

Mobile Application Prototype: Learning in the Programming Course in Computer Engineering Students

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Abstract—Students need to continue with the learning process related to the world of programming because today are in the era of technological globalization. Therefore, it is very important to learn about it, since programming is used in different areas and as a result obtain software, electronic devices, among others. seek to design a mobile application that helps students learn much more about programming, since students in the first cycles of computer science and computer science have difficulties learning about different programming languages. That is why the application seeks to help the student by complementing their learning in such a way that they can obtain favorable results in their progress thanks to the development of the application. The objective is to design a mobile application for teaching programming in a didactic way that helps computer science students with learning difficulties. The methodology used is Design Thinking, because it is an agile methodology that is based on phases that help us understand and collect information about the problem encountered in order to provide a solution. As for the case study, the design of the mobile application and the detailed development of the prototype are shown. The result obtained is the prototype of the mobile application in which students with learning difficulties will benefit. In addition, a survey carried out at the University of Sciences and Humanities to students and teachers is shown, where very relevant data is obtained according to their learning.

Keywords—Design thinking; learning; mobile application; students; programming.

I. INTRODUCTION

Due to The worldwide pandemic by the coronavirus or also called Covid-19 has led to a global rethinking as teaching either in schools or universities, around the world countries had to close student centers for several weeks due to the pandemic, therefore, technology has taken huge steps in a very surprising and significant way [1],[2],[3]. An important factor is programming; because websites, applications, software and everything have as a tool today to work from home or remotely or take classes from the comfort of home requires devices that are developed based on codes and that is where programming becomes of paramount importance worldwide [4],[5].

The education related to programming is very essential for the technological development in Latin America and around the world, this is because most of the organizations, in the labor and student field are subject to the applications that are created through codes coded in different programming

languages performing their functionalities correctly [6]. However, programming is involved in the development of different industries [7]. Nowadays learning the art of programming has a high transcendence in the trade field as learning English, since nowadays it is very essential worldwide, therefore programming can not only be useful for computer engineers or computer technicians, because programming is present in everything that surrounds us, that is why it can be for everyone who has a university degree as well as for those who do not have one, it does not vary in the result of learning. It should be noted that the most interesting thing about a programmer is that he can create new things from 0 [8] by means of codes for the resolution of existing problems.

Unfortunately, the Latin American continent does not have enough experts to be a world power in the field of software or information technology in general [9]. Due to the fact that there is no incentive since childhood in the art of programming, so it is important to encourage children today as well as young people with seminars or courses to join their own research establishments related to computer science [10]. Being more and more innovative, having as direct consequence the economic and social growth of the country where an innovative method is applied in such a way to begin to create a better future [11],[12].

Several university students of the first cycles in the University of Sciences and Humanities return to take the course of Programming is why the importance of this research is to help students with this mobile application so they can learn more about programming in a didactic way since that is an advantage for students in the student subject. Likewise, Peruvian universities in an applicative approach in programming generate great uncertainty to their students of the first cycles, since, they only count on referring their grades. The most common problems in these students is the difficulty of learning programming languages. For all these reasons, the present investigation took as a reference the University of Sciences and Humanities in the faculty of computer engineering where students of the first three semesters are involved, identifying some problems of complication in programming.

The methodology to be implemented is Design Thinking, which is an innovative procedure to produce outstanding ideas with great effectiveness in understanding and offering a solution to the needs of the users in order to obtain favorable results.

The implementation of the mobile application is very important, so formulate the following question: How will it improve the learning of computer engineering students in the programming course?

The objective of this research work is to implement a prototype of a mobile application to improve learning in a didactic way with the students of the first cycles of the programming language course.

The paper is structured as follows: Section II describes in detail the literature review. Section III shows the methodology, Section IV shows the case study, Section V shows the results and discussion and finally, Section VI presents the conclusion and Section VII presents the future work.

