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Teaching-learning Strategy in Geometry through the Children's University with Emphasis on Engineering

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Abstract

The article presents a strategy based on the University of children where each participant becomes a little engineer, allowing the learning of geometry, making them know, analyze and locate themselves in a Cartesian plane, through activities of analysis, design, construction and programming of cubes of lights and cars programmed with directional instructions. The strategy seeks to get children interested in geometry and motivate them to continue learning in their respective schools.

Keywords: Children's university, child engineer, bigtrak, programmable car, geometry teaching.

1. INTRODUCTION

Geometry is an area that is taught in the early grades of primary school, and it is a complex task for some children, understanding the Cartesian plane and the rotations through angles often becomes a problem for teachers. The way in which this teaching-learning process can be made easier is through training in Science, Technology, Engineering and Mathematics (STEM). That is why methodologies and strategies must follow clear guidelines that focus on a more didactic and efficient pedagogy.

If geometry is not taught in a complete way, it can affect the comprehension for later courses and even reach the university, becoming a difficult problem to solve, that is why it is tried that it is not so forgotten in the first years of learning [1]. Among the strategies we can include those that use geometric shapes through materials, helping to understand the utility in a real world [2], [3]. Geometry through art, which favors the exploration and observation of the environment through playful activities in order to evaluate metric and projective contents [4].

Game-based strategies that promote favorable learning scenarios have proven to be more effective than traditional ones in topics such as polygon recognition [5], [6]. Not only can fun lessons be taught with technology, but also with manipulatives that encourage exploration, sensory input, and help solve learning problems [7]-[9].

The manipulative material has already demonstrated its efficiency in other areas of mathematics such as algebraic expressions, that is why teachers build their own materials, using it through games allowing each student to feel interest in algebra [10].

Technological materials have helped in the teaching and learning of mathematics, through the use of ICT [11], [12]. Augmented reality is one of the most promising tools, since it awakens interest in learning geometry, implementing innovation and abstraction in an educational environment [13].

In some cases and depending on the area or community where the educational center is located, it may not have adequate technological resources, and that is where universities can help through the extension process in such a way that reinforces the teaching-learning process through activities that use games with tools through programmable cars, cubes of lights, robots of competence strategies or 3D printers. This research presents a strategy that incorporates the first two tools, and are developed by teachers and students of the seedbed, who begin to transfer some of their knowledge to the little ones, for this activities are conducted where they help children think as future engineers with all the teaching in STEM, so that they are motivated and reinforce what they have already learned in the educational institution.

2. METHODOLOGY

It is a program that aims to bring the university closer to children and adolescents and their families. It was created by the Grucite research group at the Universidad Francisco de Paula Santander Ocaña in 2013 [14], which is born from each of their careers and their area of training, through which they have contact with science, technology, engineering and mathematics.

The activities are developed based on the theme of interest for learning. For this activity was to learn geometry and its location in the Cartesian plane, programming through directionality instructions and angles, and distance measurements to complete each of the missions to be performed. That is why the emphasis for this theme is that of the child engineer, based on specific activities. For this, a methodology based on 4 activities is developed, which will help the teaching-learning process through playful activities, using technology. The activities were developed in the Simón Bolívar No. 2 Headquarters, with 48 children from the urban area of Ocaña.

The objectives of the child engineer are:

- Engage children with science, technology, engineering and mathematics.
- To provide the necessary knowledge to understand the work of the engineer in a real, creative and playful environment.

- Encourage children to exercise their memory by means of didactic games.
- Encourage children to learn geometry by recognizing different angles to have a spatial vision and directionality of objects.
- To develop in the children, by means of mathematical exercises, the logical thinking for the understanding of computer programming.
- Promote the approach of children to the Universidad Francisco de Paula Santander Ocaña.

There are 4 activities with a maximum time of 3 hours. Assembly of the activity and presentation of the work team and the participating children: Image analysis and representation, Image design in the light Stax, Learning to locate oneself in the Cartesian plane and Electric vehicle programming.

