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Development of a Web System to Improve and Reinforce Learning in Mathematics in Primary and Secondary Students in Peru

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Abstract— This article describes the development and evaluation of a web system that aims to improve and reinforce mathematics learning in primary school students in Peru. Mathematics education is central to the school curriculum and it is important that students gain a solid understanding and ability to apply mathematical concepts in everyday situations. However, it is common for students to have difficulty learning and understanding courses in this subject, which can negatively affect their academic performance and self-confidence. To address this issue, a web-based system was developed that includes interactive lessons and personalized learning tools that are tailored to the individual needs of each student. The system also offers online resources and activities to help students deepen mathematical concepts and apply them to practical problems. To evaluate some drawbacks, a study was carried out with a group of parents of some primary school students in Peru. The results of the study showed that there is a worrying distrust of online study. Technology is set to revolutionize the way primary school students in Peru learn and study, providing access to a wide variety of digital resources and tools that can improve comprehension and academic performance. This work demonstrates the effectiveness of the web system developed as a tool to improve and reinforce mathematics learning in primary school students in Peru. The system provides a personalized and adaptive online learning platform that can help students improve their math skills and understanding, and increase their motivation and confidence.

Keywords- Online learning, educational platform, mathematics in primary education, reinforcement of learning, educational technology, digital tools for learning.

I. INTRODUCTION

Nowadays, education is essential for our formation as a person, the need to acquire knowledge from our childhood is practically an obligation if we want to have a fairly stable future, it should be noted that in previous centuries access to education was complicated for many people, because of the status they had, but in our time it is very accessible, and one of the many ways that exist are mobile applications, we believe that it is a dynamic way for schoolchildren to learn, since we see the madness that exists on the part from them to cell phones. Education is of vital importance for the development of the human being, which is why with our project we want to encourage schoolchildren to become passionate about learning, since it is one of the first steps that a human being must take in all his life. lifetime. When we talk about education in Peru we are talking about a really and, above all, worryingly low performance compared to many other countries worldwide.

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In 2015 our country began to compete in the International Program for Student Assessment (PISA), where some selected students participated to represent our country in the areas of science, reading comprehension and mathematics, the results obtained from that contest year was that Peru ranked 64 out of 70 competing countries [1].

While in 2018 our country competed for the second time, but this time the contestant countries were 77, 7 more than the previous year, the result of this test was that Peru was located in the same position, that is, position 64 of 77 contesting countries, it is true that this year we were not among the last 10, but we are still in alarming positions below Chile, Brazil, Colombia and other countries of our continent [2].

It seems somewhat contradictory to say that Peru is in the last places with respect to education, we say this because on some occasions we see news where young Peruvians obtain international prizes in the area of mathematics [3], when seeing this type of news, it seems that we are making progress with regard to education, but unfortunately this is not the case, we cannot deny that there are children and adolescents with incredible abilities and knowledge, but for many reasons it is difficult for most schoolchildren to acquire a taste for learning. Education has become a controversial issue due to the low performance of most schoolchildren internationally, and they try to find the reason for this worrying problem, and many hypotheses arose, such as little investment in education, poorly paid teachers, inadequate teaching methodology, lack of infrastructure and technology, among others [4].

Given the emergence of COVID and its consequences, one of the most affected groups were schoolchildren. One of the reasons was because the country was not prepared for such a problem, therefore not going to class and not receiving education made the school performance stagnant. This pandemic made us realize that in Peru there are many inconveniences to be able to carry out virtual classes, because not everyone has access to technology due to their low resources, other problems to mention are the lack of internet, coverage in rural areas of Peru, etc. [5]

Another study shows that education is still very little familiar with the use of web systems, in our case, to reinforce mathematics teaching. Some studies point out that one of the factors behind this lack of familiarity is that some applications have very technical language and are difficult for schoolchildren to understand. [6]

