Mobile application for the registration and control of student attendance at the Universidad Católica de Santa María based on Google technologies and Machine Learning

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Abstract

The constant evolution of emerging technologies in the midst of the digital era highlights the need to replace traditional methods of student attendance registration in universities. Often, students record their attendance at the beginning of classes. This method can divert students' attention during class, and the time it takes for the teacher to record attendance increases significantly [1], considering the number of students enrolled in certain subjects. In this context, this research proposes the development of a mobile application for the Android operating system for attendance registration and control for students at the Universidad Católica de Santa María (UCSM) using the XP (Extreme Programming) project management methodology. The phases of XP detail the entire process for the development of the application and its launch, with Firebase as the Database Manager. To conduct the respective tests of the application, tests were carried out on fourth-year students of Systems Engineering, belonging to the Faculty of Physical and Formal Sciences and Engineering at UCSM. The attendance system was connected to a database that stores information about students and their attendance records. Additionally, the user interface displays attendance records from an attractive, intuitive, and easy-to-manage perspective for both teachers and students. The research results show that the use of the application by UCSM teachers and students reduces and optimizes the time invested in the attendance registration process compared to traditional methods, according to the satisfaction and acceptance criteria of the "ASYS" application.

Keywords

Emerging technologies, Mobile application, Attendance system, Android, XP Methodology, Google technologies, Machine Learning.

1. Introduction

In the January-February-March 2021 quarter, out of the total internet user population, 88.5% accessed it through mobile phones or smartphones, 16.7% through laptops, and the rest through other internet-connected devices [2]. When compared to the same quarter in 2020, there is a 0.6 percentage point increase in internet access via mobile phones. This figure is expected to rise further in 2022. The usefulness of mobile phones lies in applications. There are various advantages to using mobile applications, particularly in the educational perspective. For example, manual attendance registration by teachers can be time-consuming and prone to errors [3]. It can also consume teachers' time when calculating averages. The use of a mobile attendance system eliminates the drawbacks of the manual system.

The primary motivation for this research is to optimize the time spent by teachers in taking attendance, especially when dealing with a large number of students. Additionally, the goal is to gain experience in developing mobile applications as part of professional growth, utilizing

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methods and new technologies such as database management, persistence, authentication, and storage with Firebase, and the BrainShop Machine Learning kit [4]. The aim is to create a well-organized, robust, and consistent application capable of meeting all the basic needs for its launch, following all stages of the XP methodology.

This paper is organized as follows. Section II provides a general overview of various previous studies on methods implemented for student attendance systems using mobile applications. Section III details the application implementation process through the XP methodology. In Sections IV and V, the results and discussion are outlined after testing the application with 100 students from the Faculty of Physical and Formal Sciences and Engineering at the Universidad Católica de Santa María during one month in the odd academic semester 2022-I. Finally, Section VI presents the research conclusions.

2. Related Work

In this section, we conduct a systematic review of related works in the development of mobile applications focused on student attendance tracking, with a focus on time optimization and resource use in this process. We also explore those that use cloud-based technologies and their implementation through the use of the XP methodology.

In [5], an automated solution is presented, where a mobile application based on JAVA was developed. It wirelessly connected to a central Database created using MySQL, tasked with registering attendance information. The system was implemented in a university to record student data, absence and presence times, and accumulated attendance per month, resulting in effective and efficient system use. Similarly, in [6], an application was developed for Android and iOS devices to register student attendance as an alternative to manual methods. The proposal includes an application dedicated to teachers and students, displaying information such as the courses taught by teachers and the courses in which students are enrolled. Attendance data is synchronized with the Moodle platform, reflecting this information on the virtual platform. Tools used for development include MariaDB as the database manager and Web Services for application synchronization with the Moodle and institutional databases. The implementation is justified through a survey where 100% of teachers would support the use of an application for attendance and rated its use and synchronization with the virtual platform at 4.8.

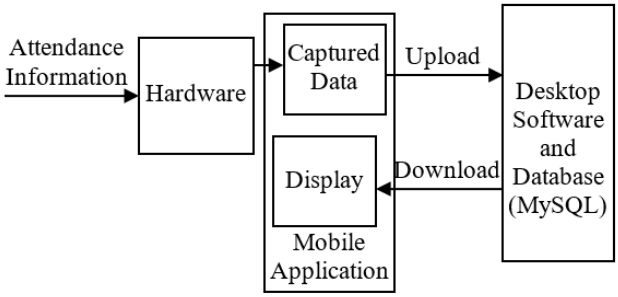

Figure 1: Block diagram of the attendance system presented in [5]

On the other hand, [7] presents a study where information from 367 students was collected to measure attendance in classes, online learning activities, and performance in online formative assessments. This study applied learning analysis methods to measure attendance, online learning activities, and performance in online formative assessments. The research results contribute to understanding the impact of class attendance on course academic performance and the interaction of participation factors in online learning in the context of technology-enhanced courses.

In the research conducted by [8], a proposed solution to the attendance control problem is presented, consisting of the development of a hybrid Android application prototype. This was achieved by employing open-source technologies such as the Ionic framework and the face-api.js

library of JavaScript. The proposal is oriented towards efficient and agile monitoring of student attendance within the classroom, utilizing facial recognition as a key element for faster and more secure control. 92.8% of teachers show satisfaction with the application, feeling more secure with the use of facial recognition for verifying student attendance.

Concerning the use of the Extreme Programming (XP) methodology, [9] developed a mobile application for managing attendance and evaluation information for university students. For this, development environments such as SQLite for database management, Android Studio, and the Extreme Programming methodology were used, allowing acceptance and compliance with the proposal and meeting the requirements demanded by the client. Among the obtained results is the high availability and integrity of information regarding attendance and evaluations. Furthermore, the use of the XP methodology allowed constant feedback with the client and, consequently, continuous improvement of the application.

The data analysis proposed in [10] is used to analyze various skills through the collection of unstructured data to identify trends in job positions in the oil and gas industry. Although the context of the case study is different from that presented in this document, it can be proven that data analysis allows a better understanding of the skills and performance of a group of individuals, identifying them on a scale of 1 to 10 in job recurrence, which is sought to be addressed with attendance analysis and academic performance.

In this context, [11] demonstrated that the use of the XP methodology guarantees the development of applications from small to medium scale. Compared to processes and tools, XP focuses on the aggressive development of mobile applications and allows an immediate response to changes that arise during the development process. Therefore, its use to develop a mobile application for student learning in various schools proves to be efficient and effective.