II. LITERATURE REVIEW

This section presents an overview of different studies on learning programming in a way that is easier for students to understand. Not only using different methods but also explaining why the different methods should be used creatively depending on the results.

According to the author [13], he mentions that the development of mobile applications is a group of processes and procedures that relate to software for different wireless computing devices either small or large, such as smartphones among others.

Therefore, the author [14], refers that the development of web applications and mobile applications has its origin in open source development. However, a very important difference is that mobile applications are commonly written specifically to take advantage of the unique properties or functionalities of a mobile device. For example, a gaming application can take advantage of the phone's accelerometer, just as a health device can take full advantage of a smart watch's temperature sensor.

Likewise, the authors [15], highlight that the most important mobile platforms today are Apple's iOS and Google's Android plus an important fact is that Apple phones and tablets come preinstalled with essential applications, including a full web browser and the app store. Android devices also come preinstalled with similar applications through the Google Play Store now live in an era of technology agigantada, where interact daily with our mobile devices, in this context, this research project is aimed at developing an interactive mobile application to enhance the learning process to students through programming.

Education is very important for the formation of students in general, likewise it is advisable to integrate the use of mobile applications in the teaching-learning process of all other fields, to take advantage of the benefits brought by mobile technology and promote students to create a creative study habit [16]. Concluding that the optimal results have been obtained, successfully implemented in the learning process related to programming, thus having a significant impact on this type of implementation; obtaining a comfortable result.

Most first-year computer science students will find learning object-oriented programming difficult. Serious games have once been used as an approach to handle this problem. But most of them cannot be played on mobile devices. Obviously,

this does not suit the era of mobile computing that aims to enable students to learn programming skills anytime, anywhere, thereby enhancing the learning of programming languages. A research project started more than a year ago and aims to create a serious gaming approach related to mobile devices along with an educational game for learning programming. To date, the project has conducted a literature review to understand the existing work and identify problems in the field, conducted surveys to find out the needs of students for a mobile device based approach and then set up a serious mobile device based gaming approach with a developed prototype of the game [17]. It is expected that the presented project will be useful and helpful to integrate more effective approaches with didactic mobile games for learning object oriented programming in such a way to enhance the learning experience for university students.

Thus, the authors [18], describe that mobile technologies have a great impact on education and teaching of computer science programming, which leads to the development of tools to benefit this process in introductory courses. The increased use of cell phones makes it possible to encourage their use in programming courses using a mobile platform, seeking to improve classes with out-of-class support. It shows the structure and experience of use of Paepoo, Platform for Learning and Education of Object-Driven Programming, a mobile application where students, enthusiastic about the use of their cell phones, accept an active and committed role in their learning process, taking advantage of the support platform with great results and approval.

The authors [19], emphasize that to explicitly model complex dependencies between applications, adopt a dynamic graph structure to learn users' interests. First, extracted users' interests in each application usage graph using the hierarchical graph attention mechanism. Second, capture the time evolving user interests and generate the dynamic user embeddings by modeling the temporal dependencies among multiple application usage graphs. Finally, obtain the current user interests in the current application usage graph, merge the interests of multiple users, and generate comprehensive user embeddings for the next mobile application recommendation.

The authors [20], mention the rapid development of information technologies makes it possible to create and innovate more mobile devices. Most of the distance learning students require access to analysis materials such as communication tools and also extra learning media not only at home or at their workplace. The purpose of this article is to expose the modalities of mobile technology in computer science and programming education. According to the results of surveys conducted in elementary schools, high schools and universities. It is possible to mention that mobile devices are used more and more in relation to learning. The results of surveys and experiments show that mobile devices have the potential to improve education in computer science, programming and algorithms. The article explains the experience of teaching and development of mobile applications, for teaching and for users with special needs.