For this reason, we want to encourage the use of mobile applications for learning mathematics, for which 3 applications will be used that are easy for students to understand and use, the first of which is called Math Formulas learning, where it provides instant access to the most advanced mathematics. used and important formulas for lessons in arithmetic, algebra, calculus, geometry, trigonometry and logic; Second website is called 6th Grade Mathematics which provides over 200 questions and charts to help students understand topics, question limit option, as well as providing 2 levels of learning and showing student progress students for each subject through statistical graphs, announcements and by mail; the third website is called Math Challenge , which improves and increases cognitive ability through psycho engineering tests. [7]

The low performance in mathematics of Peruvian urban public school students in 5th and 6th grades of primary school could be improved through the use of dynamic web systems called Oracle Math. The authors performed 2 math tests on an experimental group and another 2 on the control group, taking into account that the students in these groups are in the 5th and 6th grade of primary school. The first test was carried out on a group that did not use the Oracle Math system, while the other was carried out on people who had used the system. The final test scores of the grade 5 experimental control group showed slight improvement as they initially scored 11, then later scored 13.55, while the same year control group received a score of 5. 11. point. they received a grade of 10.77 before using the system, then they received a grade of 12. If the difference between the final scores of the groups that used the system and those that did not use it is weak, then it is because the students already use the system, they have very little time to use it before the test, if they had more time, they could have gotten used to and studied the system more and therefore get a higher score [8].

In a thesis entitled Development of Android Mobile Applications in augmented reality for learning in the field of mathematical logic for the glorious Educational Institution 821 Macusani - 2014, he says that augmented reality improves student learning in mathematical logic elections, since this technology provides a better vision of graphics, mainly in geometry and trigonometry lessons , which allows a better understanding of the exercises and, therefore, can be approached with greater ease and safety. After the development of the application, results were found that support the effectiveness and usefulness of the application.

The first result tells us that 8% affirm that the image is excellent, while 8% affirm that the image is good and the remaining 8% affirm that the image is of normal quality. As for the second result, it is based on the benefits of the use of augmented reality in a student's geometry course, where clause 83 means that it benefits excellently, clause 13 indicates that it benefits well and the fourth sign that it benefits regularly. [9]

Although there are more results, the most important result has been taken, which is enough to test the effectiveness and usefulness of the application, and above all, the Bad option in the above results is still at 0%. [10]

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The presence of mobile phones is a daily reality and a constant in the lives of our young people. The new generations, the so-called "digital natives", that is, those born in the early 1990s, grew up surrounded by new technologies, including mobile phones, which significantly expand learning contexts to full spatiality, ubiquity, and temporality. . Any scenario, real and virtual, is a learning space possible thanks to ICT and especially mobile devices. [11]

Soon, mobile phones will be able not only to access content via the Internet but also to store information of a certain volume. Educators, far from responding with misgivings to another new challenge, should start thinking about new educational strategies to make the alternative profitable. [12]

II. METHODOLOGY

A. Development Planning and Analysis of the web system

To carry out this system, its development will be analyzed and planned through the use of methodologies and tools that help us to carry out the correct development of this software, likewise each aspect of the web system will be analyzed so that it satisfies those who use it.

1) Target audiences

Our target audience is the students who are in primary grades, we focus on them because we analyze that in order to have a better academic performance in the future, it is necessary to have a base or reference from the educational foundations, on the other hand, the topic of Mathematics is such a broad and highly varied subject that it helps to improve comprehension, ingenuity, creativity, among many other attributes that serve the educational , personal, and professional training of all of us.

2) Methodologies to be used for the development and direction of the software

a) SCRUM methodology

For the implementation of the mobile application, the agile SCRUM methodology will be used, which is easy to use, adapts to changes and helps identify errors and impediments during the implementation of the application.

In the following table 1 and table 2, we can visualize the functionalities of the needs and stories of the users with respect to the sprints (deliverables) that we are going to want to develop. To understand this, we must know our priorities and the importance of this product, whose final objective is to teach and improve learning in young people and children in the area of mathematics. That is why we group the most important needs into functions that the software will perform, with the aim of making it more functional and easier for everyone to use.

