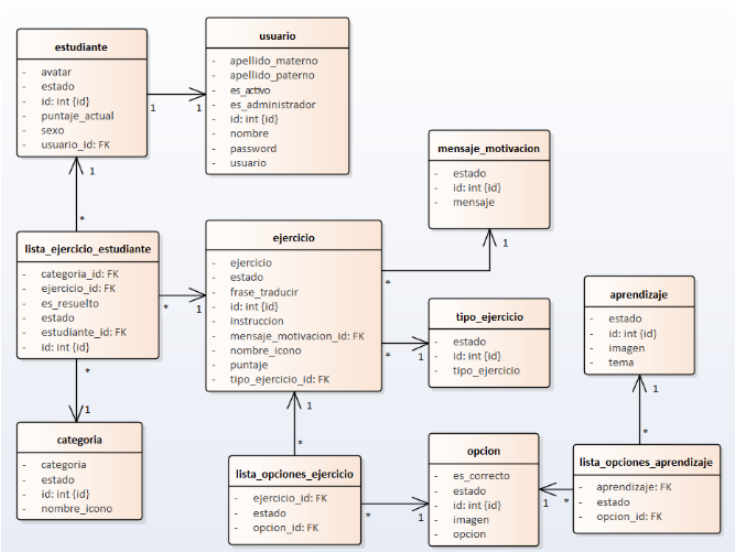


Figure 7. Logical database diagram

4.3. Production

In this phase, all the necessary functionalities are generated, as shown from Figure 8 to Figure 12.

4.3.1. Backend

- User Control

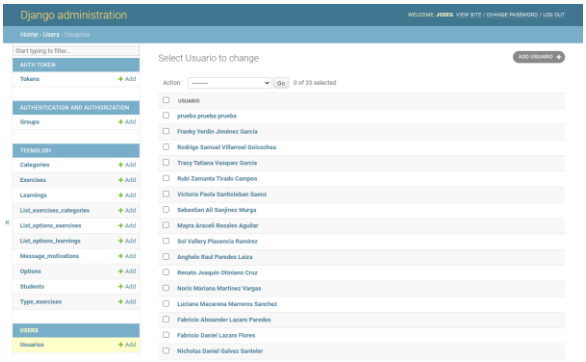


Figure 8. User administrator

Table IV. User Control Story Card

Identifier	Guy	Difficulty		Effort		Priority
		Before	After	Dear	Used	
B01	New	Easy	Easy	44 h	38 h	Casualty
		Moderate	Moderate			Media
		Difficult	Difficult			Loud

Description
The main function of this part of the backend development is to have strict control of the user who logs into the application, using token security to protect the backend routes, also prohibits the entry of the same account simultaneously by deleting the current token, so the user's current session will be automatically closed for security, In addition to this, the system encrypts the user's password.

Date	**State**	**Comment**
01/03/2022	Defined	We had the definition of the control we will have over the user
15/03/2022	Implemented	We had the first version
20/03/2022	Checked	Optimal service functionality sought

- Exercise Management

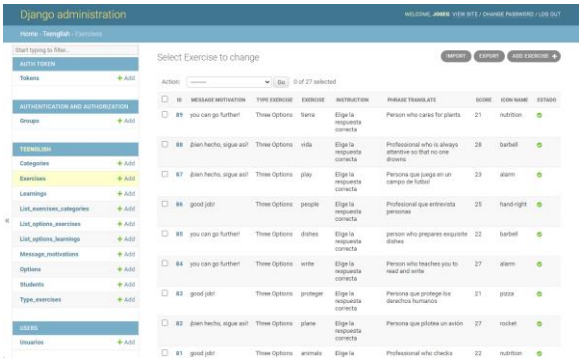


Figure 9. Exercise Manager

Table V. Exercise Management Story Card

Identifier	**Guy**	**Difficulty**		**Effort**		**Priority**
		Before	**After**	**Dear**	**Used**	
B02	New	Easy	Easy	60 hrs	65 h	Casualty
		Moderate	Moderate			Media
		Difficult	Difficult			Loud
Descripción						
The main function of this part of the backend development is to have control of all the data necessary for the use of the mobile application, such as exercise, user, category, type of exercise, motivation message, among others.						