For predictions and data analysis to be accurate, sensors or tools that collect real-time data are necessary. An example of this is presented in the research [12], where Google tools (Firebase) are used for the immediate collection and ordering of data for the detection of cardiovascular diseases. This demonstrates great effectiveness in recognition and ease of handling a large amount of data. In this context, in the research conducted by [13] on the use of frameworks in the development of mobile applications, a comprehensive investigation is presented on the needs and characteristics that a mobile application must meet. To discover these characteristics, a systematic study mapping, consultation with experts, implementation in projects with agile methodologies, and testing in a university environment were used. The results showed improvement in development and a useful guide to cover all needs or aspects of the mobile application, improve development times, and can also be used as teaching material.

Finally, in the research proposed by [14], an application was developed to monitor the health status of patients with heart problems. Considering that data must be updated in real-time, the researchers concluded that Firebase was the most suitable platform for handling data in the cloud. As mentioned earlier, this tool provides various services such as Analytics that provide data and charts of user interactions. As a final point, the authors highlight the accuracy of the application in offering advice and predictions in sensitive health areas.

In this regard, in relation to the use of NoSQL databases (non-relational databases), [15] presents a method based on computer vision to automate the process of reading water and electricity meters through a mobile application, storing photos and data of readings in a NoSQL database. Through Firebase Storage, it allows a dealer to store and process these readings with the aim of conducting predictive analysis in the future for water or electricity resource management. This method was patented, generating viable results in the meter reading market in Brazil. On the other hand, in [16], they propose a personal and decentralized cloud-based data model to manage health data in schoolchildren using the real-time NoSQL database provided by the Firebase platform. Through this service, a school's health information system can have total control over the administration of sensitive data such as the student's school number, name, temperature test time, temperature data, and the test machine number. This model was tested and applied, fulfilling its objective, and provides schoolchildren with more active control over the health information data of their personal status.

Considering the research conducted, for the development of the proposal, Firebase will be used as the Database manager, as it is a fast and efficient technology for handling a large amount of unstructured data [17], Android as the development platform, and the XP methodology to manage the development of the proposal.

3. Materials and Methods

In order to evaluate the satisfaction of teachers and students regarding the use of an application for attendance marking, data will be collected from students of the Professional School of Systems Engineering at the Universidad Católica de Santa María, whose ages range from 19 to 25 years.

The XP methodology consists of the following phases [18]: Planning, Design, Coding, Testing, and Release. As shown in Figure 2.

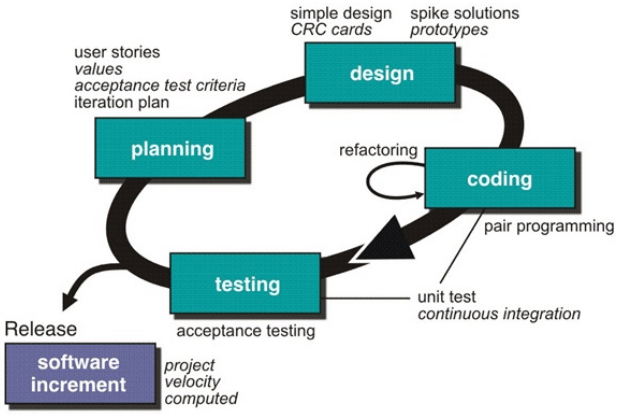

Figure 2: Phases of the XP methodology. [19] cited by [18]

3.1. Phase 1: Planning

According to [20], it is important to select the priority functions that will be developed first so that the application can be implemented gradually and meet the main needs of users. In the operation of the application developed in [20], two types of data (Primary and Secondary data) are collected. In this research, primary and secondary data are related to student attendance (see Table 1).

Table 1
Student attendance data, adapted from [20]

Primary Data	Secondary Data
Student identification code, and name.	University profile
Student enrollment data	Location data
Calendar data (Day, Month, Year)	Student's academic performance data
Global time data	Attendance recap report format
Internet quota	Application development time
	Development difficulty level
	Application design difficulty level
	Feature development rate

In this context, the first thing defined in this phase was the user stories, which in other development methodologies are known as requirements, to later prioritize them. Some of the identified user stories are shown below [21].

Table 2
User Story 01. Own elaboration

User Story 01	
Number: 1	**Name:** Access to the application
User: Teacher, Student	**Assigned Iteration:** 1
Business Priority: High	**Estimated Points:** 2
Development Risk: Medium	**Actual Points:** 2
Description: Users will have a unique username and password with which they can log in. **Observations:** Only registered users will have access to its functionalities.	

Table 3
User Story 02. Own elaboration

User Story 01	
Number: 2	**Name:** Attendance registration
User: Student	**Assigned Iteration:** 1
Business Priority: High	**Estimated Points:** 2
Development Risk: Medium	**Actual Points:** 2
Description: The application will allow students to register attendance by selecting the subject they need to mark attendance for through a card on the main screen of the application. **Observations:** Only courses that correspond to marking attendance will be enabled. That is, if the allowed time for attendance registration is met (±5 minutes) at entry and exit times.	

Table 4
User Story 03. Own elaboration

User Story 01	
Number: 3	**Name:** Attendance control
User: Teacher	**Assigned Iteration:** 1
Business Priority: High	**Estimated Points:** 2
Development Risk: Medium	**Actual Points:** 2
Description: The application will allow downloading a spreadsheet-format file that will contain student attendance (in CSV format) when selecting a specific subject. **Observations:** Only the attendance of those students who marked their attendance within the specified time frame (±5 minutes) of entry and exit will be counted.	

3.2. Phase 2: Design

In this phase, all the mockups of the application were developed with which end-users would be interacting. While other methodologies usually develop deliverables such as sequence diagrams, in this case, the client-server model was chosen [21]. Below are the main interfaces of the mobile application.

- Students
  - Screen for user login.
  - Screen to view the list of student courses and the attendances they need to mark at the scheduled time.
  - Screen to mark the entry and exit attendance of students.
- Teachers
  - Screen for user login.
  - Screen to view the list of courses they teach.
  - Screen to download the attendance list of a specific course.

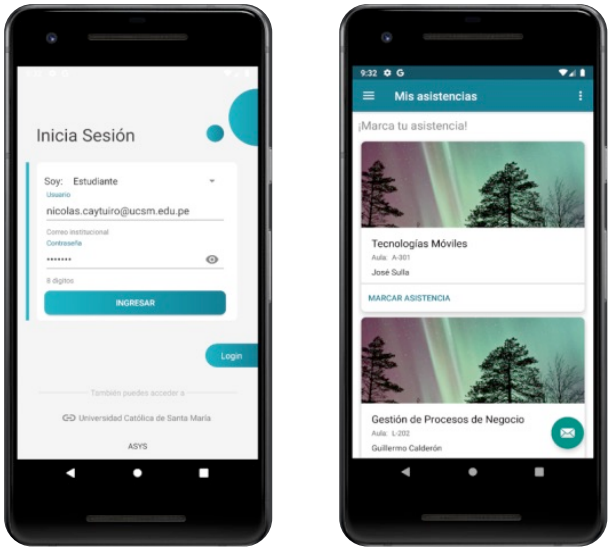

Figure 3: Mobile Application Interfaces

3.3. Phase 3: Coding

3.3.1. Implementation of the Model View ViewModel Design Pattern

In this phase, the application's functionalities were coded using the Model View ViewModel (MVVM) design pattern. MVVM allows the implementation of more robust Android applications and aligns well with the chosen development methodology [22]. The structure can be observed as follows.