Likewise, the authors [21], researched and analyzed the development of a mobile application for the education of basic concepts such as programming. The purpose is to help students acquire skills while having fun and using their own

devices. The mobile application was designed according to a cross-platform approach to reach the widest possible audience of students, saving development and maintenance time and effort. The code is fully shared between IOS, Android and Windows mobile platforms, allowing students to install the app on any device. The core application is based on a multivalent system to make the app interactive, flexible and dynamic and provide students with personalized instructions [22]. A prototype showing the main features of the application is presented.

In summary, the authors analyzed in their research conclude that over the years in the field of learning together with technology has been advancing rapidly so must adapt to the era of globalization using beneficial tools that help us to be able to do new things from 0 as is the programming applied in computer science.

III. METHODOLOGY

The Design Thinking process is made up of 5 phases and the Design Thinking methodology contains iterative processes, it is not linear, therefore it is a process that serves to address complicated challenges made up of the so called wicked problems or drawbacks, drawbacks that are complicated to conceptualize and solve as they was discovered during the practice of the process of the methodology. The most interesting thing is that at any time you can take steps forward or backward if required in the Design Thinking process, jumping even to non consecutive stages, collecting information and generating a huge proportion of content, which will grow or shrink depending on the stage in which are. Fig.1 shows the phases that implement next [23], by means of questions so that these are answered in an effective way in order to have good results.

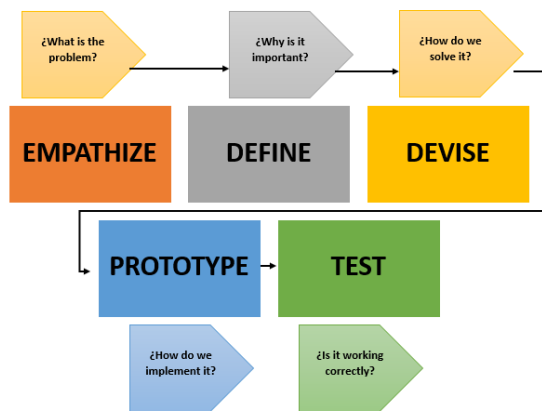


Fig. 1. Design Thinking.

Phases of Design Thinking

1) *Empathy*: As the first phase begins with understanding the needs, based on the requirements of the users, that is why in this first phase we must put ourselves in the situation of the users, so that from this we are able to create resolutions for a better lifestyle.

2) *Define*: As a second phase must process the information collected throughout the previous stage in such a way that are left with what really adds value to the research, therefore, it leads us to the scope of the perspectives. Therefore, identify drawbacks to solve the problem as a key point to obtain a satisfactory result, but above all innovative.

3) *Ideation*: As the third stage of Ideation, its purpose is to generate an infinite number of possibilities for the resolution of the problem encountered, which is why should not just go with the first thing that comes to mind, must analyze the situation well. At this stage, the requirements favor the creation of the application. Sometimes, the most extravagant ideas are the ones that produce creative resolutions.

4) *Prototyping*: As a fourth phase implement prototyping in which turn ideas into reality. That is, building prototypes directed towards the ideas helps us to visualize the probable resolutions. Therefore, at this stage can see the resources that must improve or modify in order to reach the final result.

5) *Testing*: Throughout the Testing stage, the prototypes will be tested with users based on the solution being implemented, therefore this stage is crucial which will allow us to detect improvements as well as failures to be solved, throughout this stage it evolves because it starts with the initiative until get to turn it into the solution were trying to find in such a way that return a properly developed final product.

IV. CASE STUDY

1) *Empathy*: Applying the first stage collected detailed information by means of surveys with university students of the first cycles, in the first instance, in order to know if they had an elementary idea of what are the algorithms related to programming, therefore it was mentioned if they would use a didactic application to complement their learning in their classes. Likewise, in order to know and understand the inconveniences and problems that emerge in the students today and to understand their situation, in such a way to collect the case since it is of great importance for our inquiry and execution of this investigation. Tables I, II, and III were validated by expert judgment. Validation was of contents where the validation scale was low from 0 to 35%; from 35% to 70% medium; and from 70% to 100% high to medium. the evaluation criteria were relevance, coherence and clarity. Obtaining 85%, giving as approved by expert judgment. As it is observed in Table I, 3 questions were made to the students of first cycle of the career of computer science where the following questions were asked Do you like the art of programming? Do you have difficulties in understanding the different programming languages? And finally, is it difficult to learn to program? Thanks to these questions valuable information was collected.