Table 1

SCRUM Sprints List Table

No. S	Sprint
I	Login (Entry and Registration to the System)
II	Menu (Agenda, Courses and Topics, Materials, Profile)
II	Questionnaire (Questions, Resolution)
IV.	Advice

In table 1 we can see the number and content of each Sprint to be carried out, of which we will refer to the following table 2 for a better understanding.

Table 2

Table of SCRUM Functions

No. F	functionalities	Sprint	Priority
F1	Login	I	Low
F2	Navigation and Search of Courses and their respective Topics	II	high
F3	User interaction with the content and material provided on topics of interest	II	high
F4	Learning evaluation obtained through questionnaire	II	high
F5	Feedback on learning through the resolution and review of the questionnaire	II	high
F6	Virtual Counseling	IV.	Half

In table 2 we can see the functionalities belonging to each sprint and in turn the priorities of each of them.

3) Tools to use for the creation of the software

a) JavaScript

We will use the tools and services they provide us. We will use them to add interaction features to the website or in academic words, with this programming language we will

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do our best to make the UX the best, it will also allow us to work on the backend.

b) CSS

This tool will help us to stylize our web application, it allows us to place colors, sizes, order the entire page, in short, it allows us to beautify our software.

c) HTML

This tool allows us to place the content on our page, through the labels that this language offers us, we can place images, videos, paragraphs, etc.

d) NODE JS

This tool allows us to work on the server side of our web application.

e) MYSQL

Database with which we will work in our web application.

B. *Functional Analysis of the Application at the Operational level*

1) Internal function of the website

The process begins when the user from his mobile device or computer enters the website and is identified by an account, if the user does not have one, they must register to the system using credentials and personal data, which will be stored in the system database. Once identified, the user accesses the server where they can interact with the content offered by the application through the menu.

From this point, the most important operations of the web system begin, since, through the database, it will provide the content to all the other operations, in the case of the visualization of the courses and their respective topics (syllabus), after choosing the desired course and topic, the database will provide us with the materials and content requested for learning and its development.

When the user learns this knowledge, he can take a questionnaire, which will be generated by the system together with the Database, these mathematical problems will be multiple choice. Something important to mention is that depending on the types of problems and the topic, the time limit that the evaluation has integrated will be varied; as well as the difficulty of the problems, if you want to repeat the questionnaire with a topic that has already been overcome. On the other hand, when you finish the quiz, the system will display the score; the mistakes; and solutions to the problems raised. All this will be recorded in the database allocated in the user's progress.

When it finishes determining the score obtained and the review, the system will opt for two decisions; the first decision will be made if the user fails to pass the questionnaire, they will be redirected to virtual advice through a step-by-step solution of the problems that were raised in the previous generated questionnaire, to then invite the user to return try to pass the quiz with new questions; The second decision of the system will be made when the user satisfactorily passes the questionnaire, redirecting to the Menu so that he can choose another topic, ending the process and in the best case, the user will carry out another process. This can be interpreted in the following figure 1, which graphically explains this entire process from start to finish from a functional architecture.

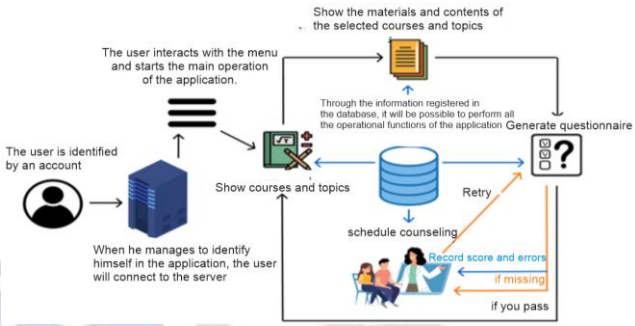

Figure 1 Internal functional architecture of the website

In this figure, we can observe the internal processes of the website, from its beginning by entering the system, to its cycle or end. This architecture was designed as a cycle to be able to encourage the user to use the system and that it can have more complete benefits and learning through feedback.