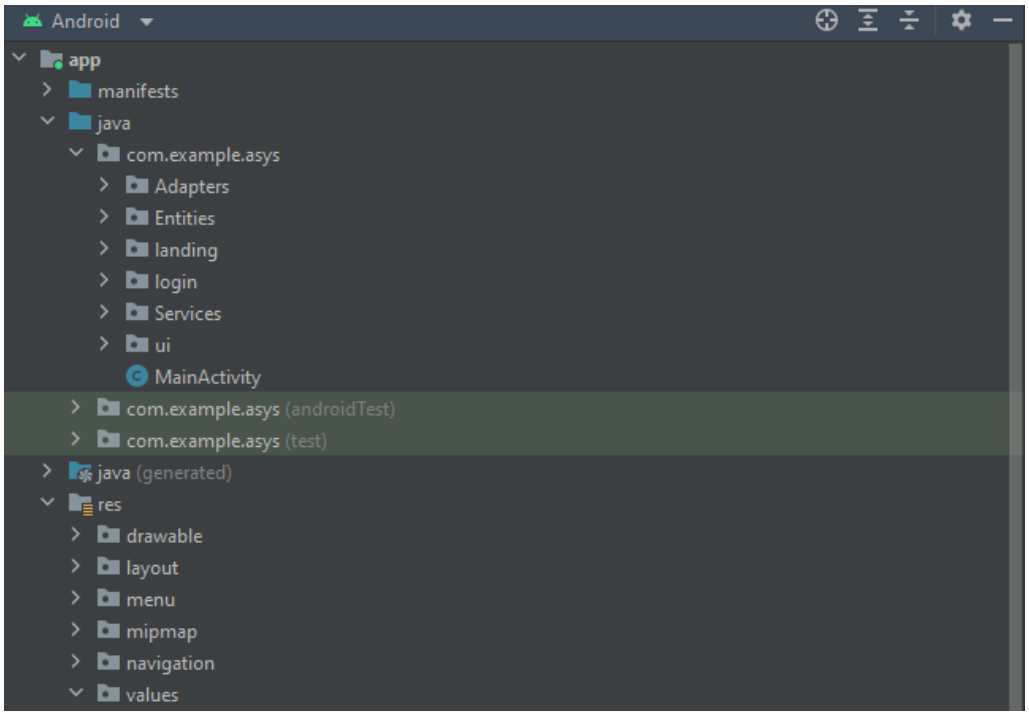

Figure 4: MVVM Pattern of the application

Where the model layer translates all the data and delivers it to the model, the ViewModel layer connects to the database or external APIs, and the view layer presents the data, which can be invoked using commands.

3.3.2. Use of Firebase as a Database Manager

As mentioned earlier, Firebase was used as the database manager due to its advantages, such as cloud storage and rapid scaling, as well as its data analytics addon for generating reports on application demand by users.

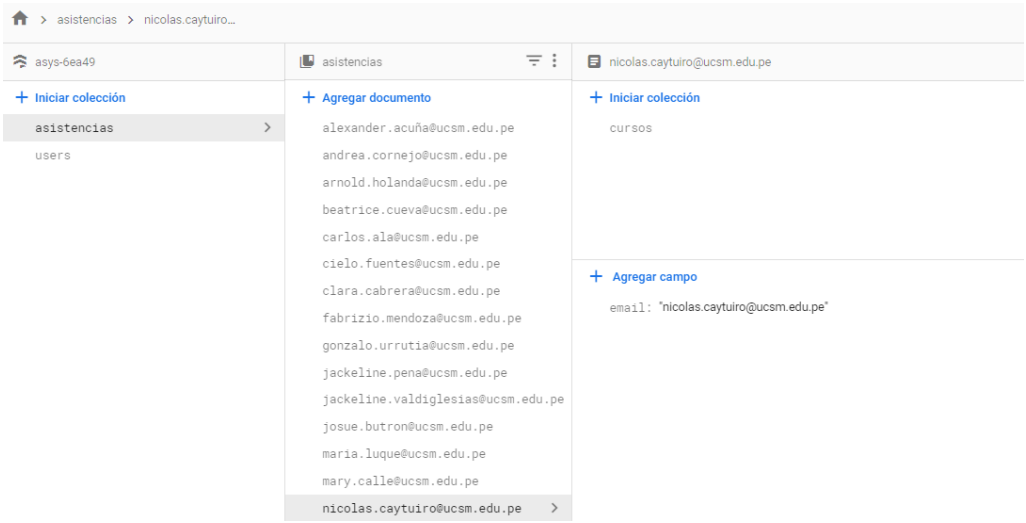

Figure 5: Firebase as a Database Manager

In Figure 5, the implemented Firebase database can be visualized. It shows the code of the courses and their corresponding fields, such as classroom, day, entry time, exit time, course name, and teacher. In Cloud Firestore, the storage unit is the document, which is a record using few resources and contains fields with assigned values [23], such as the "email" field. Collections store documents, and in Illustration 5, there is a collection called "attendance," which contains a set of documents that can, in turn, store collections, such as the "courses" collection storing the courses each student is enrolled in.

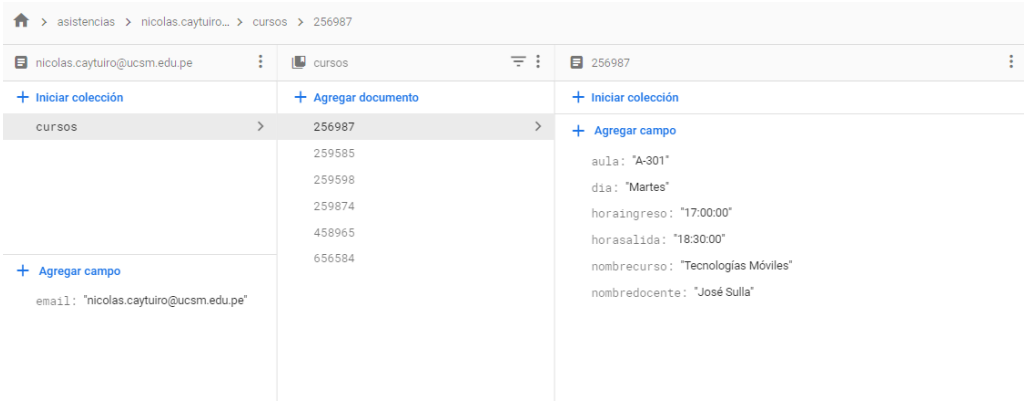

Figure 6: "Courses" Collection in Cloud Firestore

Figure 6 shows the collection of courses, which stores the courses in which the student is enrolled. Each subject has a unique identifier, the subject code.