Date	State	Comment
21/03/2022	Defined	We had the definition of the models to be used
04/04/2022	Implemented	We had the first version
10/04/2022	Checked	Tested and adjusted some existing bugs until optimal service functionality was available

4.3.2. Frontend

a) Login

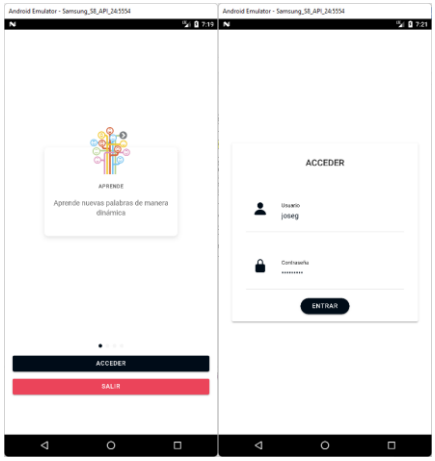


Figure 4. Initial instructional screen and login

Table VI. Story Card for initial instructions and login

Identifier	Guy	Difficulty		Effort		Priority
		Before	After	Dear	Used	
F01	New	Easy	Easy	3 p.m.	3 p.m.	Casualty
		Moderate	Moderate			Media
		Difficult	Difficult			Loud

Description

The main function of this part of frontend development is to complete the login process, this service sends credentials such as username and password to wait for a response from the server; When validating the login this service obtains data from the student to save it in local memory and use it later to display it on the home screen.

Date	State	Comment

11/04/2022	Defined	We had the definition of the data to be saved in the local memory of the mobile application
15/04/2022	Implemented	We had the first version
16/04/2022	Checked	Tested and adjusted some existing bugs until optimal service functionality was available

b) Main screen

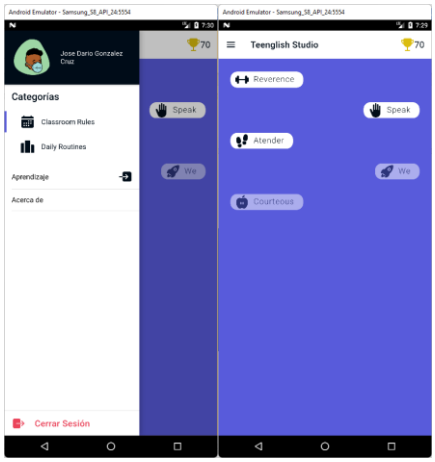


Figure 11. Main screen and menu

Table VII. Main screen Story Card

Identifier	**Guy**	**Difficulty**		**Effort**		**Priority**
		Before	**After**	**Dear**	**Used**	
F02	New	Easy	Easy	3 p.m.	10 a.m.	Casualty
		Moderate	Moderate			Media
		Difficult	Difficult			Loud
Description						
The main function of this part of frontend development is to display the learning categories that the user can access and the list of exercises						
Date		**State**		**Comment**		

27/04/2022	Defined	We had the definition of the learning categories and the topics to be worked on
05/05/2022	Implemented	We had the first version
06/05/2022	Checked	Tested and adjusted some existing bugs until optimal service functionality was available

c) Exercises

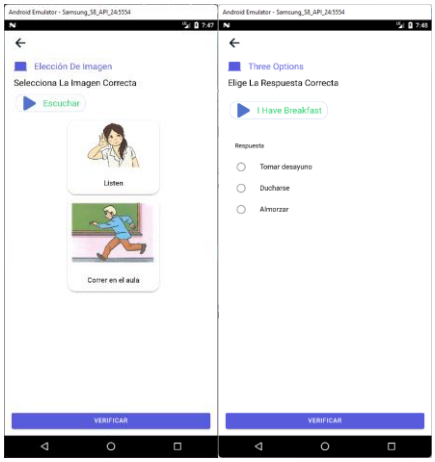


Figure 12. Exercise screen

4.4. Stabilization

In this phase, all the activities that allow the integration of the functionalities described in the Production phase are carried out. (See Figure 13, Figure 14, Figure 15)