Table 1. Description of activity 1

Image analysis and representation.	
Target	Encourage children to exercise their memory by means of didactic games.
Materials	Printed Image Cartesian plane Red pencil Draft Rule
Developmen t	1. Delivery of the materials to each child. 2. Explain how they should do the image analysis and how to count the grids. 3. Representation in the Cartesian plane of the delivered image.

Table 2. Description of activity 2

Image design in the light stax.	
Target	Design an image with the light stax, using the ingenuity and creativity of each child.
Materials	Building Blocks
Development	1. Make groups of three children. 2. Delivery of the box of building blocks. 3. Each group must represent with the building blocks the image given in activity 1. 4. Sample of the images created.

Table 3. Description of activity 3

Learning to locate oneself in the Cartesian plane	
Target	To encourage children to recognize different directionalities in order to have a spatial vision.
Materials	Printed Image Cartesian plane Red pencil Draft
Development	1. Delivery of the materials to each child. 2. Explain to children the recognition of different directionalities when moving through the code. 3. Do the scrolling using the code.

Table 4. Description of activity 4

Electric vehicle programming	
Target	To develop children's logical thinking through mathematical exercises.
Materials	Electronic vehicle Cartesian plane Instructions
Development	1. Delivery of materials. 2. Explanation of the instructions for driving the vehicle. 3. Design the code. 4. Program the code in the e-vehicle.

3. RESULT

3.1 Image analysis and representation

In this activity, children are given rulers, colors, pencils and a sheet of paper with a figure drawn in the Cartesian planes. The ordinates and abscissae and the values corresponding to a boat (Figure 1), a house (Figure 2) and a helicopter (Figure 3) are explained to them. By locating each point starting on the X-axis and moving up the Y-axis, the children make parallel and perpendicular lines and measure the distance of each line by means of each space on the grid. This activity allows them to learn about the Cartesian plane, where all the children were able to do the activity without any problem.

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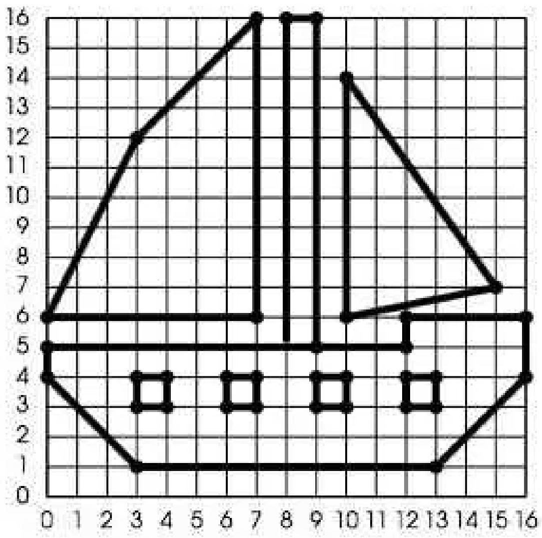


Fig. 1. Boat drawn in Cartesian coordinates. Source: [15]

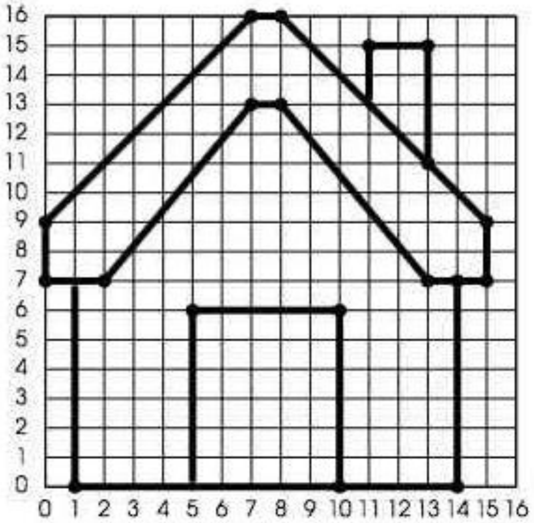


Fig. 2. House drawn in Cartesian coordinates. Source: [15]