The following details the data model represented in the student and their corresponding courses' data dictionary.

1. Data Model

The attributes handling the main functionalities of the mobile application were collected from students and their corresponding courses in the 4th year of the Systems Engineering professional career (odd semester 2022-I) at the Faculty of Physical and Formal Sciences and Engineering of UCSM, and are shown in Table 5 and 6, respectively.

Table 5
Data Dictionary – Student

Attribute	Description	Encoded Domain	Data Type
Student Code	Student code	codigo	String
Email	Student's institutional email	email	String
Professional School	Professional school of the student	eprofesional	String
Name	Full name of the student	nombre	String

Table 6
Data Dictionary – Courses

Attribute	Description	Encoded Domain	Data Type
Classroom	Classroom where the student attends classes	aula	String
Day	Day on which the student has classes	dia	String
Entry Time	Time of entry to classes	horaingreso	String
Exit Time	Time of exit from classes	horasalida	String
Course Name	Name of the course	nombrecurso	String
Teacher Name	Name of the teacher who teaches the course	nombredocente	String

3.3.3. Implementation of Automatic Responses in the Application

To generate automatic responses to user questions, such as obtaining instructions on how to use the application or how to mark attendance [24], the BrainShop.ai Machine Learning kit was used. It can respond to user questions based on a knowledge base (a set of previously entered responses in the model) and generate automatic responses for users [25]. The knowledge base and its training are shown below.

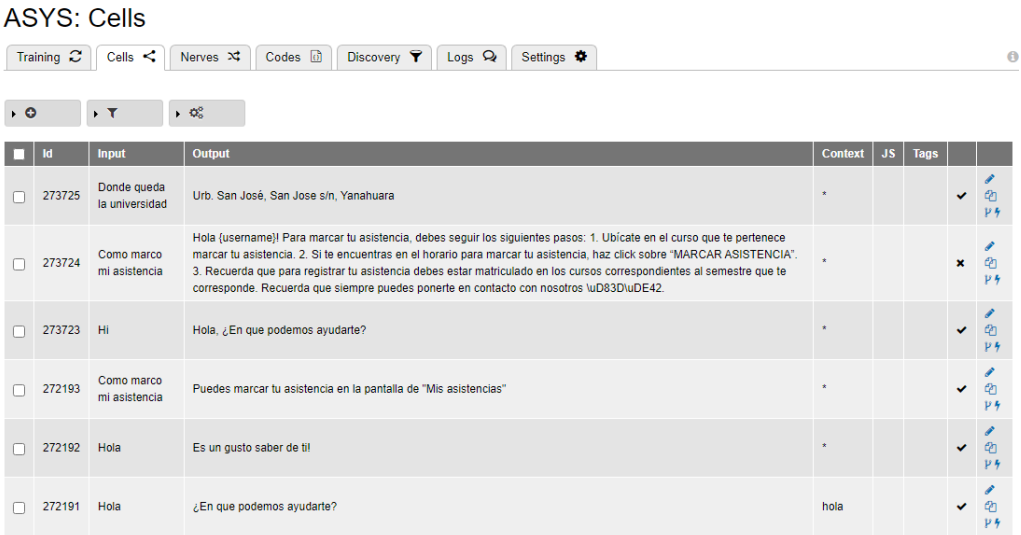

Figure 7: BrainShop.ai Knowledge Base

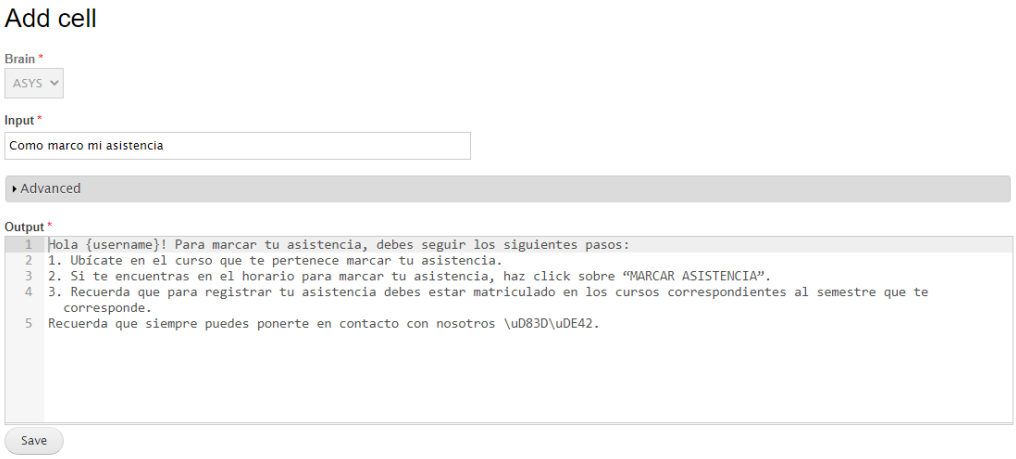

Figure 8: Training of the Machine Learning Model Knowledge Base

Additionally, Figure 9 shows the implementation of the ChatBot in the application.

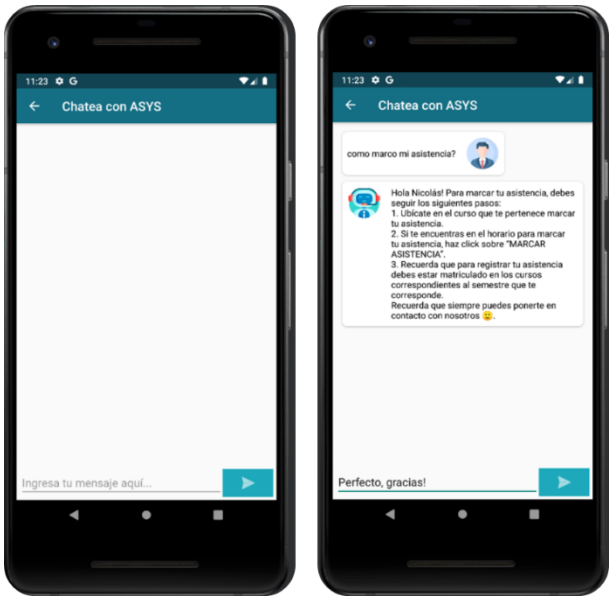

Figure 9: Result of ChatBot Implementation in the Application

3.3.4. Results of the Coding Phase

The following are the main screens of the resulting application based on the user stories from the planning phase (Phase 01 of the XP methodology). It is important to note that these results are after the testing phase (Phase 04 of the XP methodology).