a) Directory structure

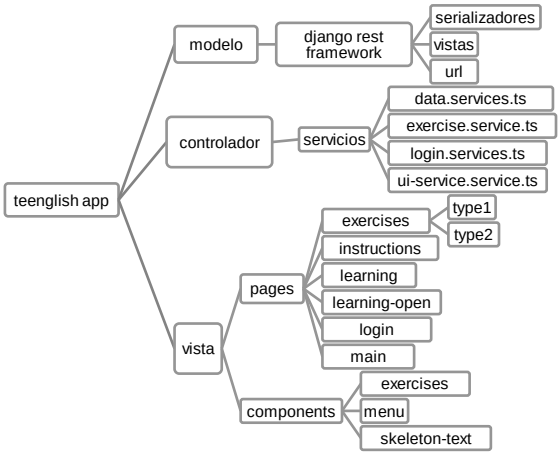


Figure 13. Directory structure

b) Publishing the application

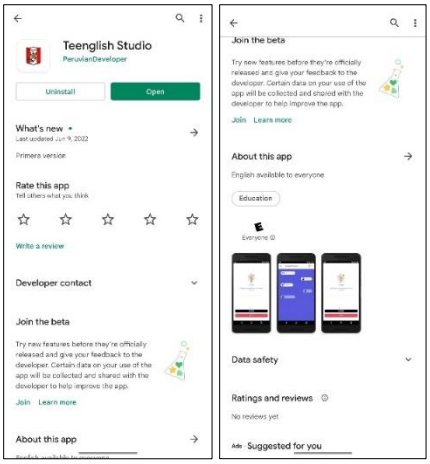


Figure 14. App published in Play Store

The name assigned to the developed app is Teenglish Studio, which is available in the Play Store for download by anyone, but this does not allow users to register due to the issue that it is an application for private use, at this time only for first-year high school students of the National Educational Institution Liceo Trujillo, In order to publish the project in the Play Store, you had to create an account in the Play Store Console and meet a series of requirements such as the creation of a privacy policy, among others.

c) Application Training

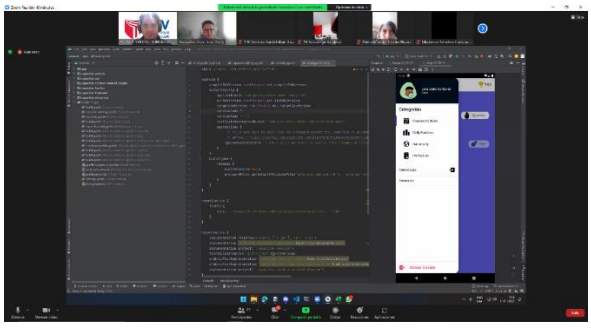


Figure 15. Zoom meeting with students

The official presentation of the Teenglish Studio multiplatform mobile application was made to the students of the first year of secondary 1B of the educational institution Liceo Trujillo; It was also trained for its correct use, the topic of login, exercise management, learning section and progress control by points.

4.5. Tests

In this development phase, a validation of each of the functionalities of the multiplatform mobile application is carried out and the errors found are corrected:

a) Incorrect credentials

As a first test, the login was performed, it is observed, in Figure 18, the response of the server when incorrect credentials are sent, such as the username or password; the server that is developed in Django Rest Framework returns an error HTTP400 (Bad Request) that means that the server can not process the request due to a client error, then the frontend upon receiving this error shows a message indicating the reason for the incident occurred.