This can be evidenced in the orange lines, which indicate that, through the failure, feedback can be obtained that improves their learning on the subject and encourages the user to take the questionnaire again.

On the other hand, the blue lines indicate the actions and processes carried out by the database, since all the content of the web system is centered there, and it is who is called to carry out all the main processes.

2) Function from the User's perspective

From the user's perspective, this will act as the actor that initiates the entire process of the operation, in which it acts as follows. The user will start the process when he interacts with the system, either by entering or by opening the program. Then proceed to log into the system or if it does not have an account, go to register through a registration form where you have to fill in credentials and personal data. Once you enter the system, the user will be able to navigate between the different courses and their respective topics that are of interest to them, after which they choose, they will be

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provided with material and content on the subject so that they can view it. Once you feel satisfied with your knowledge, you go to the next phase of the System that you must overcome to demonstrate that your knowledge was fruitful and mastered, for this you submit to a questionnaire on the chosen topic where ten questions will be asked. It depends on how you did. If you have mastered the test by getting a perfect score, the system will congratulate you and mark the topic in your assigned course profile as "passed", thus ending the process. On the other hand, if you fail in the test or in any problem, the system will show you the resolution of the questionnaire/problem and its development step by step, once that is seen, the user will be redirected with virtual advice where can make queries that complement their learning, they can consult as many times as they want until they satisfy all the doubts they have, to try a new quiz again. However, the user who completed the questionnaire without any failure, can also view the resolutions to get better feedback, but he cannot go to the advice as he does not need it. All this process can be seen in the following Figure 2, which is the flowchart of the respective function.

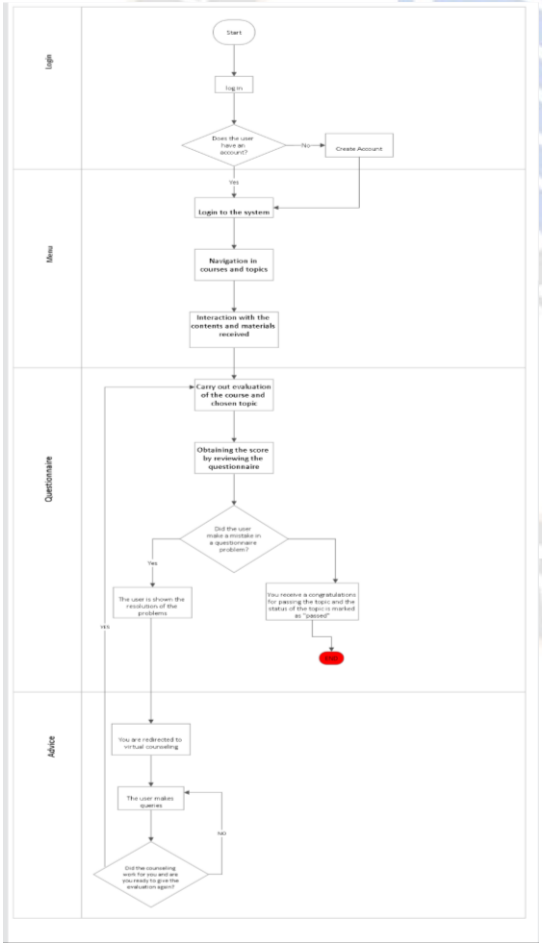

Figure 2 Flowchart of the function from the User's perspective

In order to have a better idea about the function of this flowchart, a graphic architecture has been built that we can see in figure 3.

