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TÍTULO: CLASSROOM RESPONSE SYSTEMS

Trabajo de integración curricular presentado como requisito para la obtención del título de Ingeniero en Tecnologías de la Información

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Dedication

"To God, my father, my mother and my brothers."

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Abstract

One of the main challenges professors face during classes is students' low participation, which might be caused, among other reasons, by the discomfort of students to fail in front of their partners. This situation leads to unidirectional, monotonous classes, where the material is covered almost mechanically. This work proposes a new system developed from scratch called EasyQuiz-YT, intended to be used as a student response tool. It allows professors to interleave their classes with quizzes that students can answer, simultaneously and anonymously, through their mobile phones, thus promoting active learning while providing professors with immediate feedback. The application is currently a finalist in the Latin American tournament TuApp. We also include the design of an experiment to measure the impact of EasyQuiz-YT on variables such as students' attendance, academic performance, and motivation of both professors and students. EasyQuiz-YT is composed of (1) a web-based system through which professors can enter their quizzes and release them during their classes in a timely manner, and (2) a mobile-based system that allows students to answer the quizzes without feeling the anxiety of failing in public.

Keywords: Classroom Response System (CRS), Android, EasyQuiz-YT, Web Application, Mobile Application, Students, Professors, Attendance, Participation, Motivation.

Resumen

Uno de los principales retos a los que se enfrentan los profesores durante las clases es la baja participación de los estudiantes, lo que puede deberse, entre otras razones, a la incomodidad de los estudiantes de fallar frente a sus compañeros. Esta situación conduce a clases unidireccionales y monótonas, donde el material se cubre casi mecánicamente. Este trabajo propone un sistema nuevo desarrollado desde cero llamado EasyQuiz-YT, destinado a ser utilizado como herramienta de respuesta de los estudiantes. Permite a los profesores intercalar sus clases con cuestionarios que los estudiantes pueden responder, de forma simultánea y anónima, a través de sus teléfonos móviles, promoviendo así el aprendizaje activo y proporcionando a los profesores una retroalimentación inmediata. Actualmente la aplicación se encuentra como finalista en el torneo latinoamericano TuApp. También incluimos el diseño de un experimento para medir el impacto de EasyQuiz-YT en variables como la asistencia de los estudiantes, el rendimiento académico y la motivación tanto de profesores como de estudiantes. EasyQuiz-YT se compone de (1) un sistema basado en la web a través del cual los profesores pueden ingresar sus cuestionarios y liberarlos durante sus clases de manera oportuna, y (2) un sistema móvil que permite a los estudiantes responder los cuestionarios sin sentir ansiedad de fallar en público.

Palabras Clave: Sistema de respuesta en clases (CRS), Android, EasyQuiz-YT, Aplicación web, Aplicación móvil, Estudiantes, Profesores, Asistencia, Participación, Motivación.

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Chapter 1

Introduction

1.1 Problem statement

One of the main problems evident in both schools and universities is the little motivation that the students show to answer the questions carried out by their professors. One of the causes may be the discomfort of giving an incorrect answer in public. This situation leads to monotonous, unidirectional, little or no interactive classes, where the instructor has little opportunity to identify the degree of difficulty that students may have in their subjects. One of the most common approaches intended to increase the attentiveness to lectures is Classroom Response Systems (CRSs).

A CRS is a pedagogical tool that allows two-way communication (generally employing radio frequencies) between an instructor and a group of students. The most common implementation of a CRS takes the form of clickers. Physically, a clicker looks like a TV remote control that students can use to answer their professors' questions anonymously. With clickers, the instructor can assess precisely how well the class is grasping complex material and clarify misinformation immediately [1].

The use of clickers in classes involve three steps: (1) Instructors present multiple-choice questions, (2) Students click in their answers using remote transmitters, and (3) The results are collected, tabulated, and sent to the instructor, who can view, save, and (if he wishes) display them for the entire class to see.

So far, the most used CRSs are clickers, but it is necessary to know the limitations that these have. First and foremost is the cost. Everything needed, from the hardware and configuration to installation and maintenance, could be significant, especially for a school. Besides, clickers are quite limited in their features; there is little variety in the questions; some only have multiple choice and short answer questions. Currently, there are other alternatives to traditional clickers, specifically online platforms, that provide at least all the features a clicker has at a lower cost and without the hassle of hardware installation and maintenance.

The tool proposed in this thesis, EasyQuiz-YT, is a CRS implemented as an online platform that promotes interactivity, allowing professors to interspersed their classes with short questions (quizzes) that can be answered anonymously and simultaneously by all students through their smartphones. The students' answers are aggregated and shown to

the professor in the form of statistical diagrams. Based on these statistics, professors can decide to move on to the next topic, reinforce the current topic, or repeat a whole class.

Broadly speaking, EasyQuiz-YT consists of a website that works in conjunction with a mobile application. Through the website, instructors can formulate four types of questions; (1) true/false, (2) short answer,(3) multiple-choice (single answer), and (4) multiple-choice (multiple answers), which are then sent to an application that runs on students' smartphones. Through these apps, students are enabled to send their answers back to the website without feeling the anxiety of giving a wrong answer in front of the class.

With EasyQuiz-YT, universities avoid the cost of buying clickers since the functionality of these artifacts is emulated in the mobile application that students must download freely from the cloud.

There are other online platforms such as Moodle, Google Classroom that are used for similar purposes. The most notable difference of EasyQuiz-YT is that it allows to activate the questions gradually depending on the instructor. Another difference is that EasyQuiz-YT presents the answers to the instructor anonymously. Finally, the professor can obtain attendance reports after taking a quiz.

1.2 Objectives

1.2.1 General Objective

- To develop an online system to be used as a response tool in classes, allowing intercalating classes with questions posed by the professor, obtaining statistics of the students' performance at the end of each class, thus increasing the participation and attention of the students.

1.2.2 Specific Objectives

- To provide statistics of successes and failures immediately in the system, in this way, the professor can know if the students have assimilated the concepts presented or if it is necessary to insist on some part.
- To develop the user interface should be visually attractive, simple, and easy to use. In this way, the professor and the students will not waste a lot of time using it, thus contributing to the normal development of the class.
- To design and carry out experiments to verify that the system is applicable in the classroom and verify the impact and results mentioned in the general objective.

Chapter 2

Literature Review

2.1 Use of Technology in a Classroom

Information and Communication Technologies (ICT) have had an explosive development in the last part of the 20^{th} century and the beginning of the 21^{st} century, giving rise to what is called as "Knowledge Society" [2]. The activities that can be performed through ICTs in education are usually motivating for students due to their playful nature, the use of visual and auditory resources, among other advantages. Thus, it can be observed that many educational entities have invested in various ways to provide resources such as virtual libraries, adaptive learning and intelligent textbooks, just to name a few.

A few years ago, students could only access education in person. The students had large quantities of books and notebooks, and searching for information manually was much more time-consuming. Paper-based information was indispensable. Nowadays, technology has brought the possibility of studying online, which simplifies access to education in terms of time and place. Finding information is much easier and huge databases can be accessed quickly. In Latin America and the Caribbean, 31 out of 38 countries (82%) have adopted resolutions that use ICT in education. The initiative to introduce and use ICT in education has become a formal government engagement in 9 countries (24%). These include Anguilla, Bahamas, Barbados, Chile, Ecuador, Guatemala, St. Vincent and the Grenadines, Uruguay, and Venezuela [3]. The policies adopted by these countries have made it possible to adapt educational methods to the digital era, where there is a greater number of teaching and learning resources for both professors and students.

2.2 Uses of Technology by Educators

Professors integrate technology into teaching for a variety of reasons such as: promoting student engagement, to stay current, for hands-on interactive learning, to vary instructional methods, to perform labs and demonstrations, and for research and communication [4]. Some educators may not be familiar with technology so it is important to integrate easy-to-use technology.

Some cases in which instructors should use technological tools are:

- **Communication and information access elements**

  This is defined as the set of information exchange processes between the professor and the student. The objective of these elements is to carry out personal relationships and the teaching-learning process. Communication between professor and student is essential when a problem arises or when information needs to be clarified. In this sense, communication is vital to achieve the objectives and develop the competencies of a given subject. Still, it also enables more significant interaction, motivation, and participation on the part of the students and, ultimately, better and greater learning. Hence the importance of using strategies and tools to promote communication in the classroom, especially in virtual learning environments. These include learning platforms, e.g., Moodle, along with all its common features, e.g., news, chats, forums, etc.

- **Didactic tools** Didactic tools are used in the teaching-learning process. They have characteristics of multimedia, interactivity, and asynchronism, which favor motivation, attention to individual differences, cooperative and collaborative work, autonomous and continuous learning, self-evaluation, and control of the instructional and educational processes [5]. These include a multimedia projector, an interactive whiteboard, or a computer connected to the Internet.

- **Curricular content** The curricular content is a study plan, where the contents of the classes are structured and organized. Thanks to technology, the professor can use specific tools to make the chronology of his classes known. For example, google classroom can be linked to google calendar, alerting all the critical dates in the curricular plan.

2.3 Classroom Response Systems (CRSs)

A Classroom Response System is a system for responding to questions or problems posed by the instructor during class. These questions are answered in real time using specific clicker devices or generic devices such as desktops, laptops or smartphones [6]. The professor's computer receiver collects the data and can display summaries of the students' responses. The responses are also stored electronically for later viewing. CRSs are also referred to as classroom response systems, personal response systems, or audience response systems. It is one of many pedagogical tools an instructor may choose to integrate with other learning strategies.

2.3.1 Most used technologies for Classroom Response Systems

The most common CRSs are clickers, mobile-based platforms and web-based platforms.

Clickers

A clicker is a small, portable device that students use to reply to the answers proposed by the professor. Physically, it looks like a TV remote control; its buttons are labeled

with the standard options of multiple-choice questions, i.e., A, B, C, D, and E. Based on the professor's methodology and the availability of clickers, one clicker can be in charge of a student or a group. Clickers use radio frequency to send messages to a receiver connected to the professor's laptop. Though this was for years the most used CRS, it has the disadvantage of the cost. For instance, TurningPoint, a well-known clicker brand, costs approximately $28 for each clicker, excluding the cost of the receiver. We expect to eliminate the cost of clickers through the development of an application that serves the same purpose but can be freely downloaded to students' devices.

Mobile platform

A mobile-based platform is an online service that provides a just-in-time training, learning, and evaluation methodology, supported by the latest mobile technology. Poll Everywhere is an example of a mobile platform, which can be downloaded from the online store after paying a fee. Professors can use this tool to make questions directly from their presentations, either in PowerPoint or Google Slides. On the other hand, students can use their mobile devices to answer the questions posed by the instructor. One disadvantage of tools like Poll Everywhere is that they force the professor to formulate questions right before sending them to the students. Thus, the professor must use some minutes of the class to write down the questions on his mobile phone, which is tedious and discouraging.

In contrast, the proposed EasyQuiz-YT enables the professor to write the questions at any time and day, probably at home, and activate them during the class. Additionally, unlike Poll Everywhere, EasyQuiz-YT does not necessarily display all the questions at once. The professor can enable/disable each question of the quiz independently, in a timely manner.

Web platform

It is a web service that allows professors to formulate quizzes for their students. Kahoot is one example of an CRS web-based tool. Within this tool, the professor can define a time for each question. At the end of the quiz, Kahoot only shows the three highest scores of the class, which might not be too insightful for the professor.

Our EasyQuiz-YT proposal, on the other hand, shows a greater variety of statistics, including results per student and per group. EasyQuiz-YT can also save these statistics for posteriority.

Another difference is that Kahoot allows students to log in with any username, making it difficult for the professor to track students' attendance. As said before, EasyQuiz-YT enforces students to use institutional email when creating their usernames.

2.3.2 Advantages of Classroom Response Systems

- Incorporating CRS activities in the classroom can help keep students more active. When listening passively, the average individual's attention span is quite short [7], so it is a challenge for professors to keep students attention during a lecture. However, by simply inserting some CRS-related activities during the lecture, instructors can keep students attention and increase participation [8].

- It encourages student participation in class. Instead of the instructor asking verbal questions and not receiving participation from students who are uncomfortable expressing themselves in public, the instructor can embrace the benefits of an CRS so these students can respond in a silent manner and even anonymously.
- It promotes dialogue in the classroom; it is a support tool for group discussion [9].
- With CRS, it is unnecessary to wait for assignments and tests to reveal the student's understanding; instead, instructors can ask questions during class and thus determine their knowledge through CRS.
- If the results of an CRS activity show that many students chose the wrong answer to a question, then the professor can provide real-time feedback [10]. In addition, instructors can refine their methods immediately, if necessary, by adjusting the pace of their presentation or providing further clarification. Similarly, if the results obtained show that most students answered correctly, the instructor knows that their instruction has been successful and can proceed further.
- A benefit of having active learning and feedback in the classroom is that students and instructors can improve reflective, discursive, and adaptive activities. At the same time, a particular topic is still fresh [11].
- For the professors, the advantages of CRSs are numerous: grading is automatic, their use encourages attendance, the need for review, or the possibility of skipping material can be easily evaluated [10]. Of course, classes become more dynamic and entertaining. This way, it increases student interest and fosters a positive relationship between the professor and the students. CRSs are novel and sophisticated tools that, when used properly, will help professors turn around classical learning systems that, in many cases, are neither dynamic nor motivating for students. The use of CRS in the classroom is part of the pedagogical innovation that leads to changes in learning or training that produce favorable results.
- Another advantage is the possibility of checking attendance in classroom through the software. Students who know that their professor will use a CRS to turn in questions or quizzes in class are more likely to attend class, as they know there will be a digital record of their presence and participation.