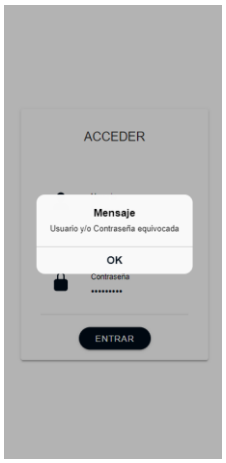
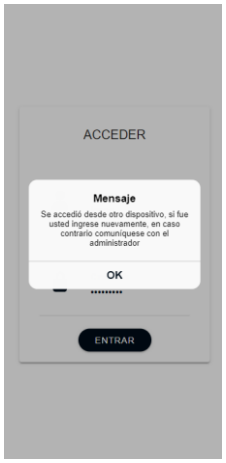


Figure 16. Login-incidence wrong parameters

b) Concurrent connections

The login takes into account another incident, which is the simultaneous access of the same account on different devices; when the server detects an access from another device internally a token update process occurs, when identifying this, the server responds with an error HTTP409 (Conflict) that means that there is a conflict due to a current situation and that the user might be able to resolve the conflict by sending the request again; When the frontend receives this error it automatically shows the following message: "It was accessed from another device, if it was you enter again, otherwise contact the administrator", thus prioritizing the security of the student's access account. (See Figure 17)



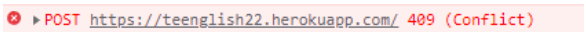


Figure 17. Login-incidence of simultaneous accesses

V. RESULTS AND DISCUSSION

5.1. Results: After application of the solution, real values have been obtained for: Time to learn a new group of words, Time to learn a new topic, Academic Performance, Student satisfaction.

A. Experimental Results

30 tests were performed for each indicator using various data collection techniques and instruments. The results for each of the indicators are shown in Table VIII and Table IX.

Table VIII. Gc Posttest and Ge Posttest Results for I1 and I2

	I1: Time to learn a new group of words (hours)		**I2: Time to learn a new topic (hours)**	
No.	**Gc Post-Test**	**Posprueba del Ge**	**Gc Post-Test**	**Posprueba del Ge**
1	10	7	11	10
2	6	4	7	4
3	10	8	13	11
4	6	5	6	5
5	8	6	8	7
6	3	3	4	3
7	4	2	5	4
8	6	4	6	4
9	7	4	8	7
10	8	4	9	8
11	11	9	12	10
12	9	6	10	7
13	12	8	13	10
14	7	6	8	7
15	6	3	6	3
16	9	6	10	9
17	10	6	11	10

18	7	5	8	6
19	3	3	4	1
20	9	6	10	7
21	13	8	14	12
22	11	9	12	10
23	9	8	10	9
24	6	4	4	2
25	6	4	7	5
26	8	6	5	2
27	4	2	5	3
28	7	2	6	3
29	5	4	6	5
30	5	3	5	4

Table IX. Gc Post-Test and Ge Post-Test Results for I3 and I4

	I3: Academic Performance (points)		**I4: Student satisfaction (Likert Scale)**	
No.	**Gc Post-Test**	**Posprueba del Ge**	**Gc Post-Test**	**Posprueba del Ge**
1	9	11	I agree	Strongly agree
2	10	12	Indifferent	I agree
3	15	16	I agree	Strongly agree
4	10	13	Indifferent	I agree
5	14	16	I agree	Strongly agree
6	9	12	I agree	Strongly agree
7	14	16	Indifferent	I agree
8	12	14	I agree	Strongly agree
9	13	15	I agree	I agree
10	13	15	Disagree	Strongly agree

11	15	17	I agree	I agree
12	13	16	Disagree	Strongly agree
13	13	16	Indifferent	I agree
14	16	18	Strongly agree	Strongly agree
15	14	17	Indifferent	I agree
16	15	17	Disagree	Strongly agree
17	14	16	Disagree	I agree
18	18	20	Strongly disagree	Indifferent
19	15	17	I agree	I agree
20	17	18	Strongly agree	Strongly agree
21	15	18	Indifferent	I agree
22	15	19	Indifferent	I agree
23	16	18	Strongly disagree	I agree
24	16	19	Indifferent	I agree
25	17	17	Indifferent	Strongly agree
26	17	19	Disagree	Strongly agree
27	19	20	Indifferent	Strongly agree
28	19	19	Disagree	I agree
29	20	20	I agree	Strongly agree
30	15	17	Indifferent	I agree