TABLE I. QUESTIONS ON THE TASTE OF PROGRAMMING

	Questions
Q1	¿Do you like the art of programming?
Q2	¿Do you have difficulties in understanding the different programming languages?
Q3	¿Do you find it difficult to learn to program?

2) *Define*: In this stage seek to detect a starting point based on the detailed information through the data obtained in the previous stage from the surveys, so that can propose the best solution for that need. As understand the student's need and have access to the different examples and tasks based on algorithms, as shown in Table II, 4 questions were asked based on stage where the following questions were asked: As a student, how important do you think algorithms are in the creation of something new? How do you create a programming algorithm? How do you develop a programming algorithm? What programming language do you often use? Thanks to these questions gathered important information.

TABLE II. QUESTIONS ON THE IMPORTANCE OF PROGRAMMING

Questions	
Q1	¿As a student, how important do you think algorithms are in the creation of something new?
Q2	¿How is a programming algorithm created?
Q3	¿How is a programming algorithm developed?
Q4	¿What programming language do you often use?

3) *Ideation*: Keeping in mind the two previous phases, which are empathizing and defining, several ideas were obtained to decide the functionality of the application. Likewise, the needs of the students will be aligned with the facilities provided by the implementation of the application. As shown in Table III, three questions were asked to students of the first cycle of computer science where the following questions were asked: How often do you use technological applications on your mobile device? Do you consider innovative the idea of creating a mobile application that helps to reinforce your knowledge related to programming? Do you think it would be helpful to use a mobile application to learn to program through algorithms? Thanks to these questions a clearer perspective was obtained.

TABLE III. QUESTIONS ON THE MOBILE APPLICATION

Questions	
Q1	¿How often do you use technological applications on your mobile device?
Q2	¿Do you consider innovative the idea of creating a mobile application that helps to reinforce your knowledge related to programming?
Q3	¿Do you think it would be helpful to use a mobile application to learn programming through algorithms?

4) *Prototyping*: Once the idea was clear, we designed the didactic application for learning programming based on the different programming languages, adding to this that is implemented with a virtual assistant (Chatbot) which will accompany and help the user to perform their learning correctly in such a way to obtain favorable results.

- Python: Python is a computer programming language widely used in the development world widely used in the development world for many different applications. many different applications. Widely used in scientific research and in fields ranging from finance to biomedicine, Python is from finance to biomedicine, Python is making inroads in many professions. many professions. The world ranking of the most popular and popular and popular programming languages

shows that Python is among the top three Python is among the top three most preferred programming languages worldwide [24]. This is why it is important to introduce the Python language as a programming language in the computer and research and research centers in such a way that it can be applied in schools and in all in schools and in all Peruvian universities.