1. User Story 01: Access to the Application

The following interfaces illustrate how access to the application is achieved, featuring a welcome screen and another where entry is made based on roles (Student – Teacher).

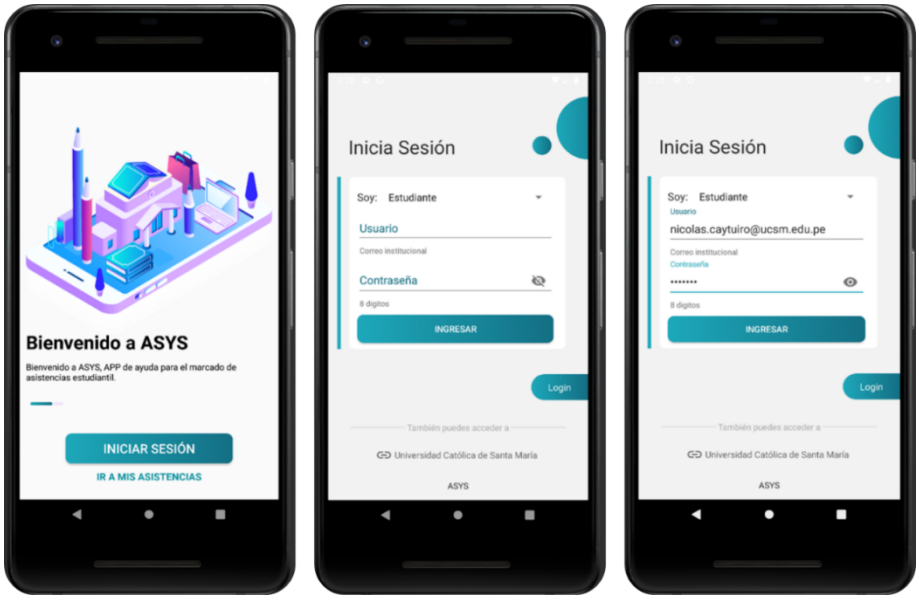

Figure 10: Access to the Application Interfaces

2. User Story 02: Attendance Registration

Figure 11 displays the list of courses in which the student is enrolled, along with various alerts depending on whether it is their turn to register attendance or not.

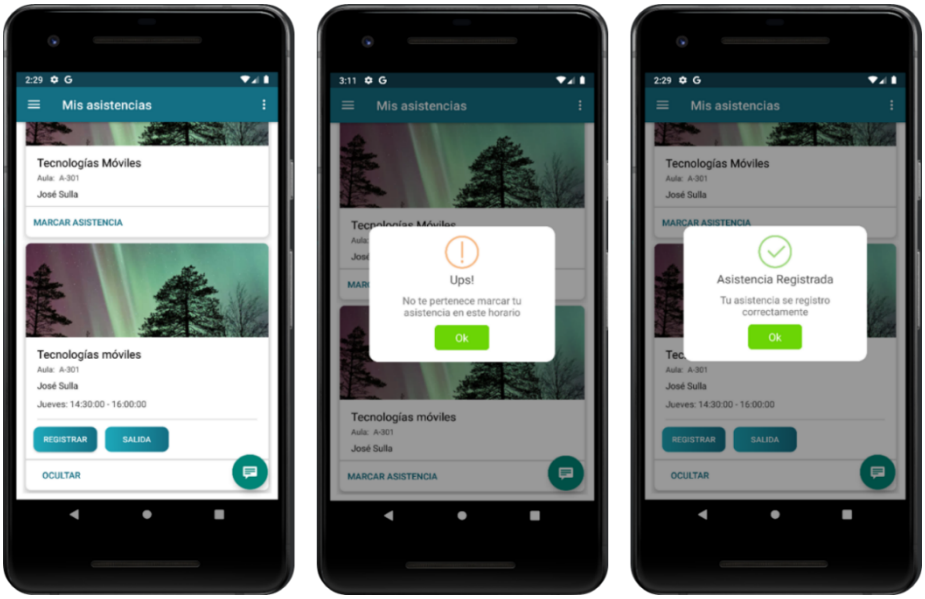

Figure 11: Attendance Registration Interfaces

3. User Story 03: Attendance Control

The following screens demonstrate how attendance control is carried out by teachers, following these steps:

- Log in to the application with the role of "Teacher" (only accesses identified with this role are recognized).
- Navigate to the corresponding course and click on "DOWNLOAD ATTENDANCE CONTROL," which will generate and download a CSV spreadsheet for teachers. Illustration 13 shows an example of attendance control performed by a teacher.

