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Teaching geometry with an app in primary school

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Abstract:
Background*: International tests have shown that the academic performance, in mathematics and science, of Mexican primary school students is low. However, technology is a tool that can help motivate and encourage children to develop notions of mathematical concepts that they are not yet using at the age of 6. Using a smartphone seems to be a good way to get closer to children because today the new generations live with these devices every day, and their use does not represent any problem for them. So, we decided to use an app to bring geometry closer to children so that they would generate the concept of perimeter of geometric figures and objects in general.*
Materials and Methods*: The app was programmed for smartphones based on the Android system because it is the most widely used system in the world. The participating children were between the ages of 6 and 7 years and were in the first year of an elementary school in Mexico. In a classroom, the children were gathered, and the app was executed by projecting it on the blackboard so that all the children could see what was happening. The app starts by providing the outer contour of an everyday object, and little by little adds elements of the object; those elements are basic geometric figures. At the end the children can guess the figure that is drawn giving characteristics of the geometric figures that form it.*
Results*: At first, the children were slow to answer the teacher's questions, but after one child made a first participation, the other children became enthusiastic and began to participate actively; As soon as the teacher asked a question, most raised their hands to answer. With the participation of all the children, at the end they could describe the figure in terms of the geometric figures that form it.*
Conclusion: *During the use of the app, it was evident that the children were using the concept of the perimeter of an object in general, and of geometric figures. We consider that the app also helped the children to exercise the argumentation of their ideas and helped them with socialization within the group. The work will now focus on applying the app to groups of more children, so that they can use it on their own smartphones.*
Key Word*: Geometric forms; smart phone; app; perimeter; primary school.*

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I. Introduction

Today the teaching-learning process in Mexico gives us a deficit in the mathematical context, according to various tests that are applied to elementary school students of the basic educational level, it offers us results that are quite disturbing since it is observed how students have not been able to develop or strengthen different mathematical topics, either the use or the appropriation of mathematical concepts. For example, the Secretaría de Educación Pública of Mexico (Mexican Ministry of Public Education) endorses the PLANEA test (from the Spanish name Plan Nacional para la Evaluación de los Aprendizajes - National Plan for the Evaluation of Learning) that evaluates the key learning of the training fields related to Language and Communication and Mathematics[1], and the results of its application in the elementary school where this research was carried out showed that in 2015, 56% of the students were in Level I (level of least knowledge) and only 19 % at Level IV (level of greater knowledge)[2]. But for the application of the same test in 2018, the values worsened, going to 82% in Level I and only 9% in Level IV[2].

Another problem is that teachers who use technological tools in the classroom do not have the necessary skills to use them. Unfortunately, the study plans do not include the use of technologies as such, it is important to comment that the leveling courses that are offered to the professors to standardize the knowledge among them often have zero impact.

Mexico is a member of the Organization for Economic Co-operation and Development [OECD], where the PISA test is applied every three years to the member countries of this organization. The results of the test carried out in 2018 indicate that Mexican students reached Level 2 with 420 points in Reading, Level 1 with 409 points in Mathematics, and Level 2 with 419 points in Science[3]. Values that place it far from the best evaluated countries.

II. State of the art

Blum and Borromeo[4] comment that mathematical modeling is the synchronous translation process between the real world and mathematics. In addition, they inform us that the study of mathematical modeling has been one of the most discussed and propagated topics for several decades, but that far from being an easy method to acquire, there are difficulties for both the teacher and the students.

Vega et al.[5] mentioned the importance of creative teaching to generate a series of important changes such as:

• Motivate the significant learning of the student
• Develop different skills, such as:
• Visual-motor coordination geometry.
• Verbal or communication.
• Of drawing.
• Logical or thinking.

With these characteristics that have been mentioned, the student appropriates skills that allow him to raise his academic indicators of school achievement.

Abramovich and Kyeong[6] conducted research on enabling technology as a modeling tool that helps in posing mathematical problems.

It is worth noting that the National Council of Teachers of Mathematics[7] [NCTM] considers problem posing as an activity that is the heart of mathematical work, and it can also be seen as the creation of a new problem from a situation or experience. This concept has been studied in times before the computational boom, by notable researchers such as Polya[8], Freudenthal[9], Krutetskii[10], and Brown and Walter[11].