- Javascript: The JavaScript language was initially created for user-side programming in web browsers, nowadays its engine is included in various types of software programs, because the semantics of JavaScript are complex [25], especially thanks to its dynamic nature as the understanding and knowledge of JavaScript programs are challenging tasks for a programmer.
- Pseint: In introductory programming courses, students learn the logic for algorithm development. In these courses the usual methodology is to teach students the logic for the construction of algorithms in Spanish using paper, then in a second course a specific programming language is taught, usually C or Java. However, the syntax and instructions of the latter are in English [26]. This study analyzes the use of PSeInt as a support for teaching programming with syntax and instructions in Spanish.
- C#: The programs that are created have different types of formatting, i.e. the syntax that is used. The syntax in C# is a sequence of rules and processes that lead the composition of a procedure. These rules must be understood by the compiler that is executing the program in such a way as to produce a valid C# program, for example, they must implement how a line of C# code begins, how it ends and at what point to use, for example, quotation marks, brackets or braces [27]. The C# language excludes uppercase and lowercase letters, and the C# language is programmed in lowercase letters.
- Java: Nowadays we are in an environment of the Internet era, by means of the learning environment in this case of the university students suffering transcendental changes in their education, besides there has been a new change in the education, in which the learning by means of Internet became a tendency [28]. The java course is a must for every programmer, besides, it is worth mentioning that java is a very required platform, above all, safe and reliable for its development.
- Html: Learning Html presents challenges similar to those of learning a programming language, i.e. it is common for a beginner programmer to have a Html validator, and there are limited tools to help programmers who are just starting out in the programming world to fix bugs in their Html code. In this analysis, we used visualization techniques to show the structural and contextual information of Html code. looked at condensing and visually representing the relevant points of the Html code [29]. In other words, to allow novice programmers to obtain data about the composition of the Html code and to locate any semantic errors in corresponding syntax.

- Kotlin: Pure Kotlin code excludes the utilization of any java graphics library where it can be transpiled to JavaScript and realized on a web. Nonetheless, writing in Kotlin code will run without modification both in a web browser and also in jvm likewise being trivial in such a way precise adherence to a timely methodology is needed [30].
- Php 8: Php 8, was released at the end of 2020, being a fundamental update of one of the most famous programming languages so to speak so implemented in 4 out of 5 developed websites that use a server-side language also note that a free platform so the code is done on Linux, Windows. Php is subjectively easy to learn [31]. Many of the novel properties of PHP 8 where they make the code more efficient and accurate for a good development.

All the programming languages mentioned above are very essential to be able to program which is why these languages were chosen, because they are very required today in the labor market, also these languages will be implemented in the mobile application.

5) *Testing*: In this last phase verified in detail what was done, identifying each phase its good execution for the realization of the learning prototype related to the different programming languages, therefore a good performance was observed.

Fig. 2 shows the flowchart which begins by entering the application so that then be registered and then go to enter the application after the main screen where they will be attended by a virtual assistant who will welcome the registered user, for this the assistant will show the programming courses that are available for the user to choose any of them, you can also choose whether to start with the basic course, intermediate or advanced, Once the student has studied the selected programming language, he will go through a test of exercises where he will develop what he has learned. It is worth mentioning that if the student makes a mistake in the exercises, the virtual assistant will encourage him with some messages so that he keeps on trying, and if he solves the exercises correctly, he will be congratulated for what he has learned.

V. RESULTS AND DISCUSSION

A) About the Case Study

In this section for the case study, it was carried out the design of the mobile application implemented with a chatbot for learning the programming course applied in computer science students as well as this application can be used by people who need to know more about the world of programming is why the implementation of the application is very beneficial because it helps to complement the knowledge acquired in addition to put them into practice as the system comes with a list of exercises so that they can be developed and increase the student's knowledge.

Fig. 3 shows the user's welcome and registration interface by entering their first name, last name, Gmail and password, and they can also log in directly from their Gmail email if they require it so that they can register in the application.

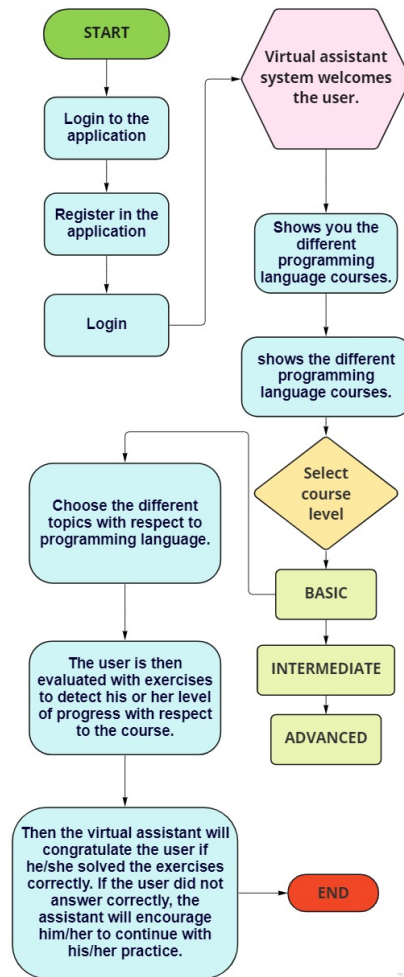


Fig. 2. Flow Diagram.