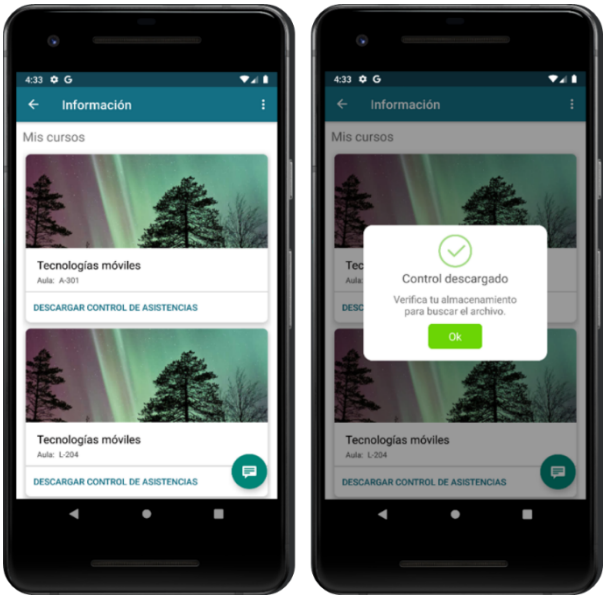

Figure 12: Screen to download student attendance control

	A	B	C	D	E	F	G	H	I
1	codigo;;;;;;;;								
2	2019118521;2/05/2022 14:55;2/05/2022 16:58;9/05/2022 14:59;9/05/2022 16:56;16/05/2022 15:00;16/05/2022 17:04;23/05/2022 15:00;23/05/2022 16:55								
3	2019600011;2/05/2022 14:56;2/05/2022 17:01;9/05/2022 15:00;9/05/2022 16:59;16/05/2022 14:58;16/05/2022 17:00;23/05/2022 14:56;23/05/2022 16:59								
4	2018800362;2/05/2022 14:58;2/05/2022 17:04;9/05/2022 14:57;9/05/2022 17:02;16/05/2022 14:59;16/05/2022 17:03;23/05/2022 15:04;23/05/2022 17:03								
5	2019600011;2/05/2022 14:59;2/05/2022 16:57;9/05/2022 15:00;9/05/2022 16:58;16/05/2022 15:04;16/05/2022 17:03;23/05/2022 15:03;23/05/2022 16:57								
6	2019700972;2/05/2022 15:00;2/05/2022 17:00;9/05/2022 14:58;9/05/2022 16:58;16/05/2022 14:56;16/05/2022 16:59;23/05/2022 14:58;23/05/2022 16:58								
7	2019802852;2/05/2022 15:01;2/05/2022 17:03;9/05/2022 15:01;9/05/2022 17:04;16/05/2022 14:55;16/05/2022 17:01;23/05/2022 15:01;23/05/2022 16:56								
8	2019702151;2/05/2022 15:03;2/05/2022 16:56;9/05/2022 14:58;9/05/2022 17:03;16/05/2022 15:00;16/05/2022 17:04;23/05/2022 14:58;23/05/2022 16:57								
9	2019205381;2/05/2022 14:56;2/05/2022 16:59;9/05/2022 15:00;9/05/2022 16:59;16/05/2022 14:56;16/05/2022 16:57;23/05/2022 15:04;23/05/2022 17:02								
10	2019119012;2/05/2022 15:04;2/05/2022 17:02;9/05/2022 14:56;9/05/2022 17:04;16/05/2022 15:03;16/05/2022 16:55;23/05/2022 15:01;23/05/2022 16:58								
11	2019205281;2/05/2022 15:03;2/05/2022 16:55;9/05/2022 15:55;9/05/2022 16:56;16/05/2022 15:00;16/05/2022 16:56;23/05/2022 15:00;23/05/2022 17:03								
12	2019215591;2/05/2022 15:00;2/05/2022 16:58;9/05/2022 15:01;9/05/2022 17:00;16/05/2022 15:04;16/05/2022 17:00;23/05/2022 15:02;23/05/2022 17:04								
13	2019205311;2/05/2022 14:57;2/05/2022 17:01;9/05/2022 15:04;9/05/2022 17:03;16/05/2022 15:55;16/05/2022 16:59;23/05/2022 14:57;23/05/2022 17:04								
14	2019802901;2/05/2022 15:01;2/05/2022 17:04;9/05/2022 15:02;9/05/2022 16:57;16/05/2022 15:03;16/05/2022 16:57;23/05/2022 14:59;23/05/2022 17:01								
15	2019205351;2/05/2022 15:02;2/05/2022 16:57;9/05/2022 15:03;9/05/2022 17:01;16/05/2022 14:57;16/05/2022 17:02;23/05/2022 15:55;23/05/2022 17:00								
16	2019802911;2/05/2022 15:04;2/05/2022 17:00;9/05/2022 15:04;9/05/2022 16:55;16/05/2022 15:02;16/05/2022 17:01;23/05/2022 15:00;23/05/2022 17:00								
17	2019205271;2/05/2022 15:55;2/05/2022 17:03;9/05/2022 15:03;9/05/2022 17:00;16/05/2022 15:01;16/05/2022 16:58;23/05/2022 14:56;23/05/2022 17:01								
18	2016600972;2/05/2022 15:00;2/05/2022 16:56;9/05/2022 14:56;9/05/2022 17:01;16/05/2022 14:58;16/05/2022 16:56;23/05/2022 15:03;23/05/2022 16:56								
19	2019205181;2/05/2022 14:58;2/05/2022 16:59;9/05/2022 14:55;9/05/2022 16:57;16/05/2022 15:01;16/05/2022 16:58;23/05/2022 14:55;23/05/2022 16:59								

Figure 13: "Mobile Technologies - Practice Group 1" Attendance Control File

The record indicates the date, entry time, and exit time registered by the student. The record corresponds to the "Mobile Technologies – Practice Group 1" course, scheduled for "Tuesday 15:00 – 17:00."

3.4. Phase 4: Testing

When using the XP methodology, it is recommended to use unit tests and acceptance tests [26]. Unit tests verify the code developed by the programming team, while acceptance tests verify if the final product meets the expectations proposed in the planning phase. In our project, each module was tested to ensure that appropriate values were entered, it led the client to correct activities, and maintained integrity and security of the data provided by students and teachers. Finally, customer satisfaction was verified through surveys and scheduled presentations of the final product to determine if all user requirements and expectations were met.

Table 7
Functional Tests

Identifier	Functional Requirement	Errors or Failures Detected	Improved (YES/NO)
CU01	Student registration in the application	No access errors detected	No
CU02	Student attendance marking	Incomplete interface	YES
CU03	Attendance saving	Inconsistency in Firebase date format	YES
CU04	Teacher login to the application	Incomplete interface	YES
CU05	Attendance list download	Incomplete downloads	YES
CU06	Attendance view	Disordered visualization	YES
CU07	Attendance marking	Attendance could not be recorded	YES
CU08	Login with email and password	Lack of email recognition	YES

For the application launch, a survey was developed. The survey includes various questions to validate and verify user satisfaction with the use of the application. The criteria considered for the survey development are shown in Table 8.

Table 8
Evaluation Criteria

No.	Criteria to Evaluate	Description
1	Satisfaction and Ease of Attendance Marking	Evaluation of attendance marking through communication with students and the ease with which they perceive the marking.
2	Organization of ASYS Application Elements	A form is provided where users rate the organization of application elements, divided into different views of the application.
3	Application Colors	A list of colors, including the current application color, is provided, and users are asked to vote for the most comfortable color for them.
4	Application Navigation Style	Communication with application users about their comfort level with application navigation.
5	Application Ease of Use	Communication with application users about their initial experiences using the application.
6	Application Learning Ease	Communication with application users about the time it takes to adapt to it.
7	Intuitive Application	Users are asked to rate the application based on the ease it provides for performing all actions within it.
8	Recommendation of Application Use	Communication with users about the likelihood of recommending the application.
9	Satisfaction Level with Application Use	A form with different areas of the application is provided for users to measure the satisfaction level for each view and a general rating.

3.5. Phase 05: Launch

For the application launch, the following steps were followed:

- Generate the APK of the application.
- Publish the APK on the website: https://coachup.site/
- Evaluate the results obtained through the survey.

This launch method was chosen for its flexibility and ease, as the application is still in its validation stage.

4. Results

Information was collected from 100 students and teachers in the 4th year of the Systems Engineering professional career at the Universidad Católica de Santa María for 1 month in the odd academic semester of 2022-I. The results of the conducted surveys are presented below.