Corpi and Rodríguez[12] mentioned that modeling is an activity through which the ability to convert a presented problem from reality to a mathematical version is achieved, thanks to abstract thinking where the student is able to build several objects of that problem and solve it using the model.

Aparisi and Pochulu[13] described the possible obstacles, challenges, factors, etc., that Mathematics teachers may face when they start the process of activities around modeling and characterized the possible advantages and disadvantages that teachers see of implementing this teaching strategy in their work classrooms in high school.

Coutat[14] defined the geometric space for learning geometric properties through the process of mathematical modeling for the basic educational level in students between the ages of 9-12.

Voskoglou[15] established two mathematical models to mathematize the analogical resolution of problems, he also provided four points that he considers essential in the process of analogical reasoning:

• Representation of the objective problem.
• Search-Retrieve in relation to a past problem.
• Mapping of the representations of the objective and the related problem.
• Adaptation of the resolution of the related problem for use of the target problem.

Duarte[16] presented a descriptive field investigation. First, where the use of the geoboard as a teaching resource would positively contribute to the understanding of geometric objects by students and would provide the teacher with a way to learn to create motivating and versatile activities to achieve the transposition of knowledge.

Resendiz et al.[17] through action research carried out the design, development and evaluation of Learning Objects for the learning process specifically in calculating perimeters and areas of the main shapes and geometric figures.

Aires et al.[18] worked with sixth grade students to see how they visualize and present the idea of a square. Their results showed that the level of geometric knowledge of the students is below what is desirable and required according to their grade.

Marmolejo and González[19] proposed various strategies and forms of work so that students, according to the information provided in assigned tasks, can visualize flat geometric figures.

Athanasios[20] focused on the way students visualize geometric figures when solving problems presented to them.

Valles[21] addressed the concern about the rejection presented and raised by many teachers in the area of mathematics regarding the use and implementation of technologies in their programs and program content. The report mentions that the rejection of technologies is strongly associated with the degree of technological illiteracy in mathematics teachers.

Cardoso[22] studied the use of technological tools such as Google Maps® and Google Earth® in a series of activities to strengthen the learning of mathematics in geometry through the use of transversal content as context.

Oliver et al.[23] conducted a study with students with an average age of 12 years. The process begins with an activity based on playing Aritban, which is an educational software oriented to fractions.

Resende and Meneguelo[24] carried out tests in a study group applying the use of software focused on the development of 3D modeling, construction of spatial figures and dynamic geometry, the focus on the use of all of them was in favor of teaching learning of the geometry.

Tessier et al.[25] worked on obtaining an ideal geometric workspace through an intelligent tutorial system called GeogebraTutor, with the aim that secondary school students use the system so that in the context of problem solving they can generate geometric thinking.

The meta-analyses carried out by Li & Ma[26] in 2010, Murphy[27] in 2016, and Higgins, Huscroft-D'Angelo, & Crawford[28] in 2017, have shown us that the use of technology in the mathematics classroom with students of different ages represents a path with ample possibilities of success. In addition, the work of Moyer-Packenham and Suh[29], and specifically that of Hilton in 2016[30], have served as a basis for us to decide to use a geometry app to stimulate 6 and 7-year-old children in such a way that using a smartphone they can develop the concept of perimeter and know basic geometric figures.

III. Method

First, we must emphasize that mathematical modeling is a process that presents various degrees of complexity, all depending directly on the problem that arises and that is required to be solved. There is no series of steps in which a person can apply to always find a resolution to problems, instead reasoning and complex thinking must be applied to find an algorithm that allows us the solution.

In this way, mathematical modeling is the method by which we can make a mathematical representation of a problem presented in the real world and that allows us to create a solution according to the needs that are required in the process of evaluation, analysis, construction and use for the problem, where the model obtained represents the necessary functions that correspond to reality.

There are aspects that can be referenced in the modeling process:

• Identify and solve problems by making decisions based on critical and creative thinking.
• Carry out individual or collective work with other team members
• Personally organize and manage their activities responsibly and effectively
• Collect, analyze, organize information in a critical way
• Carry out effective communication using semiotic language
• Use ICTs in the context in which they are working.
• Demonstrate understanding of the world as a set of related systems by recognizing the context in problem solving.