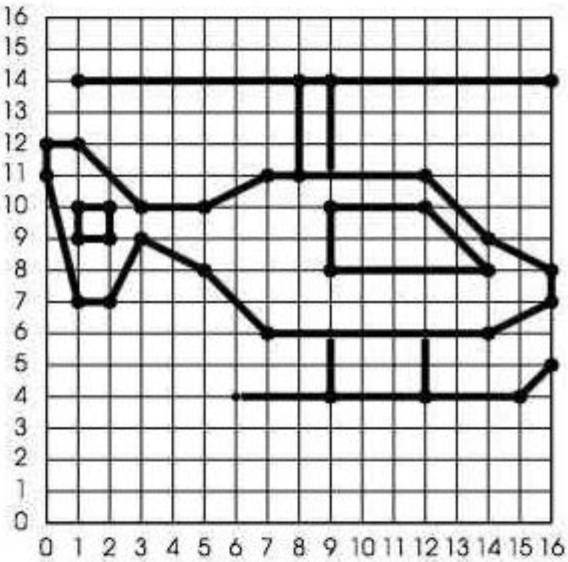


Fig. 3. Helicopter drawn Cartesian coordinates. Source: [15]

Some inconveniences arise at the time of positioning on the Y axis, but they detect the error and correct it as in figure 5, where the height on the Y axis of the right side of the house rises to a value of 8 when it should be 7 on both sides.

Once they have finished activity number 1, which is a two-dimensional plane, they are encouraged to think in 3D, so that they can take these figures to the X,Y and Z plane, with activity 2.

Fig. 4. Drawings developed by the children following the X and Y values.

The activity was individual so that it was possible to know if they could locate themselves on the map, before using a tutor to help develop activity 2 (Figure 5).

Fig. 5. Children creating the figures on the Cartesian plane.

3.2 Image analysis and representation of the image in the Light Stax

In the design of the image for the activity, the Light Stax cubes were given as materials, which have 3 lighting sequences. They were formed in groups of 2 boys and girls (Figure 6), in such a way that they created the previous figures, however none of them wanted to create them, innovating with their own proposals such as a child with his hands raised, symbol of success and joy of the group that developed them (Figure 7).

Fig. 6. Children formed objects.

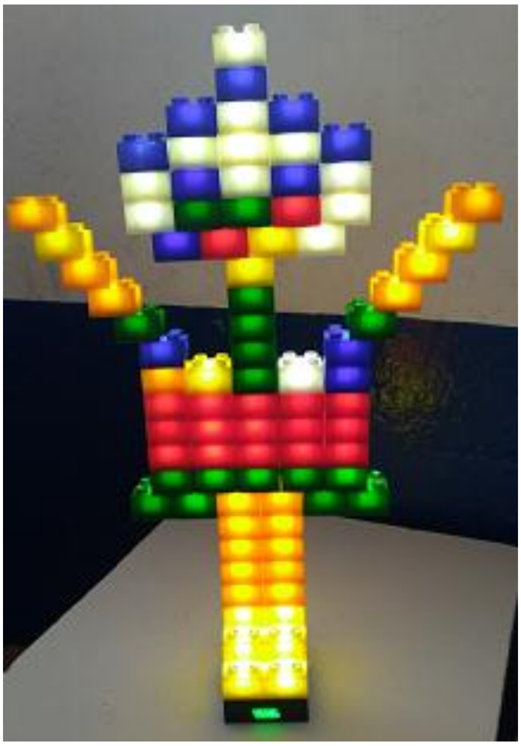


Fig. 7. Creation of a child with hands raised and showing his joy.

The groups made up only of girls had an easier time delivering 3D shapes such as hearts or flowers (Figure 8). They all had a very clear sense of spatial location, and once they finished, they took a photographic record of each figure and disassembled again to start with new shapes.