1. Population

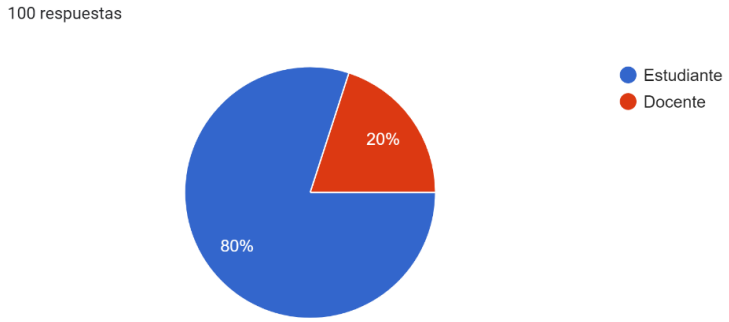

Figure 14: Total Population

The chart shows that 80% of respondents are students, and 20% are teachers. Likewise, a scale was made to assess the satisfaction level of users with the mobile application. Table 9 shows the scales, and the chart below shows the responses obtained by students.

Table 9
Satisfaction Levels with the Mobile Application

Satisfaction Level	Description
1	Poor
2	Regular
3	Good
4	Very Good
5	Excellent

2. Satisfaction Level with the Application Use

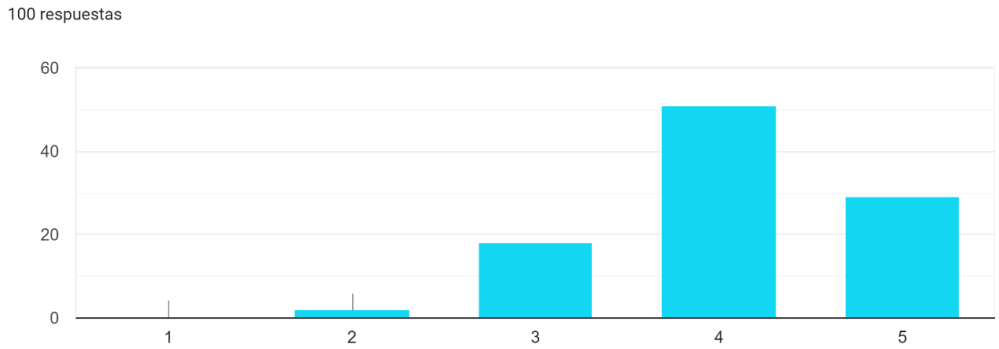

Figure 15: Users' Satisfaction Level with the Mobile Application

Among the total respondents, 18 (18%) consider their interaction with the application to be good, 51 (51%) consider it very good, 28 (28%) consider it excellent, and 2 (2%) consider it regular. The latter cases may be due to a lack of internet connection or inappropriate use of the application by users.

3. Application Acceptance Level

Additionally, given that one of the long-term objectives of this research is for the application to be used in all schools of the Universidad Católica de Santa María, a question was asked about whether users would recommend the use of the application to others. The responses to this question are shown below.

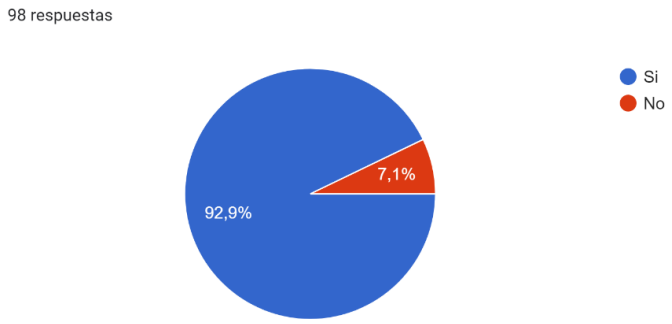

Figure 16: Would users recommend the use of the application?

The chart shows that 92.9% of users would highly recommend the use of the application, while the remaining 7.1% would not recommend it. These cases were evaluated in the testing phase, as many of these users may not have constant internet access or may not use the application appropriately.

5. Discussion

The results demonstrate that users (teachers and students at UCSM) feel comfortable using the application to register their attendance, indicating ease of use.

Additionally, acceptance criteria were developed to verify the acceptance levels of the "ASYS" mobile application [8], achieving the following compliance levels for each criterion:

Table 10
App Acceptance Criteria. Adapted from [8]

Criteria	Results	Compliance Level (%)
Functionality	The system meets the necessary functionalities for the correct process in attendance registration and control.	100%
Operability	The system works in an integrated manner with the database manager for subsequent functionalities implemented in the application.	100%
Satisfaction	The results obtained in section IV indicate the degree of satisfaction that both teachers and students have with the use of the application.	98%
Acceptance	The "ASYS" application meets the registration and attendance control of students.	92.9%

The table indicates that based on the acceptance criteria, 100% compliance was achieved in the functionality and operability criteria, indicating complete fulfillment. In contrast, in the

satisfaction and acceptance criteria, 98% and 92.9% were obtained, respectively, which, according to [8], represents a significant percentage compared to the resulting percentage of the difference (2% and 7.1%, respectively).

6. Conclusions

- It is concluded that the XP methodology, after executing its first three phases, ensures the quality of the mobile application. It has the advantage of being more customer-oriented than development process-oriented, unlike other traditional methodologies that impose a disciplined development plan.
- The use of tools and techniques oriented in the XP methodology contributed to the identification of functional and non-functional requirements, which helped in developing an application oriented to compliance with specified guidelines and requirements.
- The use of the XP methodology contributes to the development of a mobile application for attendance control by enabling constant communication and feedback with the client/user. It also provides quick responses to changes suggested by the client, thanks to the flexibility of the tools and techniques found in this methodology.
- The execution of the mobile application demonstrated positive results in the correct implementation of Firebase services (Cloud Firestore and Firebase Authentication) in the access and attendance marking modules.
- The use of the application facilitated attendance registration for students and teachers, allowing the generation of a record with the attendance of each student.
- Machine Learning techniques were employed to generate automatic responses to user questions. This functionality of the application proved to be useful when users do not know how to mark their attendance or have other questions related to the use of the application.

Future Work

As future work, the use of other ML techniques such as image recognition and geolocation for student attendance registration is proposed.

Improvement in control is also suggested. This includes the ability for teachers to download files that allow them to select which types of data they want to retrieve from the database, such as dates or student information. Additionally, enhancing the visualization of control data is proposed, as currently, it is only downloaded in a date and time format when the student registered their attendance (Entry/Exit).

Furthermore, scaling the database to a relational database schema is considered, which can work hand in hand with the UCSM database.