Fig. 4 shows the welcome screen where the user will enter the username and password established so that the chatbot can then welcome him by greeting him with his respective name, the virtual assistant will accompany the user in his learning process so that the teaching is more didactic and the student can better grasp the different topics provided by the application.

Fig. 5 shows the different programming languages where the user can choose the course he/she wants to learn. Once the free course has been chosen, the user will be asked whether he/she wants to start at the basic, intermediate or advanced level.

Fig. 6 shows the different topics of the course where, after having studied with them, you are given exercises to put into practice the skills you have learned.

Fig. 7 shows the results of the survey where students of the University of Sciences and Humanities of the systems and computer engineering career were asked if they like programming, thus obtaining a result of 39%, they were also asked about the different difficulties in understanding the programming course, where they answered that they had problems in understanding the process, thus obtaining 31%;

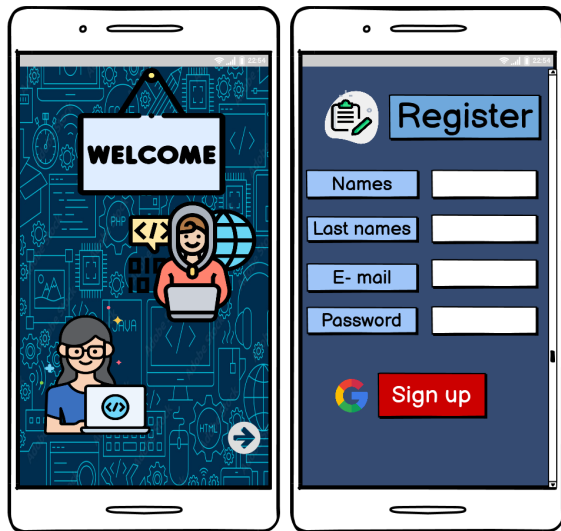


Fig. 3. Registration.

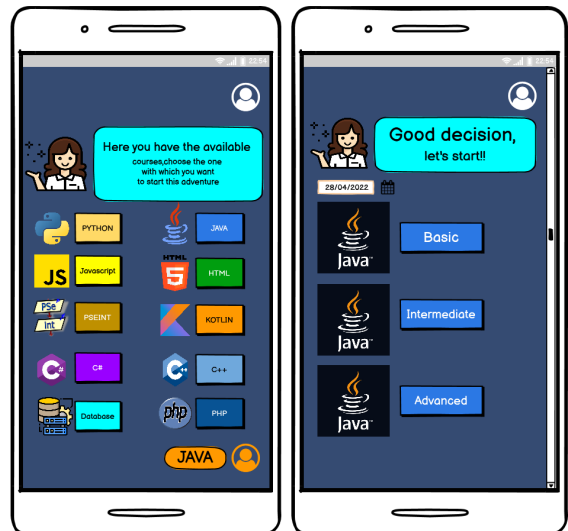


Fig. 5. Programming Languages.