Our objective was to develop a mobile application based on modeling that helps first-year primary school students (6-7 years old) in learning the notion of perimeter and geometric figures.

That application would show children different figures of everyday objects generated by basic geometric figures. Initially, objects such as a car, a space rocket, the head of a fox and a skull were thought of. All of them formed with triangles, rectangles, and circles.

App

We carry out the design of a mobile application because today apps are used naturally through so-called smartphones, specifically that work with the Android® operating system since this is the most widely used system worldwide.

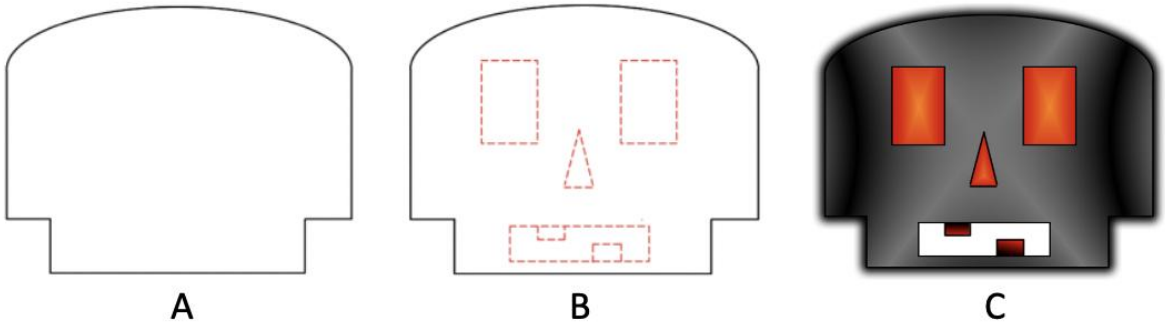
Once the system was chosen, in the next step images were generated that would be displayed in the didactic activity referring to the everyday world. Images have three states:

A. The figures are captured only through their representation of the contour or perimeter.

B. The drawing shows its shape from the real environment. The layout of the internal parts that make up the image is made, this layout is made up of red dotted lines that interconnect all the vertices of the image figure.

C. This last phase of drawing allows the student to visualize the image in its final real-world state.

Figure 1: States of the figures that are presented in the app.

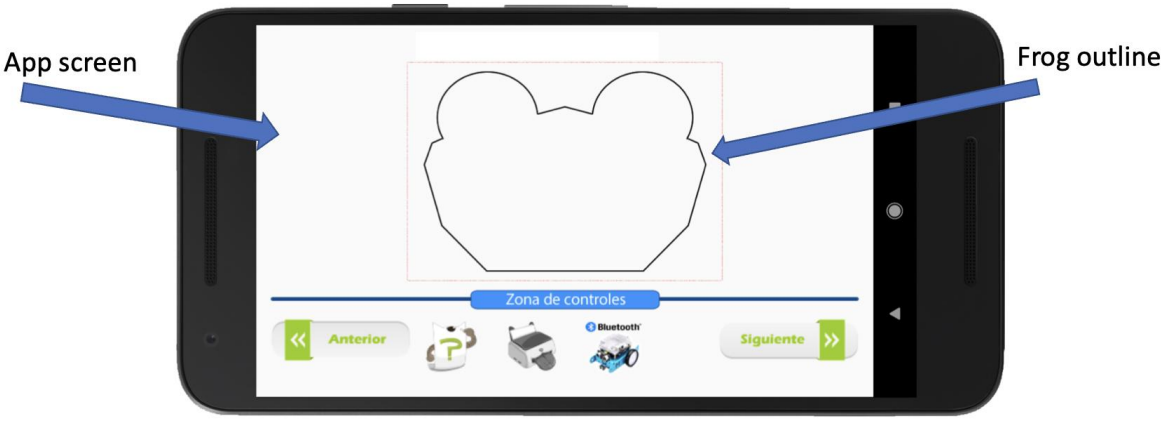


Application

The students were boys and girls with ages ranging between 6 and 7 years. They were chosen randomly with the sole condition of belonging to the first year of primary school. To allow the children to see what was happening, a smartphone emulator was used on the computer and the application was run, so that by means of a projector it was possible for all the children to see what was happening in the app at the same time. .