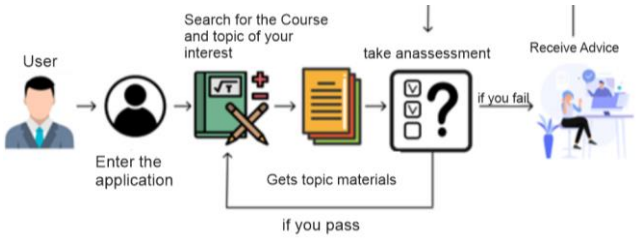

Figure 3 Architecture of the application function from the user's perspective

In this architecture we can see that a cycle is created once the search for the topic and its interest has been reached, it is because the user can carry out the learning process of the desired course/topic repeatedly, until this user is satisfied with their respective knowledge.

III. RESULTS

a) Beginning

As shown in Figure 4, we will begin by presenting a start that is too flashy and didactic, features of the application as well as a video tutorial of it, we will have a button which will redirect us to the available courses, we also have a drop-down section that will show us the other characteristics and contributions of the same.

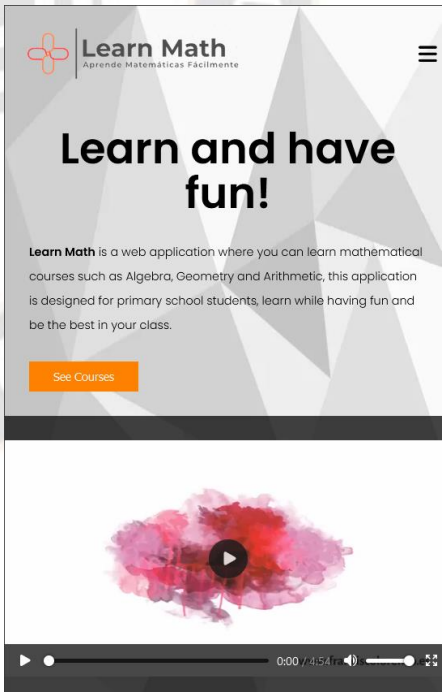

Figure 4: Home

b) Available Courses

As shown in Figure 5, you will be able to choose in which course you plan to improve your performance in mathematics, in this case they are courses implemented for

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elementary students, the dynamics of the application will be that students will be able to indicate in which grade they belong and thus recommend that they courses match their characteristics.

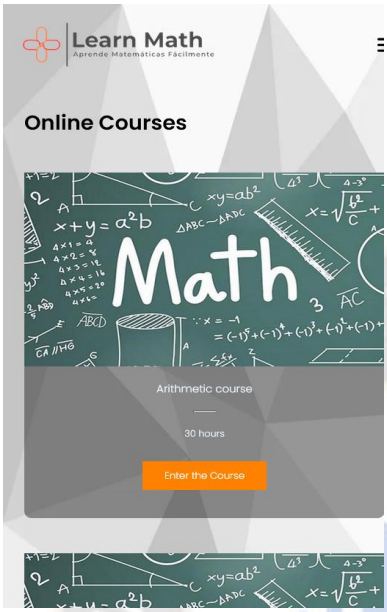

Figure 5: Courses

c) Student Testimonials

As shown in Figure 6, we will have a section where the students themselves will be able to raise their doubts and also comments about the new application.

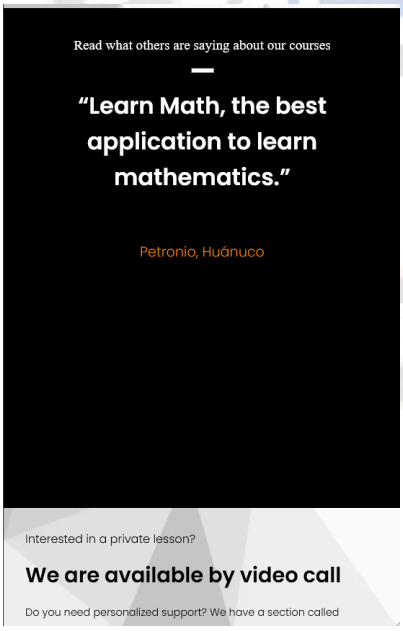

Figure 6: Testimonials

d) Questionnaires

As shown in Figure 7, we will have an evaluation to determine the student's performance after using our application, the evaluation consists of a certain time, the user will have the facility to have alternatives or be able to choose between them, it should be noted that the evaluation will be able to assimilate if the student needs feedback or not.