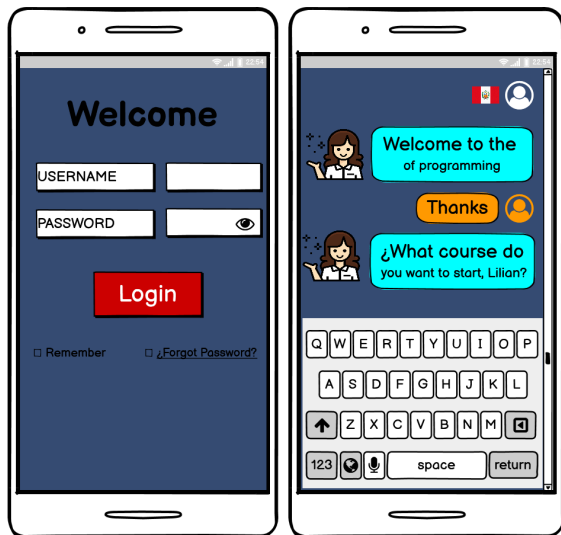


Fig. 4. Welcome.



Fig. 6. Course Level.

they were also asked if they had difficulties in programming, thus obtaining 30%.

Fig. 8 shows the results as first question 36% answering that algorithms have great relevance in the creation of something new, as second question 18% mentioning that algorithms are created by means of sequences or processes that must be executed efficiently, as third question 18% were obtained by means of tools such as the different languages that exist, also as fourth question 28% were obtained where students mention that they use Java and Python.

In Fig. 9, we return with a 35% mentioning that students use their device most of the time, also as a second question obtained a 31% where students mentioned that they consider the innovative idea of using a mobile application to help reinforce their learning based on programming and finally as a third question obtained a 34% having as a result that if it would be very useful to use the mobile application to help

them to increase their learning ability related to the different programming languages.

B) About the Methodology

The Design Thinking methodology has the possibility of approaching the creations in different fields in an adaptable and extreme way. Design Thinking also has a sequence of tools that are applied throughout the process of building the innovative product, therefore it can be used constantly because it is based on the resolution of problems from the customer's point of view, that is why the Design Thinking methodology was chosen because it is considered quite suitable to propose IT resolutions in process models in which prototypes are applied to clarify the requirements to the customer's satisfaction, some of these process models are used as prototypes for their solution. They allow a great relationship with the users, such as the construction and evaluation of the elaborated prototypes.



Fig. 7. Results on the Taste of Programming.

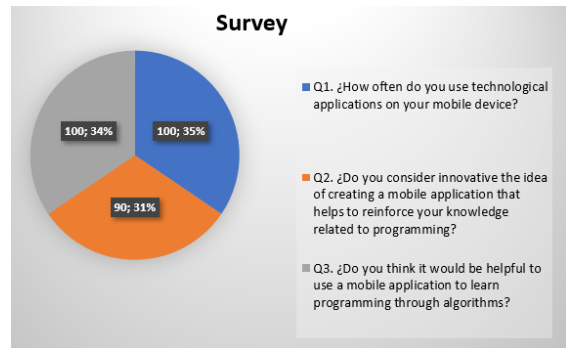


Fig. 9. Results on the Mobile Application.

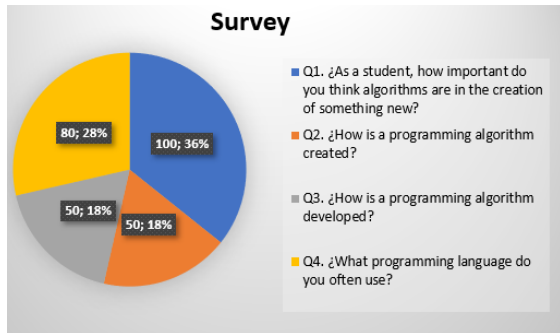


Fig. 8. Results on the Importance of Programming.

1) *Advantages:* One of the benefits of using this Design Thinking methodology is that it promotes the immediate solution to the problems that may arise during the development of the project. This is why the client is placed as the center of the construction process, in which the development is clear to overcome the challenges by guiding on the techniques and tools to use to solve a challenge both in an organization and in other spaces. It is necessary to emphasize that this methodology is people-centered, this means that it is a user-centered procedure whose fundamental potential is to solve real problems, also another benefit is that it adapts to the solution of the product and service through the customer's needs, thus excellent results are obtained.