2.3.3 Disadvantages of Classroom Response Systems

- Integrating CRS into the class schedule requires a great deal of time that professors must anticipate. When some dialogue or discussion is accomplished, the time consumed is more considerable. In addition, the instructors need some time to design questionnaires [12].
- Technical support problems can occur, such as malfunctions, loss, or incorrectly recorded. Interruptions in wireless signals, glitches in software can render the system inoperable. Such events, however rare, require the attention of a staff technician [13].

- One particular disadvantage of clickers (not CRSs in general) is the cost. Since clickers are single-function devices, the price may be an issue compared to their intended use. The cost of receivers and software is approximately $1000 per 100 students in a classroom [14].
- The professor, on the other hand, needs to learn how to integrate the system into the lecture format of the computer system, which may be undesirable for some professors [15].

2.4 Reviews on the Classroom Response Systems

Comparing success and engagement in gamified learning experiences via Kahoot and Quizizz [16]

Orhan and Gürsoy conducted a study that aimed to investigate the effects of Kahoot and Quizizz used as assessment tools for student's academic performance and engagement. Kahoot and Quizizz are platforms that are used as CRS and work both mobile and web-based. Kahoot is used for real-time formative assessments, quizzes, and classroom discussions. Quizizz uses techniques that transfer the mechanics of games to the educational-professional environment, which is known as gamification. According to Shute Spector (2010), the use of gamification as an evaluation tool allows us to observe the motivation of individuals, monitor their emotional and metacognitive traits. The objective of this study was to determine the strengths and weaknesses of these gamification experiences through two different tools. The study participants included 97 pre-service professors who took scientific research methods SRM course in Adıyaman University.

The experiments involved three groups: Group A, composed of 30 students, used Kahoot as the designated CRS. Group B, composed of 33, used Quizziz. Group C, cimposed of 34 participants, did not use any CRS; it was the control group. The study last one full semester. All the participants were students of the SRM course in Adıyaman University, Faculty of Education during the 2017-2018 academic year.

The experiment measured two variables: academic performance and student participation. Data were collected using the following tools: An academic achievement test, developed to compare academic achievement on the content of the initial six weeks of the SRM course, and a student engagement scale developed by Günüç and Kuzu (2015).

In the final stage of the experiment, qualitative data was also collected by means of interviews with participants of each group and the opinion of the professors regading the use of CRS.

The findinds of the quantitative study suggested that gamification affected students academic performance and participation in the scientific research methods course. Also, it was observed that the impact of Kahoot on students' academic performance and participation was higher compared to that of the control group. On the other hand, the educational activities that were performed with Quizizz were less effective compared to the control group. Finally, with regard to students' preferences, it was determined they wanted to use both Kahoot and Quizizz. The reason is that students seem to have a need for strong stimuli or willingness to receive immediate feedback on how well they performed on the

test.

Using the iClicker Classroom Response System to Enhance Student Involvement and Learning [17]

Whitehead and Ray, in 2013, conducted a study on iClicker as a classroom response system to learn about the impact on student learning. iClicker is a wireless response system and resembles a remote control, invented in 2005 by a team of physicists at the University of Illinois, allowing students to respond to questions posed by their instructors instantly. The instructor first presents a multiple-choice or true/false question on a Microsoft PowerPoint slide to solicit student responses, then starts a timer allowing student responses to be registered. iClicker must be installed on the instructor's computer to perform the interactive presentation, and the USB receiver that collects the answers must be plugged in. After the questions are formulated, iClicker compiles a report containing the students' responses in different forms: histograms, graphs, percentages, etc.

The study involved the two instructors who taught four different groups of "Introduction to Information Technology" during the Spring 2009 semester. The first two groups of 43 students were given iClicker during their class. The other two groups, of 50 in total, did not use any CRS tool.

The instructors developed a set of 5 to 14 questions per lecture with a median of 8 questions to find results. These questions were presented via PowerPoint presentations and answered orally in the last two groups, and via iClicker, in the first two groups. Through these surveys, it was found that students in the two sections that used iClicker received significantly higher grades than the course sections that did not use iClicker. Therefore, the results of this study provide evidence that the use of iClickers had a positive impact on student learning during the course. These results are supported by the number of students who passed the course in the sections where iClickers were used.

Effectiveness of student response systems in terms of learning environment, attitudes and achievement [18]

This third study wants to know the effectiveness of an CRS in terms of (a) the learning environment, (b) the students' attitudes, and (c) the students' performance. For the evaluation of the students' opinions about (a) and (b) the questionnaire called; "How do you feel about this class?" (HDYFATC) was used, which incorporates numerous WIHIC scales, a TOSRA scale that is composed of 70 items related to attitudes towards science.. The response alterations for HDYFATC items were Strongly Disagree, Disagree, Not Sure, Agree, and Strongly Agree. For evaluating the last variable (c), performance tests and examinations were made during the study. In the end, the professor determined an average score based on each test and exam grade.

Data were collected from 1097 science students from 47 southern New York State classes. The study involved comparing two instructional groups (CRS and non-CRS). The CRS group consisted of 532 students and 565 students in the non-CRS group. To minimize the teacher as a variable in the study, each teacher involved used CRS in half of their classes but not in the other half. The amount of time during which CRS was used was approximately four months.

The study's findings suggest that the use of CRS in science classrooms can help improve students' perceptions of the learning environment, their attitudes toward science, and their achievement. Comparison of the CRS and non-CRS groups revealed considerable differences of 1.17-2.45 standard deviations for seven learning environments, attitude, and achievement criteria.

Student perception on a student response system formed by combining mobile phone and a polling website [19]

In 2016, Wong conducted a study on student perception on a CRS formed by combining mobile phones and a polling website. The study was conducted at the School of Professional Education and Executive Development, Hong Kong Polytechnic University. The CRS was used in 12 classes over 6 weeks. Thirty-five questions were asked and 1,155 responses were received.

For data collection, a survey was conducted using an online questionnaire. The survey was conducted in a computer lab where students completed the questionnaire anonymously on a website. The surveys showed that out of 39 students 85% prefer a mobile phone as an CRS tool, while 5% prefer a tablet and 10% prefer notebook computer. Other results determined that students respond best to true/false questions, which have the highest response rate of 68%. Students are also willing to answer multiple choice questions, whose response rate is 56%. However, less than half of the students responded to the open-ended questions. The low response rate for the open-ended questions is due primarily to the fact that many students did not follow the instructions and used more words than allowed by the question. Second, there are grammatical and/or spelling errors in the answers.

Thanks to a final ten-question questionnaire that measured the perception of an CRS, it proved feasible to combine students' cell phones and the PollEveryWhere polling website to create an effective CRS. Students also agreed that it made them more attentive and made classes more interesting. Overall, this study found that students had a very positive perception of the CRS, although the author recommends that studies of this type be made for large lecture classes since most studies focus on courses that are not as large.

2.5 Correct formulation of questions

The findings demonstrate that the key to successful CRS implementation resides in developing effective questions and the enactment of questioning (grade-linked, with follow-up; appropriate answers, probing questions, or discussions).

According to Bruff, there are several types of questions used for different purposes in class [20]. Here are a few types of questions for CRS:

Recall Questions: These kinds of questions invite students to remember concepts. It is used to know if the student remembers previously viewed topics. However, these questions rarely generate discussion, and do not require higher-order thinking skills.

The following is an example:

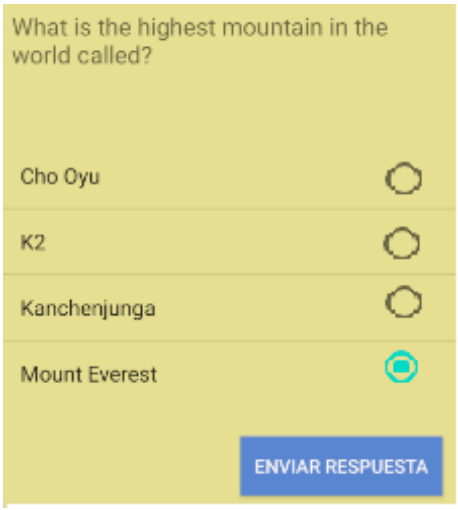


Figure 2.1: Example of Recall Question

The above question cannot be refuted in any way. Thus, no debate is generated, and there is only one correct answer. So choose the multiple-choice question type in its single answer version.

Conceptual Understanding Questions: These questions assess students understanding of essential concepts and help professors identify and address misconceptions.

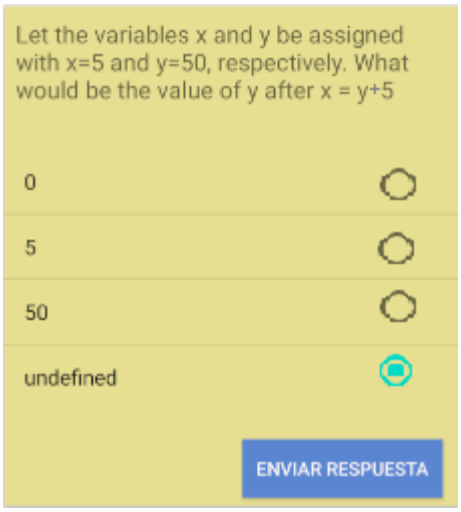


Figure 2.2: Example of Conceptual Understanding Question

The correct answer is 50. The variable y does not change its original value since it has not been updated. However, solutions like 0 or undefined will reveal that students are confusing variable assignments with mathematical equations. A high number of these answers must motivate the professor to talk about this misinterpretation explicitly.

Application Questions: These questions require applying concepts, usually asking the student to make a decision, connect the content to the "real world," and use procedures

(see Figure 2.3 for an example).

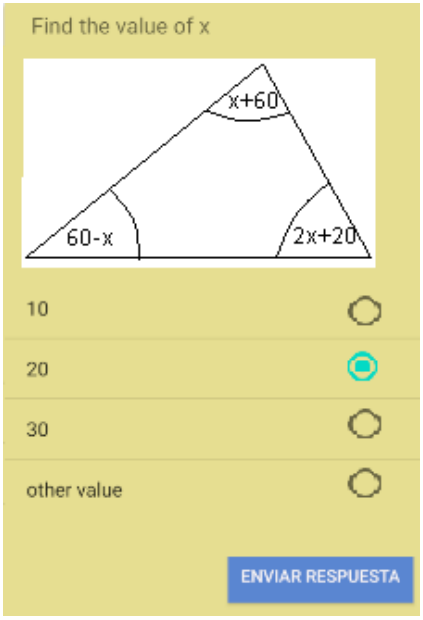


Figure 2.3: Example of Application Question

Assuming that students have been taught that the sum of angles in a triangle is 180, the aforementioned question allows them to apply such knowledge by doing (2x+20)+(60-x)+(x+60)=180, from where it is obtained that x=20.

Critical Thinking Questions: These questions require students to analyze concepts or evaluate concepts based on personal criteria. Often these questions are open-ended. Also, it can be very effective in preparing students to engage in class discussions about their reasoning (see an example of this question in Fig. 2.4)

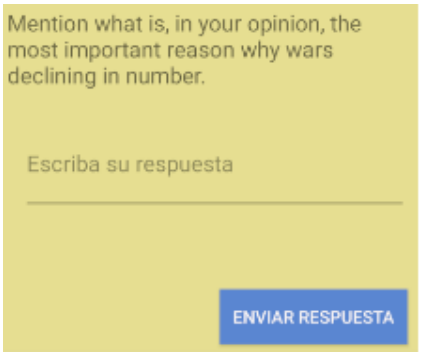


Figure 2.4: Example of Critical Thinking Question

This open question will definitively motivate discussion. Some may answer that wars are too expensive; others that people are more rational and less aggressive; others that international organizations impose sanctions against offenders, which is discouraging; others may even put into question the decline of wars and mention that wars have changed their

original form to new ones, such as biological war or cyber war, etc. After sending their answers to the professor, students will naturally be curious about their neighbor's answers, which will be a fertile ground for discussion. On the other side, the professor can quickly overlook all the answers and discuss those that he considers more relevant.

Student Perspective Questions: These questions invite the student to share personal experiences. The answers will be open-ended; since there is no correct answer, it is helpful to know each student's perspective on ethical, legal, or moral issues (see an example in Fig. 2.5). For these questions, it is best to opt for anonymity.

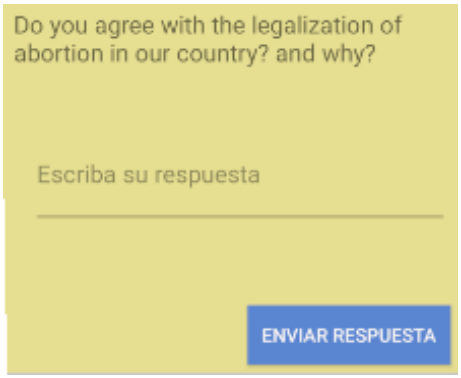


Figure 2.5: Example of Student Perspective Question

In the previous example, the student is invited to show their perspective about a sensitive or controversial topic, thus generating a link. Researchers can use these types of questions to generate statistics and understand trends.