B. Normality Test

This test allows you to compare the empirical cumulative distribution function (ECDF) of the sample data with the distribution expected if the data were normal. Evidence for three indicators is presented. (See Figure 18, Figure 19 and Figure 20)

- I1: Time to learn a new group of words

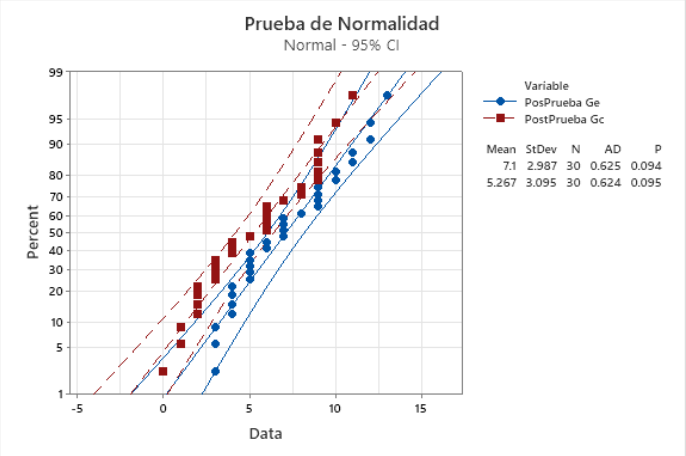


Figure 18. Normality test for Indicator 1

It can be seen that for the time indicator to learn a new group of words, there is a normal behavior in its data; because in the Gc Posttest the p-value is 0.095 and in the Ge Posttest the p-value is 0.094, and these 2 values are greater than α=0.05.

- I2: Time to learn a new topic

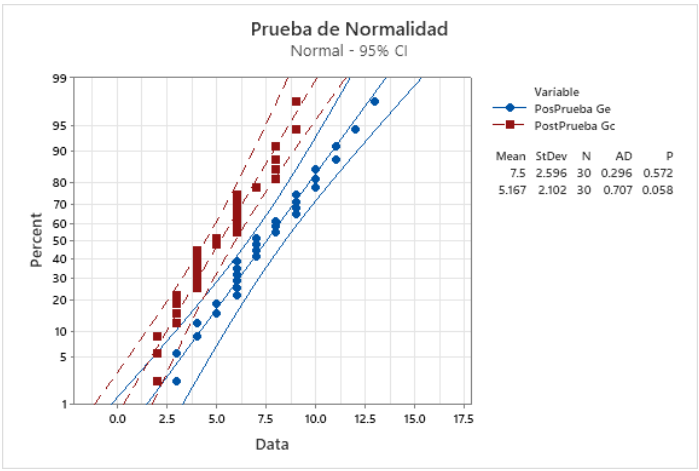


Figure 19. Normality test for Indicator 2

In this scenario it is perceived that, for the time to learn a new topic indicator, there is a normal behavior in the data obtained; because in the Gc Posttest the p-value is 0.058 and in the Ge Posttest the p-value is 0.572, and these 2 values are greater than α=0.05.

- I3: Academic performance

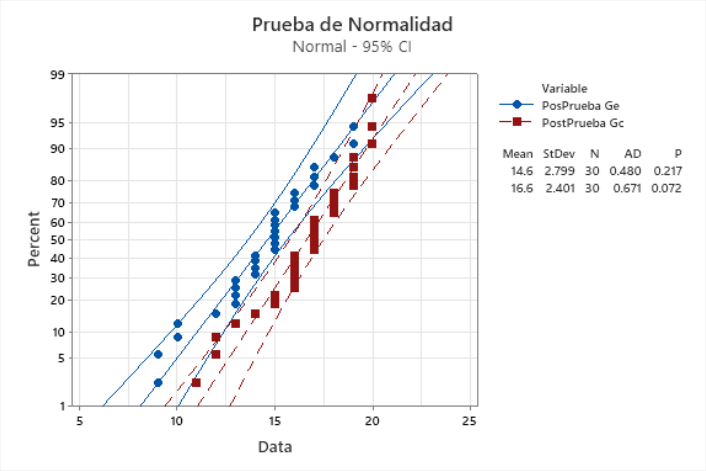


Figure 20. Normality test for indicator 3

It is also appreciated that for the academic performance indicator, there is a normal behavior in the data obtained; because in the Gc Posttest the p-value is 0.072 and in the Ge Posttest the p-value is 0.217, and these 2 values are greater than α=0.05.