At the beginning of the execution of the app, the children were waiting to see what was happening on the screen. When the teacher started the app and the first image (in state A) appeared on the screen, the children only saw the outline, without any filling, without strokes or colors.

Figure 2: App screen with the outline of a frog's head.

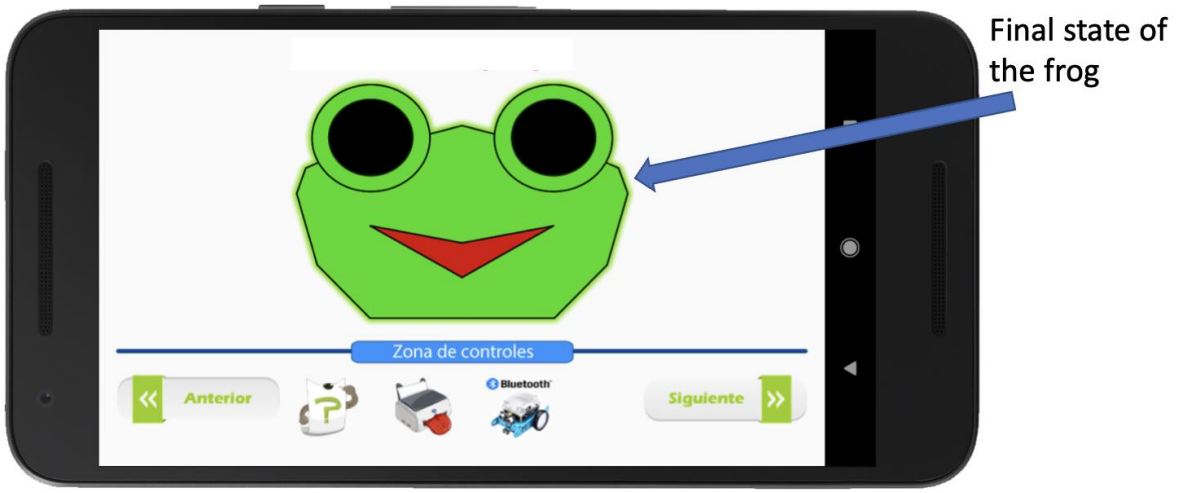


Then the teacher began to ask the children questions to generate in them the concept of perimeter, in this part of the application we want the student to learn to identify the perimeter in the images shown and to be able to visualize various figures and shapes of the real life and transform them physically and mentally just by their perimeter.

On the first question the teacher asked, the children hardly participated; however, one child said that he wanted to say his idea and that was enough for all the children to want to participate as well. From then on, the children raised their hands every time the teacher asked a question.

At this moment, the app is showing new elements of the image so that at each moment it can be easier to identify the final figure. So in the end, an object that the children know from their daily lives appears on the screen. In the first example done with the children, the final image was the face of a frog, made up of triangles for the mouth and circles for the eyes.

Figure 3: Final state of the frog image, está formada por círculos y triángulos que los niños logran mencionar.



First, the students participated in turns, the teacher asked questions so that the children were giving suggestions about what object represented the perimeter that appeared on the screen and then each student could advance at their own pace in discovering the total images contained in the game.
The teacher who gives them clues of images that they cannot locate.
We emphasize that the objective of the game is to discover the greatest number of images so that the student can visualize many examples and thus learn the various patterns that can occur in the different objects that exist in real life.

IV. Conclusion

Through the app, the children were able to play with geometric figures that appeared on the screen; they guessed what final object would appear on the screen using the description of the image through the basic geometric figures.

The interaction between the teacher and the children was very active and agile, the participation of the children was varied and together they managed to anticipate the final image that would appear on the app screen. We consider that the app helped the children to exercise argumentation, since they had to say which figure would be formed with the geometric figures.

By participating in the game, the children learned and exercised the concept of perimeter; they also managed to know the basic geometric figures.

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