In conclusion, the different perspectives and points of view on an issue and the reasons for these positions are clarified.

Chapter 3

EasyQuiz-YT

3.1 System Architecture

EasyQuiz-YT is composed of two subsystems. The first is a mobile application that is intended to run on an Android device. The students are to be the users of this application, which will be utilized to read and answer to the professor's questions. The second subsystem is a web application that is intended to run on the professor's laptop. From this web-based application, the professor will be able: (1) to write and release the questions that the students are expected to answer, and (2) to receive students' answers. We do not expect the professor to formulate the questions during the class; he is able to do it at home and to enable the questions for students during the class, at a timely manner. Both subsystems interact with an Apache server through PHP commands, as shown in the following figure:

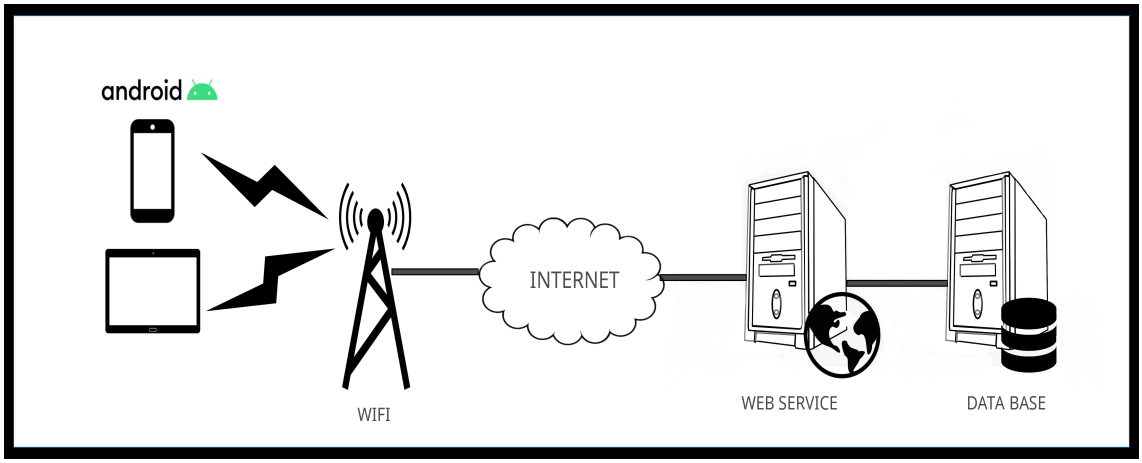


Figure 3.1: System Architecture

3.1.1 System Vulnerabilities

We know that no system is exempt from attacks that could make it vulnerable. Among the most common attacks in which the system could be vulnerable is the server crash that

could be produced by a wide range of causes, both internal and external; hardware failure, network problems, viruses, trojans and even sabotage. One of the most common of all is system overload, generally due to high traffic on the website in question. In this case it is necessary to implement a solid security plan containing organizational and personal measures, as well as protection against external threats. Technically, prevention consists of providing redundant hardware to ensure high availability of information, or to bridge periods of suspension by means of standby systems. To protect the information, the data must be secured by means of various software whose function is to make backup copies to recover the information if necessary, as well as by a redundant storage architecture.

Another of the most common attacks in which the system could be vulnerable is the authentication and authorization of users, that is why we have implemented the following technique.

Security and authenticity

For registration and authentication, users must register with their institutional email address through which their identity can be verified. It should be noted that only emails that contain the domain of the institution that is using the CRS will be entered in register form. This domain will be registered in the database beforehand. The account will be validated only if you access the link that will be sent to the registered institutional email. This link contains the institutional email and a unique hash code generated for each user (e.g. `http://server/easyquizyt/verify.php?email=jorge.fernandez@yachaytech.edu.ec&hash=07a96b1f61097ccb54be14d6a47439b0`). In this way the user will only have access to the EasyQuiz-YT account if the institutional email with which he/she registered is confirmed through the validation link, otherwise the account will not be validated. Invalid accounts cannot use the application.

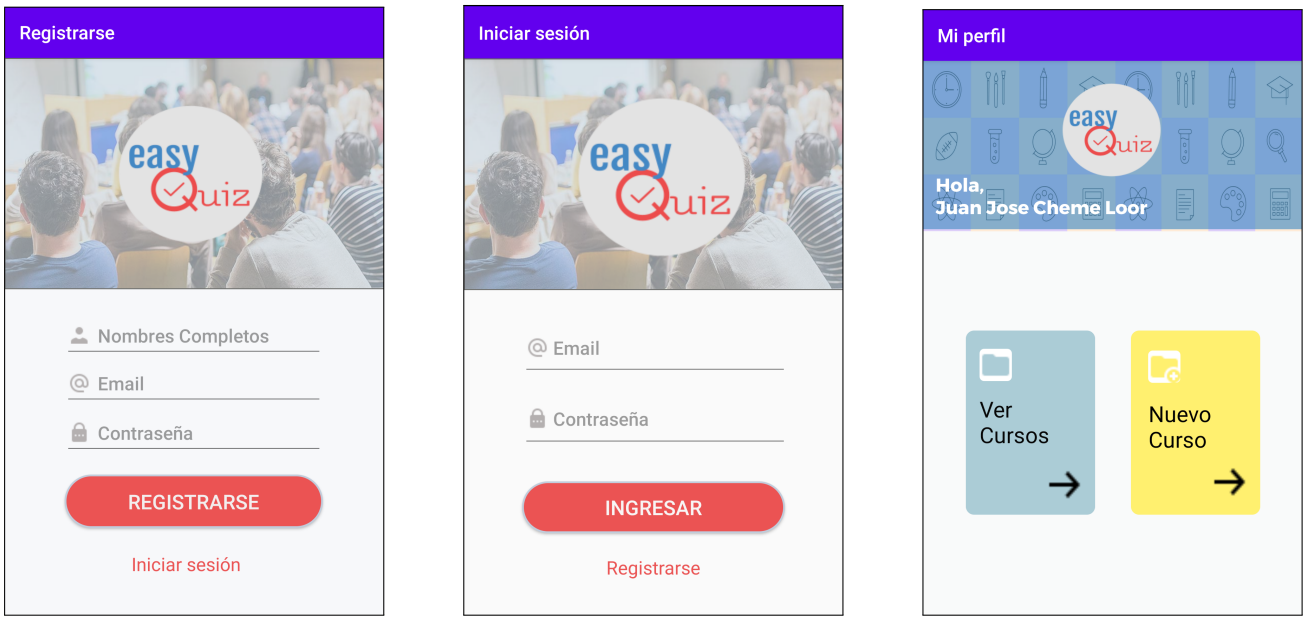
3.2 Workflow System

3.2.1 Mobile Application

Below we describe the functionalities of EasyQuiz-YT's mobile application.

Creating a new account

The creation of an account is required to use the application. To register, the student must introduce his full name, his email, and a password (Figure 3.2a). These three entries are stored in the database and will be essential for the student to log in later. After registration, the student can log into the system through the interface shown in Figure 3.2b. Here they can enter the email address and password used in the registration phase. After logging into the system, the student will reach a form called Student's Profile (Figure 3.2c). This is the central part of the mobile application. From here, the student will be able to (1) see a list containing all the courses that are using EasyQuiz-YT and (2) to add a new course to the list. The former is achieved by clicking on the "VER CURSOS" button; the latter, by clicking on "NUEVO CURSO."



(a) Registration form (b) Login form (c) Student's profile

Figure 3.2: Login forms to access the system environment

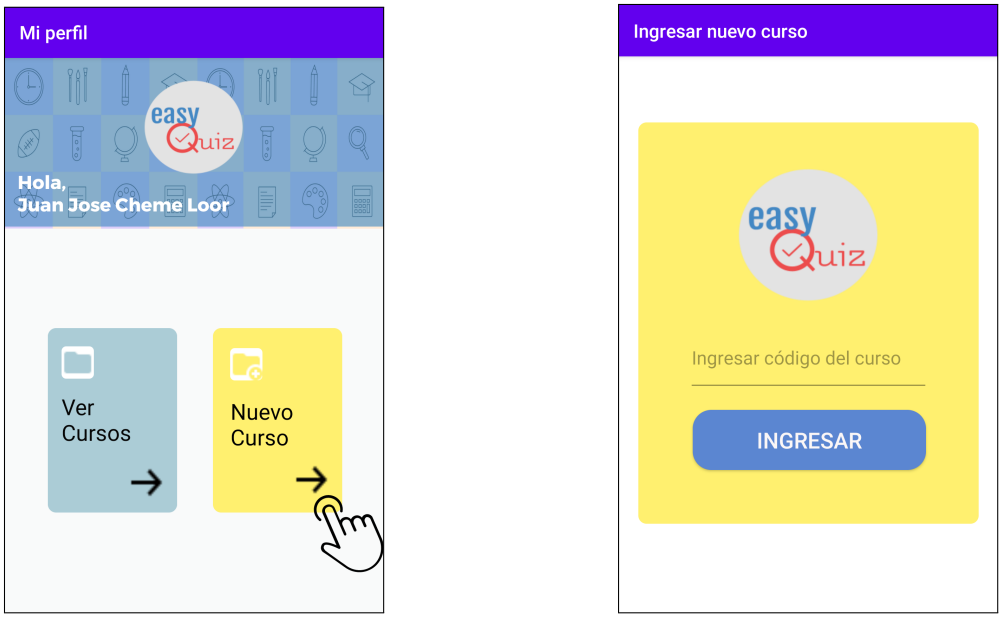
When navigating the list of EasyQuiz-YT-based courses, EasyQuiz-YT will show the course name, professor name, and the creation date of each course (Figure 3.4b). The student can access any of these courses by just double-tapping on its name. By doing so, one can find the questions that remain pending for answer in that particular course. This way, EasyQuiz-YT provides a desirable organization and prevents questions from different courses from being mixed. Every time the professor delivers a question and asks students for an answer, the students are expected to find that question along with a choice menu through the course list. In our approach, the professor is expected to use the web side part of EasyQuiz-YT to feed the questions along with their choice menus into the system before the class, probably at home

Registering a course

At the beginning of each term, the student has to register for the courses that will require EasyQuiz-YT. This can be achieved by clicking on the "NUEVO CURSO" button (Figure 3.2c). To register a new course, EasyQuiz-YT will require a course code. The professor will provide the code in person, the first day of class; the registration code will be disabled at the end of the first class. This is to prevent people out of the course to infiltrate, perhaps with malicious intentions. The professor does not arbitrarily choose the course code since this could cause crashes, i.e., two professors accidentally choosing the same code. Instead, the code is randomly generated in the website part of EasyQuiz-YT so that a code is never generated twice. The student does not have to memorize the registration code either; he will never use it again. Later, he can access the quizzes of his courses by means of a graphical menu.

More precisely, by clicking on the "NUEVO CURSO" button (Figure 3.3a), the student will be able to add a new course that is to be supported by EasyQuiz-YT. The registration

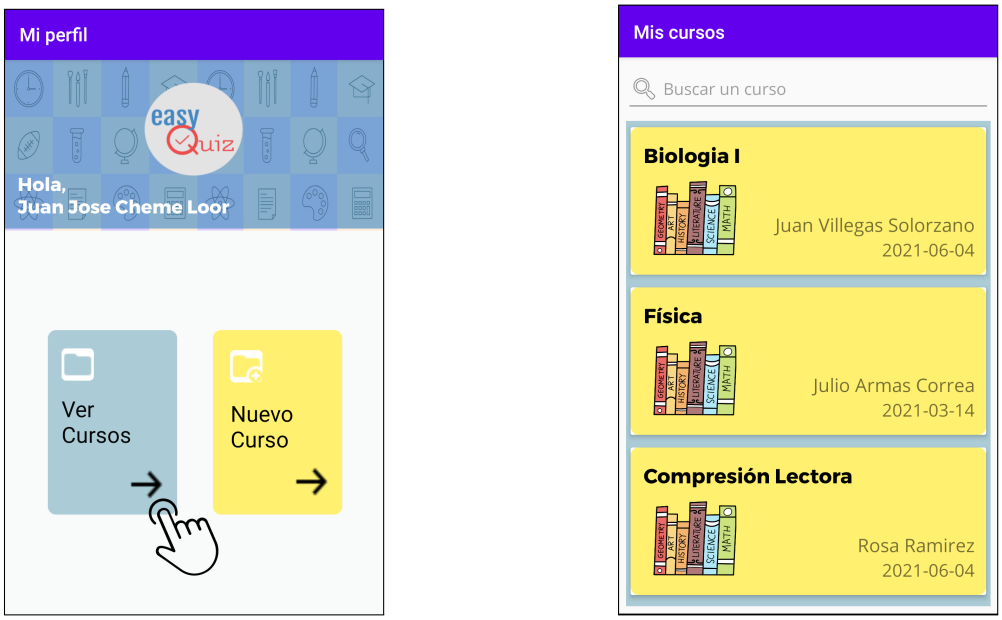
code provided by the professor must be entered into a text-box as shown in Figure 3.3b.