Improving the security of the application is suggested, considering that data is an important asset for an organization. Enhancing application security to a much higher level is part of the future plans.

Implementing the application for iOS operating systems is also planned.

References

[1] A. Abdul, R. Mohamad, F. Abdul y N. Izzati, «Student Attendance System Using An Android Based Mobile Application» 2021 IEEE 11th IEEE Symposium on Computer Applications & Industrial Electronics (ISCAIE), pp. 224-227, 2021.

[2] I. N. d. E. e. Informática, «El 66.8% de la población de 6 y más años de edad accedió a internet de Enero a Marzo del presente año (2021),» INEI, Lima, 2021.

[3] I. Milon, H. Kamrul, B. Masum y U. Manik, «Development of Smartphone-based Student Attendance System,» de 2017 IEEE Region 10 Humanitarian Technology Conference, Dhaka, Bangladesh, 2017.

[4] BrainShop, «BrainShop Documentation: Quick Start,» 2020. [En línea]. Available: https://brainshop.ai/node/260732. [Último acceso: 10 Junio 2022].

[5] O. Adewale, S. Olatunde y A. Segun, «Development of mobile and desktop applications for a fingerprint-based attendance management system,» Indonesian Journal of Electrical Engineering and Computer Science, vol. 24, nº 1, pp. 570-580, 2021.

[6] C. A. Roca Espinosa y A. J. Villafuerte Benavides, Aplicación móvil para registro de asistencias de la Universidad Central del Ecuador, Quito: Universidad Central del Ecuador, 2017.

[7] C. Lu y M. Cutumisu, «Online engagement and performance on formative assessments mediate the relationship between attendance and course performance,» International Journal of Educational Technology in Higher Education, vol. 19, nº 2, p. 23, 2022.

[8] A. L. Padilla Cando y J. Y. Sánchez Pilay, Desarrollo de una aplicación Móvil prototipo para el registro y control de asistencia estudiantil en la Carrera de Ingeniería en Sistemas Computacionales basada en Tecnología de Reconocimiento Facial, Guayaquil: Universidad de Guayaquil, 2020.

[9] J. Martínez-López y D. R. Obregón-Colina, «Aplicación móvil para la gestión de registros de asistencia y evaluaciones de los estudiantes universitarios,» Dialnet, vol. 18, nº 3, pp. 97-111, 2020.

[10] A. Alibasi, H. Upadhyay, M. C. E. Simsekler, T. Kurfess, W. L. Woon y M. A. Omar, «Evaluation of the trends in jobs and skill-sets using data analytics: a case study,» SCOPUS, vol. 9, nº 32, 2022.

[11] N. Qotrun Nada, U. Khotimatus Saadah, A. Khoirul Anam, Widianingrum, S. Wibowo y M. Novita, «Design on 'FunPhy: Fun Physics' Educational Game Apps using Agile EXtreme Programming,» Journal of Physics, vol. I, nº 1, pp. 216-226, 2019.

[12] A. Shah, S. Ahirrao, S. Pandya, K. Kotecha y S. Rathod, «Smart Cardiac Framework for an Early Detection of Cardiac Arrest Condition and Risk,» Frontiers in Public Health, vol. 9, nº 762303, pp. 2296-2565 , 2021.

[13] D. Martinez, X. Ferre, G. Guerrero y N. Juristo, «An Agile-Based Integrated Framework for Mobile Application Development Considering Ilities,» IEEE Access, vol. 8, nº 1, pp. 72461 - 72470, 2020.

[14] D. Forum, D. Chowdhury, K. Rupinder, P. Marloes, R. Chand, G. Singh, S. Singh y R. Buyya, «A system for monitoring health status of heart patients using machine learning and cloud computing,Internet of Things,» HealthCloud, vol. 17, 2022.

[15] A. J. Alvares, A. C. Alves Souza y M. Feitosa de Castro, «Implementation of a meter reading mobile application (App) for water and electricity based on computational vision,» Revista Brasileña de Computación Aplicada, vol. XII, nº 3, pp. 107-121, 2020.

[16] X. Weng, H. Wu, Y. Pan y H. Chen, «Decentralized Personal Cloud Data Model and its Application in Campus Health Information System,» 2021 IEEE Intl Conf on Dependable, Autonomic and Secure Computing, Intl Conf on Pervasive Intelligence and Computing, Intl Conf on Cloud and Big Data Computing, Intl Conf on Cyber Science and Technology Congress, vol. I, nº 1, pp. 879-883, 2021.

[17] C. Khawas y P. Shah, «Application of Firebase in Android App Development - A Study,» International Journal of Computer Applications, vol. 179, nº 46, pp. 49-53, 2018.

[18] P. Reyes y R. Marín, «Aplicación web empleando la metodología XP para la gestión académica del instituto de informática de la Universidad Nacional del Altiplano Puno - 2019,» Repositorio UNAP, Puno, 2021.
[19] R. Pressman, Software engineering, Americo: Mc-Graw Hill, 2010.
[20] T. A. P. Katrilla y P. Dewa, «Optimization of Innovation features in Mobile-Based Attendance Application,» Management Systems in Production Engineering, vol. 30, nº 1, pp. 18-26, 2022.
[21] J. L. Reyna Robles, E. Cieza Mostacero, O. R. Alcántara Moreno y J. F. Pacheco Torres, «Aplicación móvil multiplataforma para mejorar la gestión de ventas en la veterinaria Janavet de Trujillo,» 19th LACCEI International Multi-Conference for Engineering, Education, and Technology, vol. I, nº 1, pp. 21-23, 2021.
[22] K. Muhammad, P. Yudi y A. Moterico, «Usability Measurement in User Interface Design Using Heuristic Evaluation Severity Rating (Case Study: Mobile TA Application based on MVVM),» 2022 IEEE 12th Annual Computing and Communication Workshop and Conference, CCWC 2022, pp. 974-979, 2022.
[23] Firebase, «Firebase Documentation: Modelo de datos de Cloud Firestore,» 2022. [En línea]. Available: https://firebase.google.com/docs/firestore/data-model?hl=es-419. [Último acceso: 16 Junio 2022].
[24] B. Ranoliya, N. Raghuwanshi y S. Singh, «Chatbot for university related FAQs,» 2017 International Conference on Advances in Computing, Communications and Informatics (ICACCI), pp. 1525-1530, 2017.
[25] K. Chung y R. Park, «Chatbot-based heathcare service with a knowledge base for cloud computing,» Cluster Computing, vol. 22, p. 1925–1937, 2018.
[26] J. Gutiérrez, M. Escalona, M. M. y T. J., «Pruebas del Sistema en Programación Extrema,» Departamento de Lenguajes y Sistemas Informáticos, Universidad de Sevilla, Sevilla, 2022.