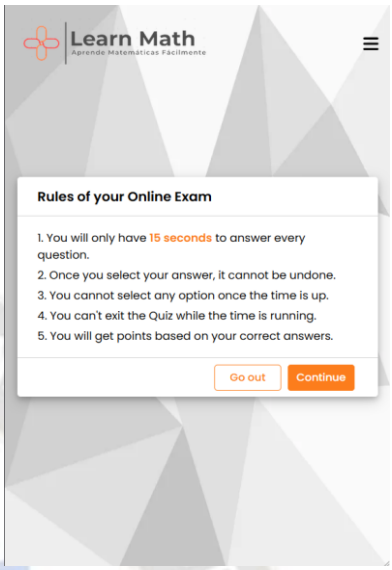

Figure 7: Rules

e) Quiz Questions

As shown in figure 8, we can see a question in the questionnaire, in this case, from a specific course, we can see that there are options, when one chooses an option, you will automatically know if it is correct or not, the time to solve said exercise It will be 15 seconds, this will depend on the complication of the question, likewise we can see that once answered you can move on to the next question.

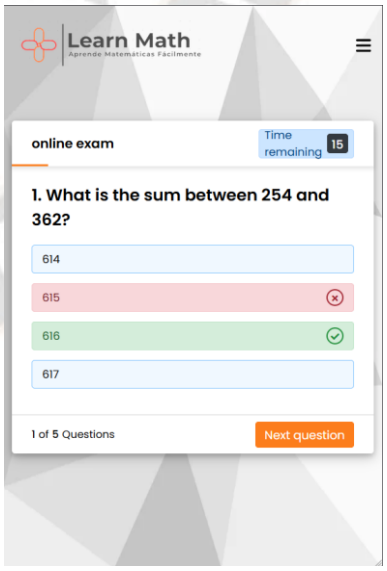

Figure 8: Examination

f) Virtual Advice Section

As shown in Figure 9, this will be the section of the application where we will offer a better consulting room for mathematical problems for user learning, which is why the

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user can interact repeatedly with this virtual advisor in order to learn and reinforce their knowledge, and thus, meet the goal, this section will have an additional cost.

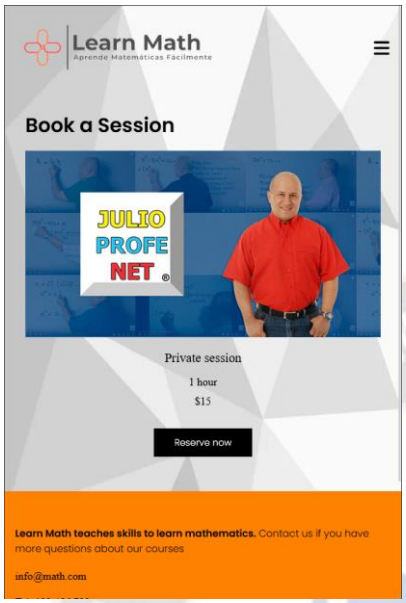

Figure 9: Custom classes

d) Statistical Graphs

In figure 10 we can see that the majority of the parents of the surveyed children do not trust too much in the online study, only 14.3% say they trust 100% while 35.7% indicate that there is a distrust for this type of learning.