(a) Student's profile (b) Registration code entry form

Figure 3.3: Registration of a new course

Once a course is registered, it will appear in the list of courses shown in Figure 3.4b, from where the student can access the quizzes.



(a) Student's profile (b) Course list

Figure 3.4: Flow to view the student's course list

Checking quizzes of a given course

In order to access the quizzes of a given course, the student has to navigate the list of EasyQuiz-YT-supported courses and double-tap on the appropriate one (Figure 3.5a). Once inside a course, the student can see all the quizzes available for such a course (Figure 3.5b).

From the list of available quizzes one can see:

1. an identifying quiz code
2. the quiz name
3. the course code
4. creation date of the quiz

By tapping on a quiz, the student can access the question he must answer.

(a) Course profile (b) Quizzes list

Figure 3.5: Flow to enter a specific course

Entering a quiz

By clicking on one of the quizzes, a form is displayed with all the questions contained in the quiz. In Figure 3.6, for instance, the quiz contains four questions; each belong to a different question type.

EasyQuiz-YT provides professors with great flexibility by offering four different question types:

1. True/False questions,

2. Short answer questions,
3. Multiple choice question in its two variants:
   (a) with multiple answers, and
   (b) with a single answer.

The response form will change depending on the type of question. However, regardless of the question type, the response form always has an "ENVIAR RESPUESTA" button. When tapping on this button, the answer is sent to the server and becomes available to the professor. This button is disabled after being clicked.

Types of questions supported by EasyQuiz-YT

1. **True/False questions**
   With true/false question types, students choose whether a statement is true or false, as in Figure 3.4a. These types of questions test the most basic level of knowledge. True/false questions do not test their ability to recall information or demonstrate comprehension [21]. These types of questions are the most popular because they are easier to create and grade from the professor's perspective [22].

2. **Short answer questions**
   The short answer question type cannot be answered with a yes or no, nor is it limited to a set of options as in multiple-choice. In a short answer question, the student writes a word or phrase in response to a question (Figure 3.4b). This type of question is both informative and descriptive. Short answer questions are a great middle ground for professors. They are easier to develop than multiple choice and generate a more in-depth answer. Because of their brevity, they are easier to grade and encourage students to integrate information into a coherent written answer [23]. This is certainly the type of question that should be encouraged in the classroom. With this type of questioning, students' awareness is fostered and responsibility for answers is increased.

   This type of questions can be used to ask the students to deduce the value of variable from a given code snippet or given a mathematical equation, for instance.

   The student must type his response. The system is configured to ignore uppercase characters.

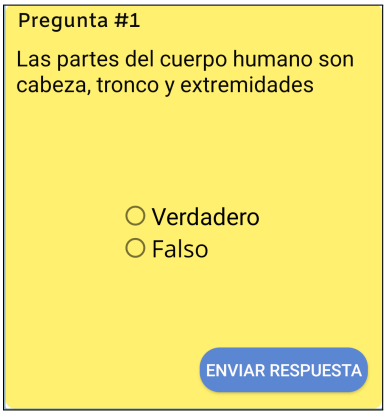
3. **Multiple choice questions**
   A multiple-choice question consists of a problem known as the stem and a list of suggested solutions, known as alternatives. The alternatives consist of one correct or best alternative, which is the answer, and incorrect or inferior alternatives, known as distractors [24]. This type of question provides the following benefits [25]:

   - They make assessment more reliable .
   - They make marking far less labour-intensive.
   - They make pupil understanding more visible to professors.

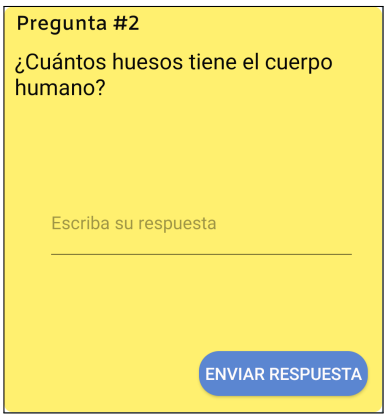
There are two types of multiple-choice questions: single answer and multiple answers. Multiple choice (single answer) questions will only allow the student to select one answer (Figure 3.6c). In contrast, multiple choice (multiple answers) questions will enable the student to choose multiple answers (Figure 3.6d).

(a) **Multiple Choice (Single answer)**: Multiple choice questions are among the most effective ways to test learners on the content of an eLearning course. They present several possible answers to a question, only one of which is right. [26].

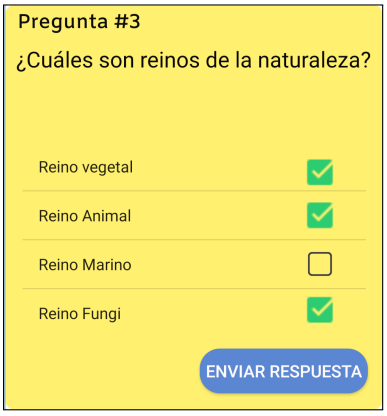
(b) **Multiple Choice (Multiple answers)**: These questions allow you to select one or more answers employing check-boxes instead of radio buttons. Each answer can have a positive or negative score, which implies that all the correct options must be chosen to obtain a positive score. Through the web-based system, the professor defines the score for each answer option.



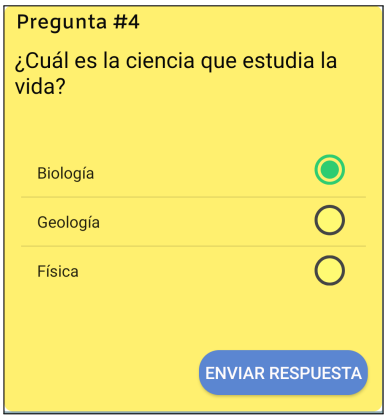
(a) True/False



(b) Short answer



(c) Multiple choice(multiple answers)



(d) Multiple choice(single answer)

Figure 3.6: (a) Question 1: True/False question type , (b) Question 2: Short answer question type, (c) Question 3: Multiple choice (multiple answers) , and (d) Question 4: Multiple choice (single answer)

3.2.2 Web Application

As mentioned before, EasyQuiz-YT offers a web side part. This is intended to be used by the professor. The reason for including a web application is that the professor might feel more comfortable by using his laptop to elaborate the quizzes than by using a small, error-prone cell phone keyboard. The first screen that EasyQuiz-YT users will see when entering the web application is the homepage (Figure 3.7). At the top, there is a menu that contains three options or items; (1) "Sobre Nosotros", (2) "Contactanos" and (3) "Crear/Iniciar sesión". The first two elements invite users to learn more about the system; how it works, its benefits, and contact information. User registration is essential before attempting to enter the system.

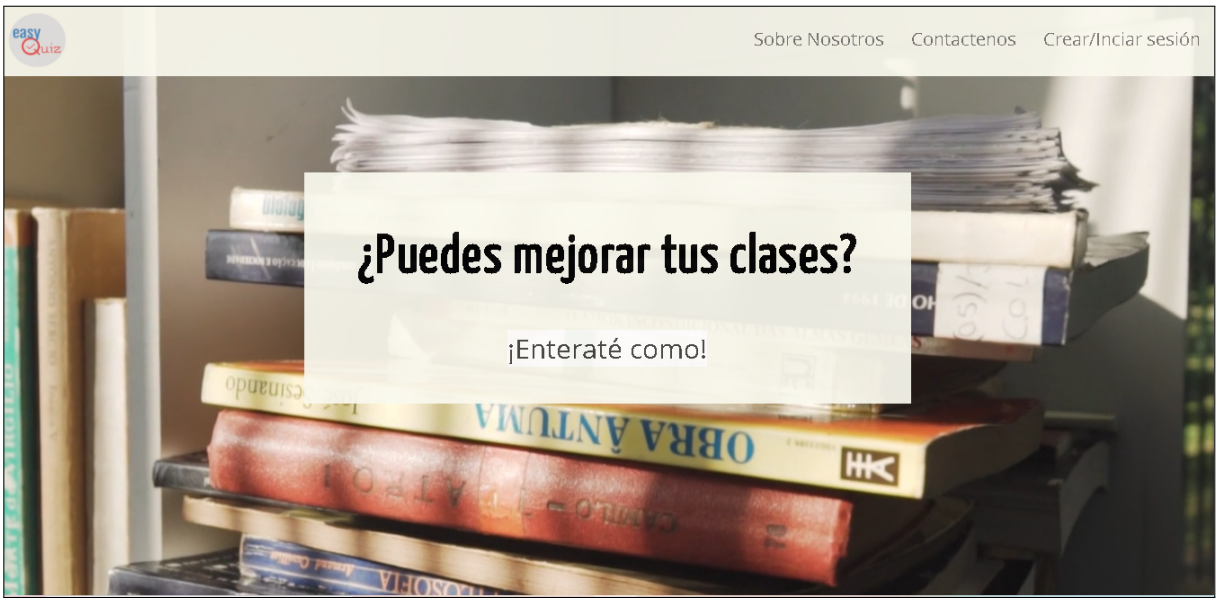
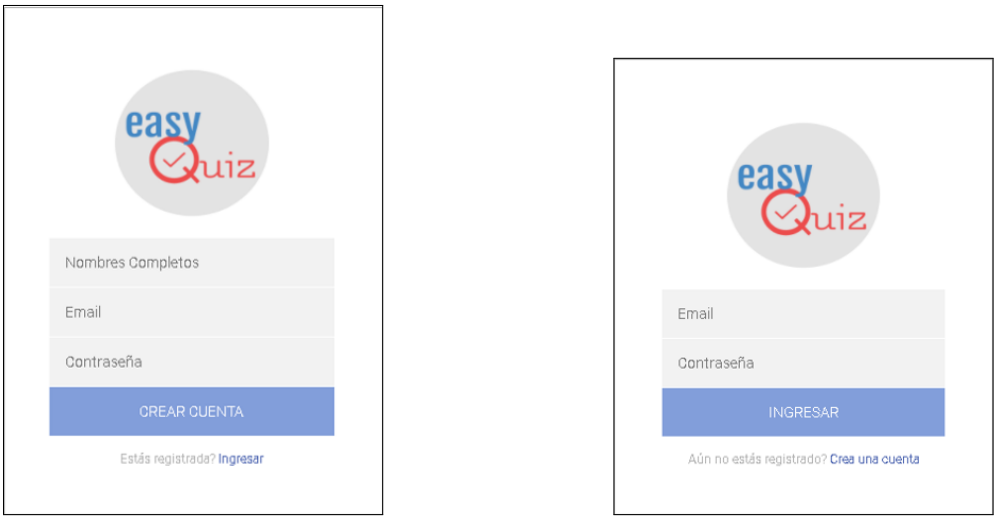


Figure 3.7: Homepage

Creation a new account

As with the mobile application, the professor has to create an account. This is a one-in-a-lifetime activity. For this, the professor must first register in the form shown in Figure 3.8a. The user obtains this form by clicking "Crear/Iniciar sesión" from the main menu. To register the professor must enter the following data: (1) his full name, (2) his institutional email, and (3) a password. The user must enter reliable information because a link for account activation will be sent to his email. Once the user's account is validated, he/she will be an active user.

After registration, the professor can access to EasyQuiz-YT's functionalities by logging into the system. The login form (Figure 3.8b) requires the email and password used in the registration process.



(a) Registration form (b) Login form

Figure 3.8: User registration and login forms

By logging into his account, the professor will enter into an environment call Professor's Profile from where he can manage the quizzes of his courses (Figure 3.9). This screen has a menu with three options. Each of the options is detailed below.

Figure 3.9: Professor's profile

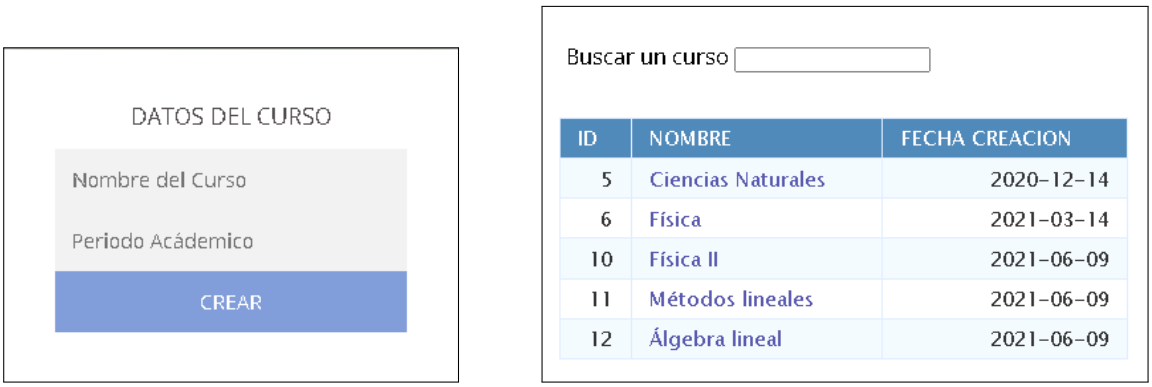
Registering a new course

At the beginning of a semester,the professor must register all the courses for which he will use EasyQuiz-YT. Since a professor usually teaches many courses, it is important to separate the quizzes for each course. Even more, a professor usually teaches the same set of courses every semester. Therefore, we can also avoid quizzes from different semesters to be mixed. For organization purposes, the quizzes formulated by the professor are grouped based on both the course and semester. To create a new course , the professor must choose

the option menu labelled as “Crear Curso”. This will lead to the form shown in Figure 3.10a.