2) *Disadvantages:* A disadvantage of the methodology is that it cannot be used for all types of projects, so it should be used in projects that require design thinking steps.

3) *Comparison:* Design Thinking is not only used by companies, in such a way that prestigious organizations have discovered its benefits and have incorporated it into their daily work because it designates the user as the main axis of the construction process before other approaches that try to move from thought to action. It also invites the user to be able to accept a more active role in the design of the required product, which involves the agents to dialogue between the user and the person in charge of making the innovative proposal, therefore the first approach of a team in innovation, it is essential to perform it in a focused way to a specific problem and then use the Design Thinking methodology offering a process where the stages have the possibility of being retaken and reiterated without further major limitations, In Scrum, you can work with a constant flow of projects that have to answer to the priorities through sprints, so there is a sequence of meetings

and therefore there is a point where there may be a contrast, however, have the possibility to take certain resources of Scrum as prioritization, or adopt organizational points that contribute to group work.

TABLE IV. COMPARISON

Design Thinking	Cascade	Scrum
They focus on the users to obtain better results.	Clear structure of the methodology	It is required for large projects.
Team collaboration in such a way accelerates the cycle for the development of new solutions.	It presents difficulty in the required changes.	Provides a democratic approach.
Innovative ideas for good control and performance.	Excludes the customer or end user.	Requires a thorough homework review.
Reduces project costs and risks.	Determines the target immediately.	Requires those who use the scrum methodology, have a high level of qualification.

Table IV shows in detail the comparison of the Design Thinking, Cascade and Scrum methodologies, identifying that Design Thinking reduces risks at low cost and is adaptable to changes, and the cascade methodology presents difficulties when making required changes, and finally the scrum methodology requires a thorough review when performing tasks.

TABLE V. TRADITIONAL METHODOLOGY VS. AGILE METHODOLOGY

Traditional Methodology	Agile Methodology
The project is carried out without divisions.	The project is subdivided into different parts.
Extensive documentation is available.	There is little documentation.
Develops in a predictive manner.	It is developed in a way that is adaptable to the project
Software deliveries at the end of the project.	software deliveries are constant.
There is little communication with the client or user.	There is constant communication with the project.
Hide the error.	Immediately detects the error for resolution.

Table V shows the comparison of using an agile vs. traditional methodology, making reference that for this research the agile methodology was used since it fits the project and also has better processes to be implemented.

VI. CONCLUSION

In conclusion, the design of the application will help many students of the first cycles of the career of computer science and computing since they have various difficulties as shown in the survey is why it was analyzed in detail and devised the prototype of the mobile application working together with a chatbot which will help the user to perform their learning correctly in order to obtain favorable results, in addition, its teaching will be didactic which many students like the pedagogical and not the monotonous that are simple applications where they will not have motivation for learning and what is required is to help the student and facilitate their teaching complemented with the various courses of programming language for free that provides the application, on the other hand, The use of the Design Thinking methodology was satisfactory, because it focuses on the user and on the problems that may arise through the realization of the project, therefore, what made possible is the development of the prototype design of the application also obtaining data on the learning of programming in computer science students of the first cycles at the University of Sciences and Humanities. With this design of the application, it is intended in the future to have the implementation of the software to be able to implement it, in such a way to help many students or people who want to learn more about programming being in different countries benefiting their knowledge and being enriched every day more through the knowledge provided.

VII. FUTURE WORK

With this design of the application, it is intended in the future to have the implementation of the software to be able to implement it, in such a way to help many students or people who want to learn more about programming being in different countries benefiting their knowledge and being enriched every day more through the knowledge provided. With this design of the application, it is intended in the future to have the implementation of the software to be able to implement it, in such a way to help many students or people who want to learn more about programming being in different countries, benefiting their knowledge and getting richer every day through of the knowledge provided. In addition, it must be applied to other courses of complexity in learning; for this they must select a complexity course for their application.

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