5.2. Discussion of Results

An exhaustive discussion of results has been carried out, assuming, the researchers, an objective and critical position with great respect for the results, without altering or distorting them. Finally, some practical and theoretical implications for each result are presented.

A. With descriptive statistics

Table X and Table XI show an initial descriptive analysis of the data, thus allowing to determine patterns and trends in them.

Table X. Results with Descriptive Statistics

Indicator	n	Media	StDev	TO	p-value
I1: Posprueba (Gc)	30	7.5	2.596	0.296	0.572
I1: Posprueba (Ge)		5.167	2.102	0.707	0.058
I2: Posprueba (Gc)	30	8.1	2.987	0.625	0.094
I2: Posprueba (Ge)		6.267	3.095	0.624	0.095
I3: Posprueba (Gc)	30	14.6	2.799	0.48	0.217
I3: Posprueba (Ge)		16.6	2.401	0.671	0.072

According to the results of the "Anderson Darling" normality test, the AD and p-value are greater than α(0.05); therefore, the normal behavior of the data was confirmed for analysis. It was observed that, with a confidence level of 95%, the mean and standard deviation revealed normal results in the data of the research indicators.

Table XI. Summary of Results for Parametric Indicators

Indicator	n	95% confidence intervals for mean	Kurtosis	Asymmetry	Q3
I1: Posprueba (Ge)	30	4.3817-5.9517 hrs	-0.932968	0.265541	6.25
I2: Posprueba (Ge)	30	5.1108-7.4225 hrs	-1.17636	0.13595	9.25
I3: Posprueba (Ge)	30	15.703-17.497 hrs	0.051545	-0.69238	18.25

The summary for each indicator in the table shows that, about 95% of the values are within 2 standard deviations from the mean, Kurtosis indicates that there are values with very low peaks, Asymmetry indicates that most values are low, 3rd Quartile (Q3) indicates that 75% of the values are less than or equal to this value.

For indicator I1: The importance of the time factor that is invested in learning with the intervention of some technology is highlighted in the research of Altamirano Di Luca and González Benítez (2020) obtaining as results when applying Cronbach's Alpha technique of 0.78, demonstrating a high reliability in the instrument, finally indicating that experts significantly value the indicators related to the time factor.

It is important to indicate that for a student learning a new group of words in English is of great help for the understanding of the language and to increase their academic performance, being essential to achieve a fluency of the English language and motivate to continue learning.

For indicator I2: The resultsare similar to those of the authors Lotero-Echeverri (2021) who in their research regarding the time factor for student learning with the intervention of a technological tool in a sample of 94 teachers, indicate that with the intervention of M-learning aimed at students, 39% of teachers totally agree that it improves learning time in students and 51.2% of teachers They agree. Máñez-Carvajal and Cervera-Mérida (2022) reported similar results in terms of reducing the time a student spends learning a new topic, determining that phonological skills allow for automation in reduced time for the basic processes of reading and writing in students suffering from learning problems through the development of a mobile application.

It is essential to point out the importance of learning a new topic of the English language in a student because it directly affects the academic performance they may have and the future understanding of the language.