To create a new course, the professor will be required two pieces of information: the course name and the academic period. This data will be saved in the database along with an identifying code (a self-increment number) and the creation date.

In the professor’s profile, specifically the course table (Figure 3.10b), we find information about his courses. For the identifier code, course name, and date of creation, the headers are “ID”, “NOMBRE”, and “FECHA CREACIÓN”, respectively. As mentioned before, the professor will distribute this course identifier code to his/her students, which is necessary for the course registration stage by the mobile application users (Figure 3.3b). When completing the form and submitting it, an alert message will be displayed saying that the course has been created successfully.



(a) Course register (b) Table of courses

Figure 3.10: User registration and login forms

When entering a specific course, the professor will have access to all the quizzes contained in that double-clicking on a specific course of the Table of courses (Figure 3.10b), the professor will find all the tools for creating and reviewing quizzes. Those tools can be accessed through the menu shown in Figure 3.11. In the centered table, you will find each quiz with its data such as id, name, creation date, and an option to delete the quiz.

Figure 3.11: Course profile

Creating a quiz

To create a quiz, the professor must click on the menu labelled as "Crear Quiz" (Figure 3.11. This will display a popup dialog box where the professor has to enter the course name. Then, the professor must choose the type of question he wants to use. As mentioned before, there are true/false, short answer, multiple-choice with single answer, and multiple-choice with multiple answers. The professor must define his question in a form that depends on the previously selected question type. The process can be repeated many times. This way the professor can add many questions, each of a different type, to the same quiz.

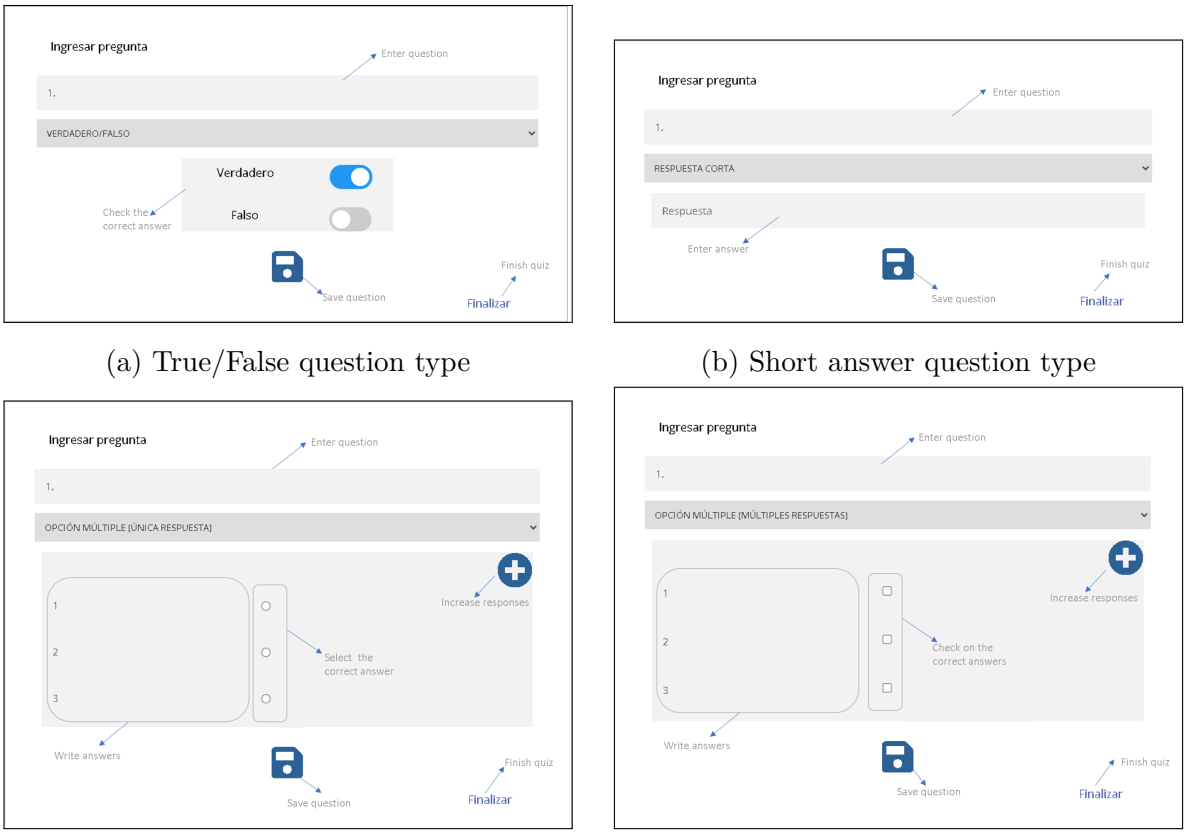
Formulating questions for a quiz

For true/false questions, the professor must enter the query statement and select to activate the switch that corresponds to the correct answer (Figure 3.14a).

For the short answer question type, the user will enter the question announcement as in all cases, and the correct answer will be entered in an edit text (Figure 3.14b). It is recommended that the answer entered be short.

The multiple-choice question type with a single answer will require the user to enter all possible solutions and mark the radio button only on the correct answer (Figure 3.14c). Note that the system will only allow the user to choose one right option.

Finally, with the multiple-choice questions with multiple answers, the professor will be able to enter as many answer options as they wish by simply clicking the add button (Figure 3.14d). In this case, the professor will choose as many correct options as he/she wishes by selecting the corresponding check-boxes.



(a) True/False question type

(b) Short answer question type

(c) Multiple option (single answer)

(d) Multiple option (multiple answers)

Figure 3.12: Forms for the four types of questions

Enabling the questions of a given quiz

Just as there is a profile for each course, there is also a profile for each quiz. The course profile (Figure 3.11) displays a list with all the quizzes for a given course. By double-clicking on a specific quiz, the system displays all the questions composing that quiz, the correct answer for each question, and the questions' status (enabled/disabled), as shown in Figure 3.13.

As can be deduced from the previous figure, the professor can enable the questions one by one, at the right moment of the class, using a toggle switch control.

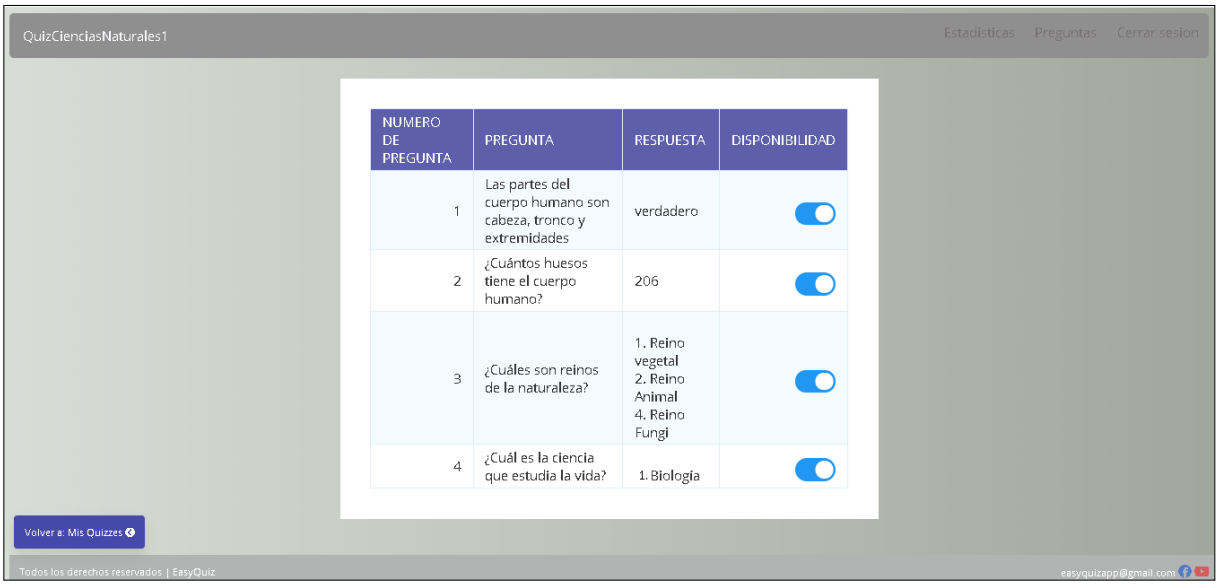
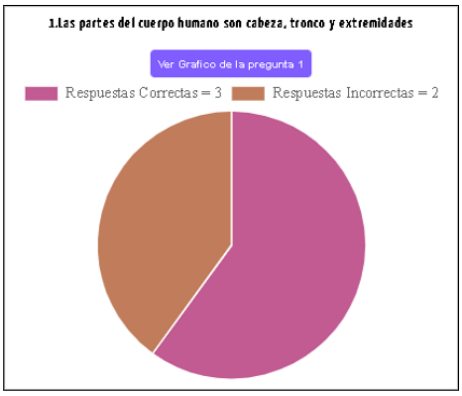


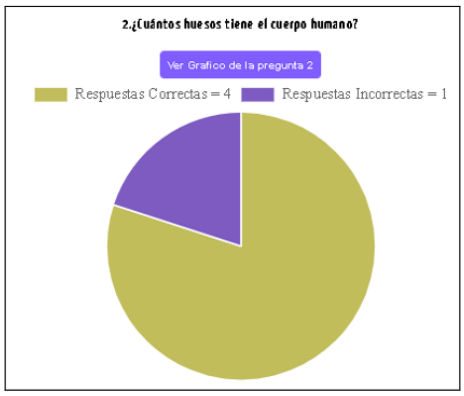
Figure 3.13: Quiz profile

Statistics

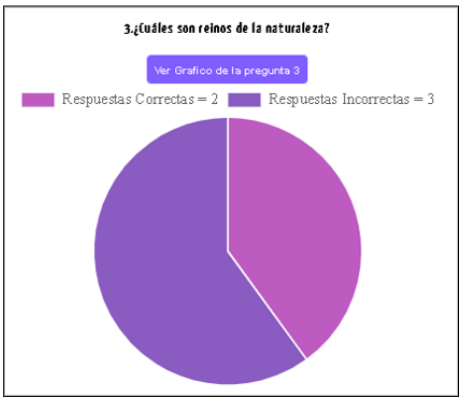
By clicking on the menu "Estadísticas", the professor will obtain statistical graphs for each of the questions (Figure 3.14). Each chart is divided into two sections; for the number of questions answered correctly and incorrectly. Through this option, the professor will have a clearer view of the shortcomings of his students and thus be able to provide more accurate feedback. Pie charts were chosen because they are intuitive and allow for quick representation of percentages and proportions. In addition, if the professor wishes, he can socialize these graphs with his students.



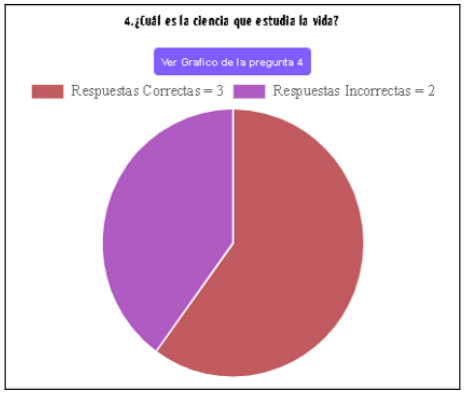
(a) Graph for the first question



(b) Graph for the second question



(c) Graph for the third question



(d) Graph for the fourth question

Figure 3.14: Pie charts four questions and six students

3.3 System Implementation

3.3.1 XAMPP

XAMPP consists mainly of the MySQL database, the Apache Web server, and the interpreters for scripting languages: PHP and Perl. The name comes from the acronym for X (for any of the different operating systems), Apache, MySQL, PHP, Perl. The program is released under the GNU license and acts as a free, easy-to-use Web server capable of interpreting dynamic pages. EasyQuiz-YT was built by using the XAMPP tools.

Benefits of XAMPP

- Stable, safe, fast and efficient.
- Simple and intuitive interface.
- XAMPP is an application easy to use.
- Support in different languages.
- Manual update.
- Support for installation / uninstallation.

3.3.2 Android Application

For the development of the mobile application, several points were considered, including the choice of the operating system (OS). Like a computer, a mobile phone has an operating system like Windows, Linux, among others. An OS is software responsible for managing and operating hardware units and helping the user utilize those units. The most popular mobile operating systems are Android, iOS, Windows Phone OS, and Symbian. The market share proportions of those operating systems are 47.51% for Android, 41.97% for iOS , 3.31% for Symbian and 2.57% for Windows Phone OS [27]. For this reason, the information that is most abundant on the web and in research works is mainly inclined to the study of Android. Also, these Android systems are completely open source software. For these reasons, Android was selected as the developer of this application.