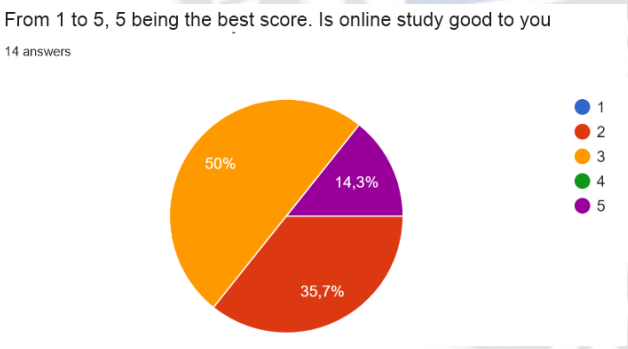

Figure 10: Obtained from the survey carried out by our team.

Figure 11 shows that there is a relationship with figure 10, when asking respondents if they would let their children study online, more than 50% said no, and this is often due to the type of education they receive online. the web, for this reason our goal is that teaching through a web application is reliable for parents and that their children have fun while they learn, the objective is the learning of our students.

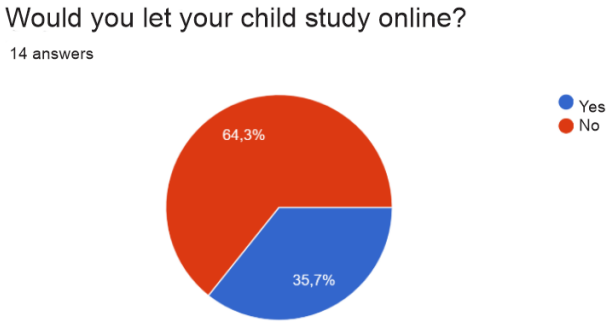

Figure 11: Question to parents about online teaching

IV. DISCUSSION

The research work tries to capture the attention of the user in such a way that they can improve their academic performance, but they will ask themselves, how will this objective be achieved? Compared to the face-to-face studies, we noticed and it is believed that the study remotely it is more viable in most cases, because it can be handled from any medium, also because you can continue studying from anywhere in the world and it is much more interactive, some may be wondering in what way?, well, the user You can choose which mathematical subject you want to take and if there are a variety of teachers for the same course, you can select the one you prefer. The user will find the classes in already recorded videos and information in pdf format. The result obtained from the survey carried out on parents, of which one of the main questions was: Do you think online study is good? It was answered that the majority of the parents of the children do not trust too much in the online study, only 14.3% say that they trust 100% while 35.7% indicate that there is a distrust for this type of learning. Which led to the other question. Would you let your child study online? 64.3% of the proxies said no.

This asks us a question, and this question is, why the mistrust of parents with education via the web? This led us to hypothesize about the reason for the mistrust, for example, could it be due to the misuse that certain people give to technology? In truth, there are many reasons why parents would not allow their children to study via the web and that makes them reject it. But this problem helps us to see the way to solve such distrust that parents have. For this reason, the work was done to help students and, in this way, make parents trust technology and give their children the opportunity. But while the work was being carried out, a few limitations were found, one of them is the distrust of parents and/or guardians, this made us reflect and look for measures in the app to generate total trust.

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V. CONCLUSIONS

It was decided to develop this application because it was known that the knowledge acquired in schools was not enough for primary school students. For the development of this application, technologies such as HTML and CSS were used for the layout and styling of the page, it was also used programming languages such as JAVASCRIPT in the frontend and NODE JS in the backend , and to store the data of our students we use MYSQL as a database, in this pandemic that has just passed, technology served as a mediator for distance learning and that is an advantage where Learn Math meets the objectives that were proposed, trying to support the knowledge acquired in the educational institution in a more optimized way, such as reinforcing through personalized classes and adapting to the level of the student.

When starting with education, innovations must be undertaken that facilitate student understanding based on technology. Something that in the long-term parents will have to understand and understand that the future goes hand in hand with technology, some ideas arose to put them in future functionalities, such as, for example, that the teacher for personalized teaching will be able to generate exams in PDF format and Said exam will be solved by the teacher and the student, a section of questions to the teacher about exercises.

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