For indicator I3: The authors Vega Velazco et al. (2022) reported similar results in their research with a sample of 73 students, obtaining that the group in which ICT was used efficiently and frequently the grades were higher than the general average of achievement, unlike the control group that obtained lower average results. Similar results were obtained by Morales Oviedo (2019) in his research with a sample of 31 students, obtaining that 94% of Ge students pass integral calculus when executing the implemented technological solution, a mobile application, called Solve Equations; compared to 76% of GC students who pass integral calculus. The results obtained by the authors Yánez Ortiz and Nevárez Toledo (2018) are similar with a sample of 26 students; they demonstrated a notable improvement in the mean of the grades between the experimental group and the control group. These results are similar to those of (Hidalgo-Cajo et al., 2021), with a sample of 31 students; they obtained Gc score values in a range of 1 to 4.5 points out of 10 and a notable improvement implementing the independent variable, technology with augmented reality, obtaining values of Ge grades in a range of 5.5 to 9.5 points out of 10. Tangarife Chalarca (2018), reported

similar results in their research, having as a population students with Down syndrome, they obtained as a result that in the knowledge component of numbers, first there was an average of 3.60 points and after the intervention of the mobile application this average increased to 4.18, demonstrating a significant improvement in the average of grades with the use of the mobile application for learning; the same happens with the addition and subtraction component.

For any course within an educational institution, academic performance is the most predominant indicator, so it is important to propose solutions to increase the interest of students and their learning, as well as the time they invest to learn.

B. With Inferential Statistics: Hypothesis Testing

Table XII and Table XIII show the values of the application of statistical tests for the contracting of hypotheses.

Table XII. Hypothesis Testing for Parametric Indicators

Indicator	n	H_0	t-value	p.valor
I1: Posprueba (Gc)	30	μ1 > μ2	3.83	0.00
I1: Posprueba (Ge)				
I2: Posprueba (Gc)	30	μ1 > μ2	2.33	0.012
I2: Posprueba (Ge)				
I3: Posprueba (Gc)	30	μ1 < μ2	-2.97	0.002
I3: Posprueba (Ge)				

Table XIII. Hypothesis Testing for Nonparametric Indicators

Indicator	n	H_0	w-value	p.valor
I4: Posprueba (Gc)	30	μ1 < μ2	570.00	0.00
I4: Posprueba (Ge)				

Since all p values are less than α(0.05), the results provide enough evidence to reject null hypotheses ($_{H0)}$, and the alternate hypotheses were true. The evidence turned out to be significant.

The author Mamani Humpiri (2021) reported similar results in his research with a sample of 154 students, obtaining as a result that a total of 81.82% students are moderately satisfied with the type of teaching applying technology, compared to 11.04% of students who are dissatisfied. These results are similar to those of Albornoz-Acosta et al. (2020) who worked with a sample of 176 students, obtained that 95% of students who participated in the flipped class indicated a good acceptance and showed that this methodology was useful for the teaching-learning process. Similar results were obtained by Márquez-Díaz and Morales-Espinosa (2019) in their research with a sample of 60 students, obtaining a 100% favorable student satisfaction with respect to the satisfaction of the interaction of the application with augmented reality, proving that it is of great help for the learning process of algebraic and transcendent functions.

It is crucial to have the student motivated for the teaching-learning process, this being essential

because of the negative effect it causes on the student's academic performance; That is why it is important to provide an excellent education service, innovate in teaching, as well as propose this research with the use of a multiplatform mobile application.

VI. CONCLUSIONS AND FUTURE RESEARCH

For the realization of this research work, it has been opted for the application of the Mobile-D methodology, this methodological approach used consists of the following 5 phases: Exploration, initiation, production, stabilization and testing; which has allowed an orderly, robust and optimal progress for the development of the project. Using Minitab software made it easy to analyze time indicators in learning a new group of words, a new topic, academic performance, and student satisfaction in 30 students. In addition, the mobile application was developed with recent technologies of the current market such as Ionic Framework and Angular Framework; this running on a server developed in Django Rest Framework with the programming language of Python and MySQL as a database; allowing to have an agile, fast, robust, safe and scalable product over time. The results have shown that having implemented a multiplatform mobile application, using the Mobile-D methodology, improves the teaching-learning of English in students of 1st year of secondary school at the I.E. Liceo Trujillo. For future research, 3D technology could be implemented for the images and somehow include artificial intelligence for better interaction with the end user.

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