Android

Android is being developed under Android Open Source Project (AOSP), maintained by Google and promoted by the Open Handset Alliance (OHA) [28]. Android is a Linux-based OS that uses Linux 2.6 to provide core services such as security, memory management, process management, network stack, and a driver model [27]. Android apps used to be written in Java, though these can also be coded in Kotlin. However, the native code and shared libraries are developed in C/C++.

Android architecture

For the development of applications on Android it is essential to know the structure of the operating system. The Android architecture is made up of several components or layers. Android software contains an open-source Linux Kernel having collection of number of C / C ++ libraries which are exposed through an application framework services. Layers use elements of the lower layer to perform their functions, due to this this architecture is known as a stack. The main components of android architecture are following:

- Applications
- Application Framework
- Android Runtime
- Platform Libraries
- Linux Kernel

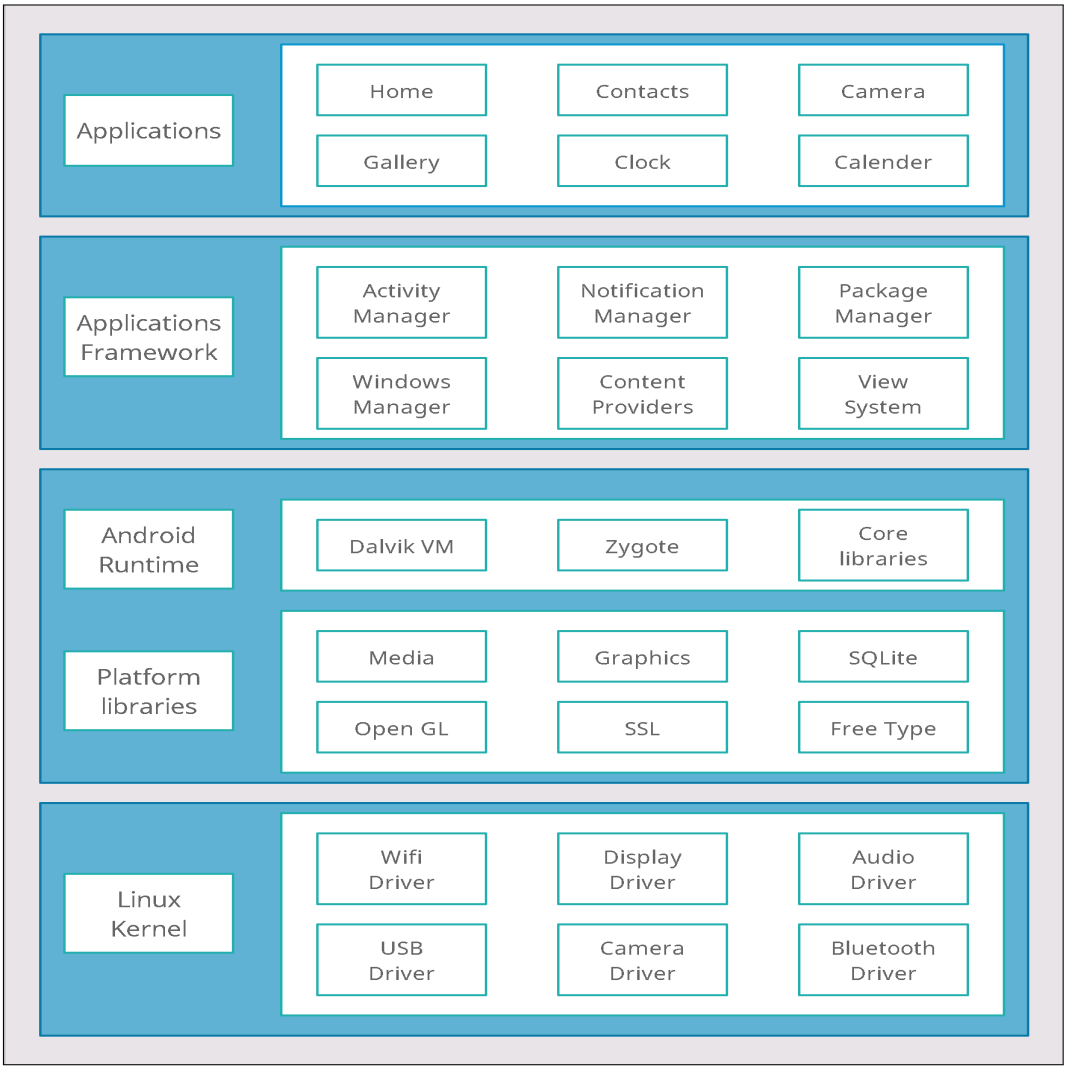


Figure 3.15: Architecture Android

1. Linux Kernel: It manages all the available drivers such as display drivers, camera drivers, Bluetooth drivers, audio drivers, memory drivers, etc. which are required during the runtime.

2. Libraries: The Platform Libraries includes various C/C++ core libraries and Java based libraries such as Media, Graphics, Surface Manager, OpenGL etc. to provide a support for android development.

3. Android Runtime: Android Runtime environment is one of the most important part of Android. It contains components like core libraries and the Dalvik virtual machine(DVM). Mainly, it provides the base for the application framework and powers our application with the help of the core libraries.

4. Application Framework: provides several important classes which are used to create an Android application. It provides a generic abstraction for hardware access and also helps in managing the user interface with application resources. Generally, it provides the services with the help of which we can create a particular class and make that class helpful for the Applications creation.

5. Application: Applications is the top layer of android architecture. The pre-installed applications like home, contacts, camera, gallery etc and third party applications downloaded from the play store like chat applications, games etc. will be installed on this layer only. It runs within the Android run time with the help of the classes and services provided by the application framework.

Android Studio

Android Studio is a development environment specifically for the Android operating system. Previously Eclipse IDE was used as the development environment since 2013 it was announced by Google that it would be replaced by Android Studio. Android Studio is available for Microsoft Windows, macOS, and GNU / Linux operating systems. Android Studio generally uses the Java programming language, although the Kotlin programming language has been integrated since 2019. For the development of EasyQuiz-YT, the Android Studio 4.0.1 version was used and as a Java programming language, since it is widely used in most platforms, consequently more information will be obtained if needed.

The advantage of using Android Studio over frameworks like Flutter is the instant execution. This feature allows us to instantly see the changes made on the emulator or devices, i.e. all changes can be seen live. This will make the development cycle faster and more competent. Android Studio provides the fastest response time for coding and workflow.

Structure of an application in Android Studio

The structure of an Android application is based on four different components, which are: Activity, Service, BroadcastReceiver and ContentProvider. An application does not necessarily consists of all four of these components, but to present a graphical user interface there has to be at least an Activity. Applications can start other applications or specific

components of other applications by sending an Intent. These intents contain among other things the name of desired executed action

Activity An activity gives the window where the application draws its user interface (UI). For the most part, one activity carries out one screen in an application.

Service Service is a component that is used to perform operations on the background such as playing music, handle network transactions, interacting content providers etc. It does not has any (UI).

BroadcastReceiver Android BroadcastReceiver is a dormant component of android that listens to system-wide broadcast events or intents.

ContentProvider A Content Provider is the mechanism provided by the Android platform to allow information to be shared between applications.

3.3.3 Web Application

In software engineering, a web application refers to those tools that can be used by accessing a web server through a web browser. In general, web applications are popular because of the practicality of the web browser. Since it is independent of the operating system, web applications use a combination of server-side scripts (PHP) to handle the storage and retrieval of the information, and client-side scripts (JavaScript and HTML) to present information to users. A web application sends requests to the middle layer that offers services using queries and updates to the database and ,in turn, provides a user interface.

Benefits of a web application

- Web applications run on multiple platforms regardless of operating system or device, as long as the browser is supported
- All users access the same version, eliminating any compatibility problems.
- They are not installed on the hard drive, which eliminates space limitations.
- They reduce costs for both the business and the end user, as the business requires less support and maintenance and fewer requirements for the end-user computer.

Web page

Long ago, the code of each web page of a website was served in a single document, but now, to make the code more understandable and to improve the loading speed is divided into multiple documents. As seen in the schema of the Figure 3.16, on our website we will serve a document with the HTML code of the page, in another document all CSS styles of our website, and in another all the Javascript code of our website. Thus, given that CSS and JavaScript documents are always the same for all the pages and that the modern browsers

get used to cache these files, these files will only be loaded the first time, improving the loading speed and decreasing server load.

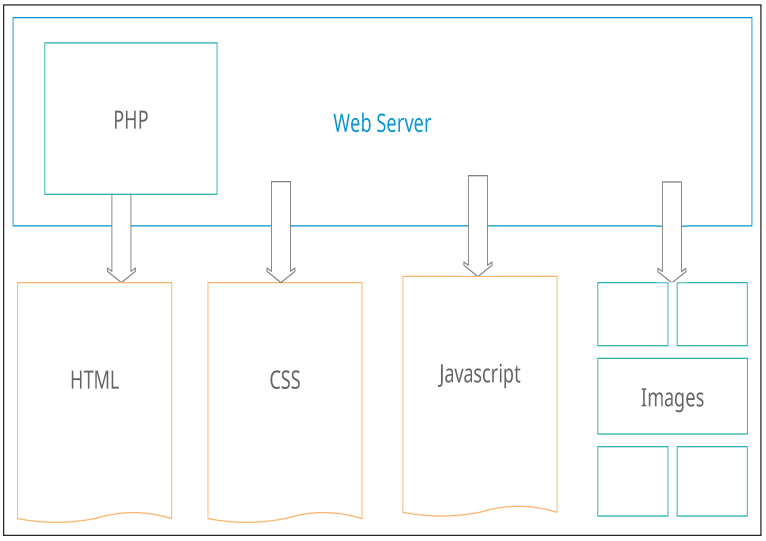


Figure 3.16: Schema of web page

PHP

is a general-purpose programming language that is especially suited to web development. PHP code is usually processed on a web server by a PHP interpreter implemented as a module or a daemon. On a web server, the result of the PHP code is interpreted and executed. Multiple database management systems can be accessed from PHP. In this case, a very popular one, MySQL.

CSS

CSS is called the Cascading Style Sheet language and is used to style elements written in a markup language such as HTML. CSS separates the content from the visual representation of the site. In the CSS file will be described all styles from all over the web, so that the browser only has to load it the first time and then keep it in cache.

Javascript & JQuery

JavaScript is a programming language that is used mainly to create dynamic web pages, but unlike PHP, runs on the client side, that is on the web browser, Javascript, among other things allows a page to be dynamic, incorporating effects like text that appears and disappears, animations, actions that are activated by pressing buttons, etc. It also serves to download data via Ajax, and to generate parts of the website on the fly.

Technically, JavaScript is an interpreted programming language, so it is not necessary to run compiled programs. In other words, scripts written in JavaScript can be tested and executed directly in browser without any intermediate processes. As in the case of CSS, will be created a specific and unique file containing all javascript developed functions that will be used on the web.

3.3.4 Database

A database is an organized collection of structured information, or data, typically stored electronically in a computer system. A database is usually controlled by a database management system (DBMS) [29]. In this case, we used a MySQL database. PhpMyAdmin is a free software tool written in PHP, intended to handle the administration of MySQL over the Web [30].

Tables

The tables contained in the EasyQuiz-YT database are as follows:

Instructor Information about the instructor or professor, such as an id assigned by the system that is sequential, instructor full name, institutional email, and finally password which is encrypted with the MD5 format for greater security.

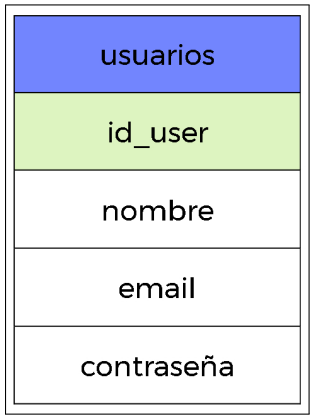


Figure 3.17: Professor table

FIELD NAME	TYPE	LONG	AUTO INCREMENT	ALLOWS NULL
id_user	int	300	true	false
nombre	varchar	60	false	false
email	varchar	30	false	false
contraseña	varchar	8	false	false

Table 3.1: Table data description (usuarios)

Students Student information, such as the unique identifier assigned by the system, full names, email and password encrypted in MD5 format.

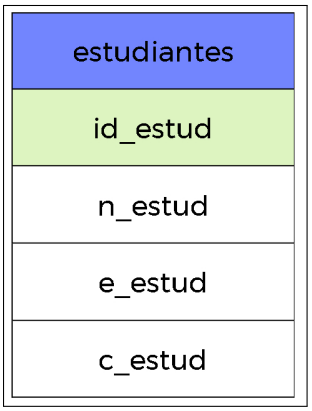


Figure 3.18: Students table

FIELD NAME	TYPE	LONG	AUTO INCREMENT	ALLOWS NULL
id_estud	int	300	true	false
n_estud	varchar	60	false	false
e_estud	varchar	30	false	false
c_estud	varchar	8	false	false

Table 3.2: Table data description (estudiantes)

Course Information about the courses created, such as the unique identifier of each cross, the identifier of the user who created the course, the name of the course, period, and the creation date.

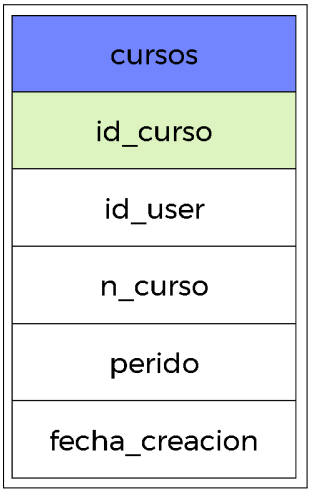


Figure 3.19: Courses table

Quiz Information about the quizzes created, such as the unique identifier of each quiz, the identifier of the course to which it belongs, the name of the quiz, date of creation, and

FIELD NAME	TYPE	LONG	AUTO INCREMENT	ALLOWS NULL
id_curso	int	300	true	false
id_user	int	300	false	false
n_curso	varchar	100	false	false
periodo	varchar	100	false	false
fecha_creacion	date		false	false

Table 3.3: Table data description (cursos)

the availability of the course that takes two values yes and no.

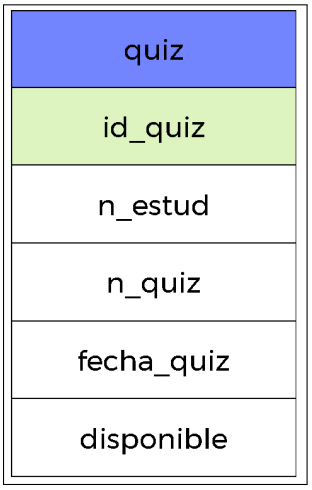


Figure 3.20: Quizzes table

FIELD NAME	TYPE	LONG	AUTO INCREMENT	ALLOWS NULL
id_quiz	int	300	true	false
id_curso	int	300	false	false
n_quiz	varchar	100	false	false
fecha_creacion	date		false	false
disponible	varchar	2	false	true

Table 3.4: Table data description (quiz)

Questions Information about the quiz questions, such as the identifier of the question, which in this case is the question number, the identifier of the quiz to which it belongs, the question, the correct answer, and the type of answer.

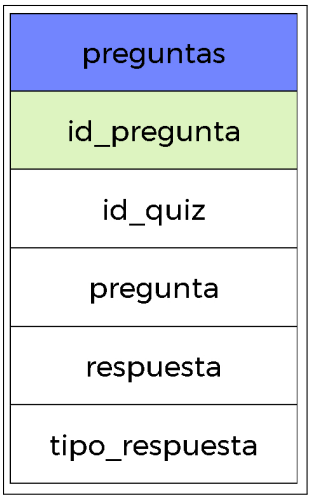


Figure 3.21: Question table

FIELD NAME	TYPE	LONG	AUTO INCREMENT	ALLOWS NULL
id_pregunta	int	250	false	false
id_quiz	int	300	false	false
pregunta	varchar	500	false	false
respuesta	varchar	500	false	false
tipo_respuesta	varchar	250	false	true

Table 3.5: Table data description (preguntas)

Student courses Information about each student's courses, such as the identifier of the student to whom the course belongs, the course identifier, course name, and the date the course was created.

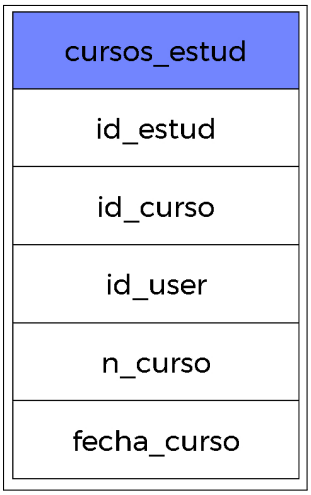


Figure 3.22: Table of the course list of each student

FIELD NAME	TYPE	LONG	AUTO INCREMENT	ALLOWS NULL
id_estud	int	300	false	false
id_curso	int	300	false	false
id_user	varchar	300	false	false
n_curso	varchar	100	false	false
fecha_curso	date		false	true

Table 3.6: Table data description (cursos_estud)

Question Answers Information about the questions already answered by the students and the attributes are the student identifier, the quiz identifier, the question identifier, type of answer, question, correct answer, and student's answer.

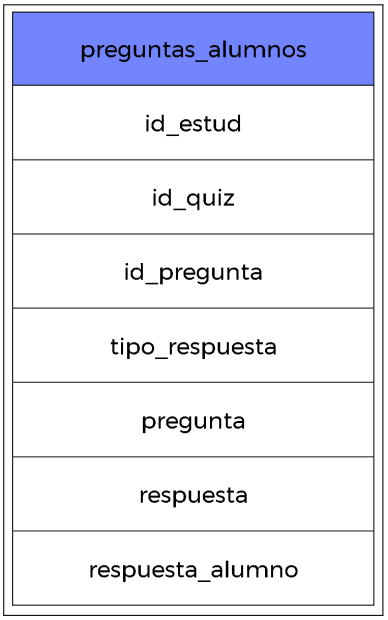


Figure 3.23: Table of questions answered by students

FIELD NAME	TYPE	LONG	AUTO INCREMENT	ALLOWS NULL
id_estud	int	300	false	false
id_quiz	int	300	false	false
id_pregunta	int	250	false	false
tr	varchar	250	false	false
p	varchar	500	false	false
r	varchar	500	false	false
respuesta_alumno	varchar	500	false	true

Table 3.7: Table data description (preguntas_alumnos)

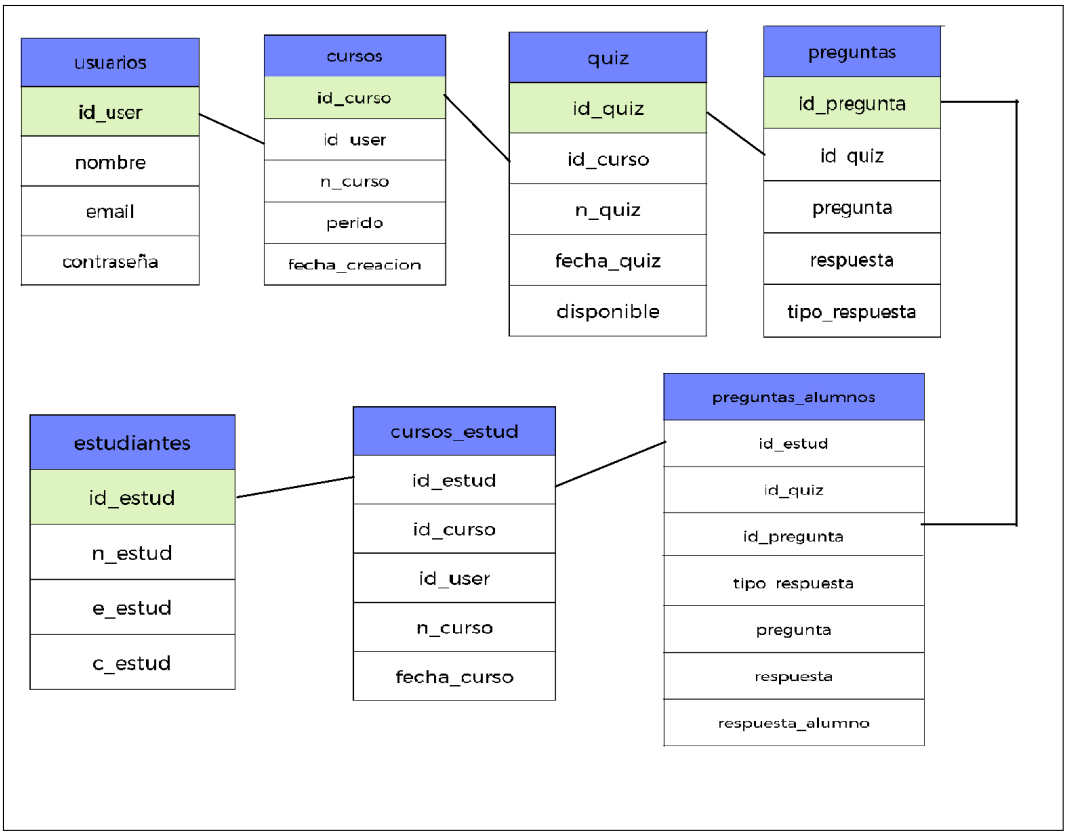


Figure 3.24: Complete database

Chapter 4

Methodology

4.1 Research Design

The present study aims to show the effectiveness of EasyQuiz-YT by measuring different variables such as attendance, interaction level, participant satisfaction, application usability, and learning performance. The participants will receive previous training according to their requirements and available schedule (see section 4.5). The students and the instructor will use the EasyQuiz-YT tool in some classes for seven weeks in the study. The instructor must take at least one weekly quiz prepared in the EasyQuiz-YT web application and answered by the students through the EasyQuiz-YT mobile application. At the end of the experiment, participating students will have to answer a survey that will measure the ease of use (usability) of the EasyQuiz-YT application. Likewise, there will be a pre-post test on the topics of the subject taught by the instructor; the professor will elaborate on these tests. The pre-test will be only for the research participants. On the other hand, the post-test will be precisely the mid-term (partial exam that generally has a significant percentage of the final grade), avoiding delays in the process.

Consequently, the pre-post test will evaluate the students' learning performance by comparing the average scores of the experimental and control groups. Finally, the interview will be conducted with the participating professor. This interview is intended to measure CRS satisfaction and interaction within the classroom through specific questions and opinions given by the professor. The research will use a mixed-methods design, i.e., quantitative and qualitative methods. A key feature of mixed methods research is its methodological pluralism or eclecticism, which frequently results in superior research (compared to monomethod research) [31]. Therefore, the collection of quantitative and qualitative data for this study will allow for fully validated findings. Qualitative data will collect through interviews and quantitative data through surveys and the pre-post test.

4.2 The University Site

The study will conduct at the Yachay Experimental Technology Research. Located in the community of Urcuqui, Imbabura province. At the time of this writing, Yachay Tech has

1,429 students and 170 professors distributed in five schools and eleven majors. In the first four semesters, Yachay students share the same group of courses. From the fifth semester, they received specific courses depending on their specialization. The first four semesters are referred to as General Studies; the remaining, as Specialization. The experiments are to be conducted within some General Studies classes since these are numerous.

4.3 Research Participants

The sample will be taken from students enrolled in one of the subjects of General Studies, which is mandatory in the first semester of Yachay Tech. All the instructors of these subjects will receive an email. Depending on their response, the course to carry out the experiment will be chosen. Priority will be given to the courses with the most significant number of students. Each subject has two or more parallels. In this case, for the study, two parallels will be chosen. In addition, it is necessary to know that not all the assistants belong to the first semester since there are repeaters of the subject. In this research project, there will only be a unique professor participant, i.e., the same instructor for the two parallels, avoiding external variables that may affect the research. Consequently, the methodology will be the same in the two parallels.

The control and treatment groups will assign according to the two existing parallels. The students in parallel "A" will belong to the experimental group and parallel "B" to the control group. This study will focus on the General Studies subject. For the classes of this subject, the instructor has three hours per week divided as follows: one hour on Monday and two hours on Wednesday.

4.4 Procedure

To begin the study, the researcher conducted an exhaustive search to find courses willing to participate in the research. First, the researcher sent several emails to each of the instructors of the General Studies courses taken in the first semester, such as Biology I, Calculus, Linear Algebra, Chemistry I, and Physics I. Considering the following criteria; that the subject is taught to at least two parallels and that the instructor is the same, and that the parallels have a large number of students. The email sent to the professors explains what the experiment is intended to evaluate. Appendix A provides a copy of the email message used for this purpose. If more than two responses are received, the criterion for choosing the subject will be the courses with the most significant number of students. In addition, the professor is asked to commit to using EasyQuiz-YT at least once a week for seven weeks, which corresponds to the duration of the experiment. After obtaining the general studies course, an email is sent to the participating students announcing the investigation dynamics and asking them to bring their mobile devices with the Android operating system only to the experimental group.

After having the groups established, the participants were trained (see section ref cap: training). For the start of the experiment in the classroom, the professor should perform a pre-test. This test aims to show the students' initial knowledge of the subject matter to be taught. During the seven weeks of the experiment, the professor will use the EasyQuiz-YT

tool to ask questions about his class at least once a week. The experimental group will have to answer the questions posed by their professor through their mobile devices in the EasyQuiz-YT application. Before the end of each class, the professor will take about 10 minutes to provide feedback. In the case of the control group, the feedback becomes more of a summary of the class since the professor has no preliminary data on the weaknesses of his students. In the case of the experimental group, the professor has reviewed the statistics and found the weaknesses. It is worth remembering at this point that the EasyQuiz-YT report is automatically generated on the professor's laptop right after all students answered the questionnaire. After having a clear picture of his student's performance, the professor proceeds to give feedback. In the last week of the experiment, the instructor will conduct a post-test, a midterm for both the control and experimental groups. Finally, a mutually agreed date was set for the semi-structured interview with the instructor, audio-recorded and transcribed .

4.5 Training Participants

4.5.1 Training Professor

The formation and training of professors in technological tools can be of low motivation for some professors since they used to have a heavy workload. In the beginning, the idea was to provide a user's manual, but we know that reading a manual can be tedious and time-consuming. Based on this diagnosis, it is necessary to provide training to promote and support the CRS tool. In this case, it is planned to teach the use and flow of the system in a personalized way to the instructor. How to log into the system, create courses and quizzes, enter questions and the different types of questions, and show the results and statistics.

Due to the limited time available by the professors, we will start by sending an email invitation to all professors who teach more than one group of the same course in General Studies. The email will contain a link to a short video explaining what EasyQuiz-YT is and the advantages that it might bring about to the attendance level, student enthusiasm, and learning performance. For those who show interest in participating, we will send a second email with the intention of scheduling an appointment. We will show the professor how to install and use (login, create courses, create quizzes, create questions, enable questions, results, and graphical statistics) the tool at the scheduled appointment. If the professor is comfortable with the tool and agrees, we will proceed to the next phase, which will be the training of the students.

4.5.2 Training Students

For student training, the professor will provide a time in the first class of the semester to explain how to use EasyQuiz-YT. The students in parallel "A" (experimental group) received an email in anticipation of the meeting. It is also explained to them that they should bring their mobile devices to proceed with installing the application. The session begins with the assisted download and installation of EasyQuiz-YT. Next, four questions are asked (one true/false, one multiple choice (single answer), one multiple-choice (multiple

answers), and one open-ended), and the students are explained how to navigate EasyQuiz-YT to answer the answers correctly. Finally, if they need reminding, students are provided with a YouTube tutorial on how to use EasyQuiz-YT.

4.6 Measurable variables

4.6.1 Attendance

In addition to using EasyQuiz-YT for testing, it can also be used for attendance purposes. Using the students' answers to the questions asked in the lectures, they can record their attendance. By solving the quiz, their identities are registered through the login. Thus, the professors can quickly obtain records of their student's attendance. The file contains the names of the students who completed the quiz and the date of completion. The professor will then be able to use this document as proof of class attendance.

In the study, the experimental group will obtain it from the attendance record generated by the EasyQuiz-YT application to take the attendance data. In contrast, the control group will acquire it from the attendance records managed by the professor. It is essential to know that only the days in which EasyQuiz-YT was used in the experimental group will be considered. Employing the normal distribution or z-test, the degree of statistical significance of the differences between the means of the two sets of data (control and experimental group) is determined. The null hypothesis is that the means of the groups are equal, and the alternative hypothesis is that the means of the groups are different ($H_0 : \mu_1 = \mu_2$
$H_1 : \mu_1 > \mu_2$).

4.6.2 Application usability

Once the experiment is completed, i.e., after seven weeks of using EasyQuiz-YT, student participants had to fill in a survey with which the usability of the application could be measured (System Usability Scale). System Usability Scale (SUS) is a reliable tool for measuring usability. It is short, only ten items on a five-point Likert scale of strong disagreement (1) to strong agreement (5) (Figure 4.1).

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	I think that I would like to use this system frequently.	1	2	3	4	5
2	I found the system unnecessarily complex.	1	2	3	4	5
3	I thought the system was easy to use.	1	2	3	4	5
4	I think that I would need the support of a technical person to be able to use this system.	1	2	3	4	5
5	I found the various functions in this system were well integrated.	1	2	3	4	5
6	I thought there was too much inconsistency in this system.	1	2	3	4	5
7	I would imagine that most people would learn to use this system very quickly.	1	2	3	4	5
8	I found the system very cumbersome to use.	1	2	3	4	5
9	I felt very confident using the system.	1	2	3	4	5
10	I needed to learn a lot of things before I could get going with this system.	1	2	3	4	5

Figure 4.1: System Usability Scale (SUS) questionnaire

In order to obtain reliable data, the survey should be carried out with a minimum of 5 people; in our case, due to a large number of participants, the number of students surveyed will be greater than this number.

For the evaluation of the data, it is necessary to know the score of each item.

- Strongly disagree: 1 point.
- Disagree: 2 points.
- Neutral: 2 points.
- Agree: 3 points.
- Strongly agree: 4 points.

To calculate the SUS score, the contributions of each point must first be added up. The contribution of each point will be worth between 0 and 4. For points 1, 3, 5, 7, and 9, the contribution will be the position on the scale minus 1. For points 2, 4, 6, 8, and 10, the contribution will be five minus the position on the scale. The sum of the results is multiplied by 2.5 to obtain the overall SUS value. The result will be between 0 and

100, these are not percentages and should be considered only in terms of their percentile ranking. If the score obtained ranges from 0 to 49 it is considered unacceptable, from 50 to 69 as mediocre and from 70 to 100 the system is considered acceptable (Figure 4.2).

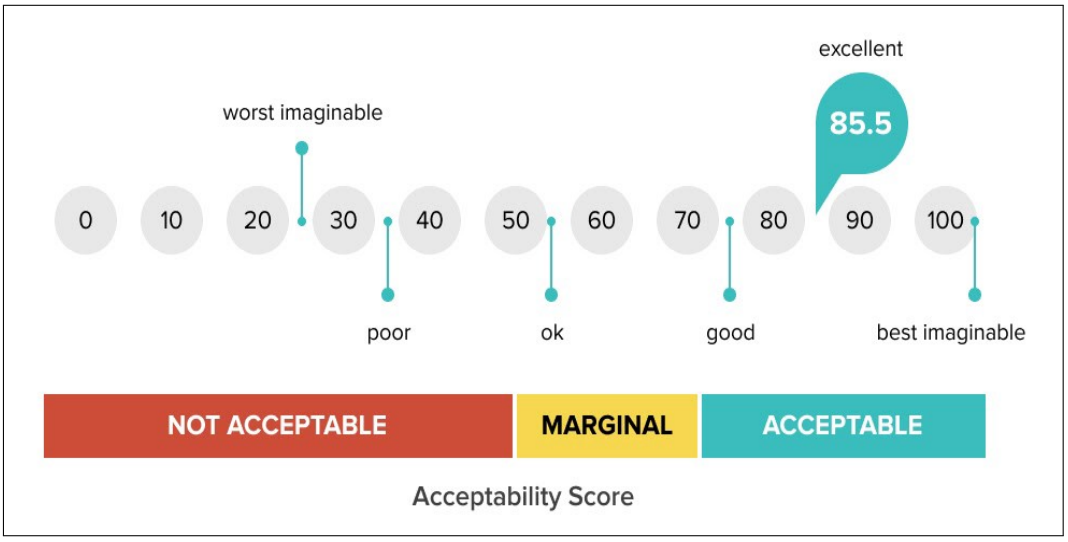


Figure 4.2: System Usability Score

4.6.3 Learning Performance

Two essential tests were proposed for the control and experimental groups to measure academic performance. First, before the experiment, a pre-test was presented at the beginning of the semester. This test contains questions about the content of the following topics to see.

At the end of the experiment, a post-test was carried out, which corresponds to the midterm. This test is also intended to determine the knowledge acquired during the investigation. The post-test will allow us to determine if there is a difference in the group that used EasyQuiz-YT compared to the group that followed the classical methodology.

Learning increase (Pretest A-Postest A vs Pretest B-Postest B)

To determine the increase in learning, the pre-test data will be taken in relation to the post-test for each group. After having these data, the results of the control and experimental groups will be compared. Subsequently, a descriptive analysis will be used to determine the mean and standard deviation. Finally, to establish possible inferences, the Z-test was performed since the number of samples exceeds thirty ($N > 30$). In this way, we will determine whether the degree of significance between the means of the two populations is considerable, thus proving that EasyQuiz-YT did or did not contribute to increased learning.

Final learning (Pretest A vs Postest B)

For this variable, only the knowledge at the end of the experiment (post-test results) will be taken into account and compared with each other. The Z-test statistic will be used to obtain results since we have samples larger than thirty ($N > 30$). The null hypothesis is that the means are equal, and the alternative hypothesis is that the mean of the experimental group is higher than that of the control group ($H_0 : \mu_1 = \mu_2$ $H_1 : \mu_1 > \mu_2$). The inferential analysis will reveal whether significant differences existed.

4.6.4 Participation motivation

The study will also measure qualitative variables

Professor's motivation

For this part, the researcher has prepared a thematic script about what the researcher wants to discuss with the professor. The questions are open-ended. The professor can express his opinions, qualify his answers, and even deviate from the researcher's initial script when emerging themes need to be explored. The researcher will maintain sufficient attention to introduce into the informant's answers the topics of interest to the study, linking the conversation naturally.

For the interview, we asked the following open-ended questions:

- How is your experience in formative assessment activities with the use of EasyQuiz-YT?
- How does the use of EasyQuiz-YT influence your teaching methodology?
- Does your academic load decrease with the use of EasyQuiz-YT?
- Would you recommend the use of EasyQuiz-YT to other instructors? Why or why not?

During the interview, the researcher will relate the informant's responses to other categories as they flow through the discussion and construct new questions by linking themes and responses. This interview lasted between 7 and 10 minutes. The interview was audio-recorded and then transcribed, after which the data will be categorized. The professor's motivation regarding the use of EasyQuiz-YT will be deduced through this interview. Finally, the thematic analysis will be carried out using NVivo software.

Students's motivation

For this part of the study, focused group interviews will be conducted with two groups of students. Each group will have between five and seven students with average GPA scores. These students were part of the experimental group that had continuous exposure to formative assessments with EasyQuiz-YT. Semi-structured questions were applied to learn about the students' perception of EasyQuiz-YT. Our objective is to know the impact of EasyQuiz-YT on self-motivation for learning.

For the interview, we asked the following open-ended questions:

- How is your experience in formative assessment activities assisted with EasyQuiz-YT compared to the traditional method?
- What is your perception of the impact of EasyQuiz-YT on self-motivation?
- How does the use of EasyQuiz-YT improve motivation?
- How does the use of EasyQuiz-YT help you to become deeply involved in the study process?
- How does the use of EasyQuiz-YT influence your academic performance?

The duration of the interviews will range from 15 to 20 minutes. The interviews will be recorded and then transcribed, after which the data will be categorized. Motivation and self-motivation will be deduced through this interview. Finally, the thematic analysis will be carried out using NVivo software.

Chapter 5

Conclusions

The EasyQuiz-YT system consists of a web application for use by professors and a mobile application to be used by the students. It allows professors to intersperse quizzes during the class in a timely manner, and students answer these quizzes through their mobile phones immediately and anonymously.

It intends to increase the students' attentiveness and foster discussions among students while providing professors with quick feedback. In addition, with EasyQuiz-YT, processes such as attendance control and quiz grading can be automated, which permit individualized monitoring of the student's work.

According to Palade, we know that a pedagogical tool such as the CRS proposed in this thesis can be used to initiate discussions and as a support tool for group discussions or for evaluation of ongoing training evaluation, trainer's evaluation, impact of training evaluation, trainees learning outcomes, etc [9].

Similar systems have proven to be effective at improving students' attitudes towards classes and sometimes even increasing academic performance.

We also hope to gain these advantages in EasyQuiz-YT. However, we are also aware that we may have certain disadvantages such as: Training is required for professors who might be reluctant to use technology. Additionally, as the questions are asked anonymously, the professor does not have the option to provide personalized help. In that case, to solve this problem, EasyQuiz-YT can be altered to enable the professor to choose whether to identify the students or not.

Along with the system, we designed a user study for measuring the system usability, learning performance, and participant satisfaction. Through surveys, interviews, and standardized tests, we expected to identify the benefits brought about by EasyQuiz-YT to the classes taught from an introductory course taken in the first semester in Yachay Tech. Unfortunately, due to the world pandemic (COVID-19) that we are going through, it has not been possible to carry out the experiments. In Ecuador, specifically at the Yachay Tech University, face-to-face classes have been completely suspended, so the proposed experiments could not been conducted.

EasyQuiz-YT qualified among the 24 finalists in TuApp 2020, a Latin American contest for innovative mobile applications. On October 29th, 2021, we will present our project at the Higher Technological Institute of Huatusco in Mexico.

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Appendices

Appendix A

Email for the professor

Subject: EasyQuiz-YT, una aplicación para mejorar la participación en clases.

Estimado profesor,

Como parte de la tesis de grado que vengo realizando en la escuela de TIC, he desarrollado EasyQuiz-YT, una aplicación que permite mejorar la participación del alumnado durante las clases. Es sabido que la timidez o falta de confianza en muchos estudiantes termina convirtiendo la clases en monólogos y exposiciones unidireccionales que podría afectar negativamente el interés de muchos. Con EasyQuiz-YT, los alumnos podrán utilizar sus teléfonos celulares para responder anónimamente a las preguntas que usted formule. Además, usted podrá ver en ese mismo momento las respuestas de toda la clase mediante cuadros estadísticos y, con ello, centrar su atención en los puntos débiles de los estudiantes. Recibirá feedback instantáneo, no tendrá que esperar hasta el midterm para saber el estado de sus estudiantes. Programas similares han probado un aumento significativo en la asistencia, mejora en el rendimiento académico y el aumento en la motivación de los alumnos y profesores. Actualmente necesito medir la eficacia de EasyQuiz-YT y, por ello, estoy buscando profesores que estén dispuestos a utilizarlo dentro sus clases. Si usted está interesado en participar en esta investigación, puede responder afirmativamente a este correo y concederme una reunión para poder absolver cualquier duda que tenga y hacer la instalación del software requerido en su máquina.
Slds