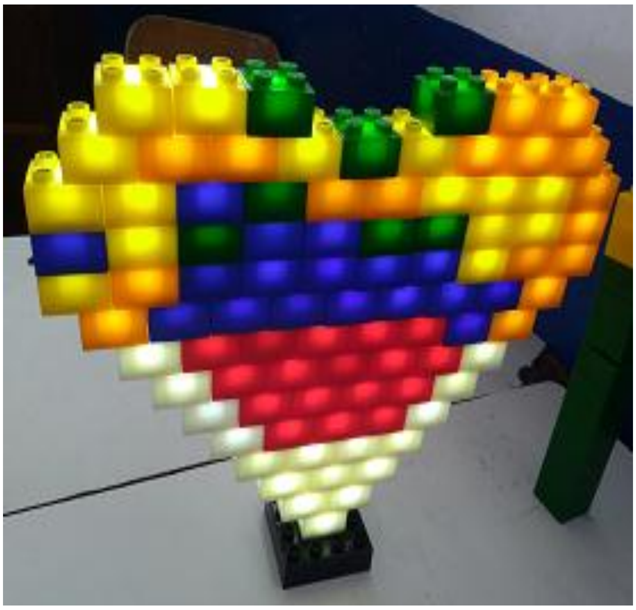


Fig. 8. Creation of solid heart.

Once they formed solid figures they began to use the Cartesian plane, and the support points in both the X and Y axis, so that the figure 9 looked more like the two-dimensional, with fewer cubes, in addition to the reinforcement points that allowed the figure to be strong without falling apart, with which they had a knowledge from the point of Civil and Mechanical engineering.

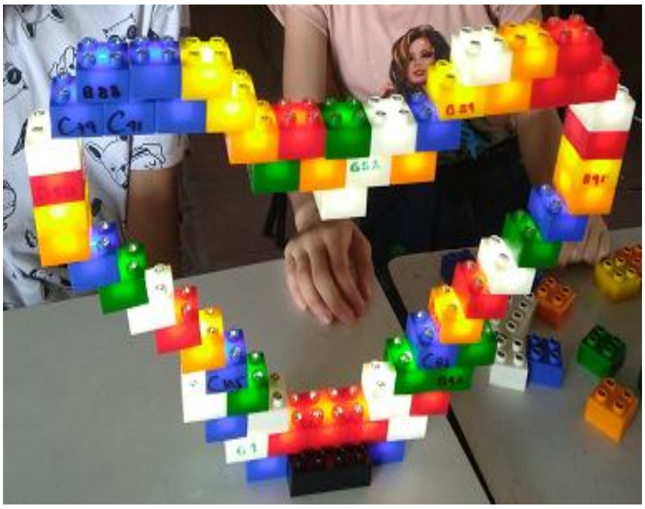


Fig. 9. Creation of the heart following the Cartesian plane.

In all the groups a solidity is observed for the development of pyramids, towers and buildings maintaining the layers in each plane that was being formed in such a way that it would not be disassembled by the support of the battery (Figure 10).

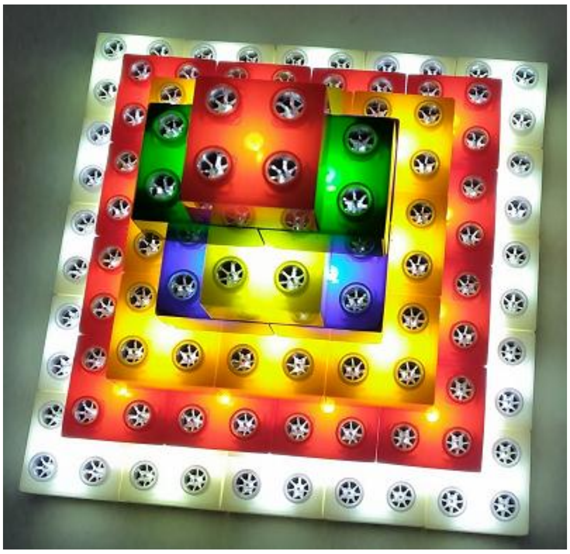
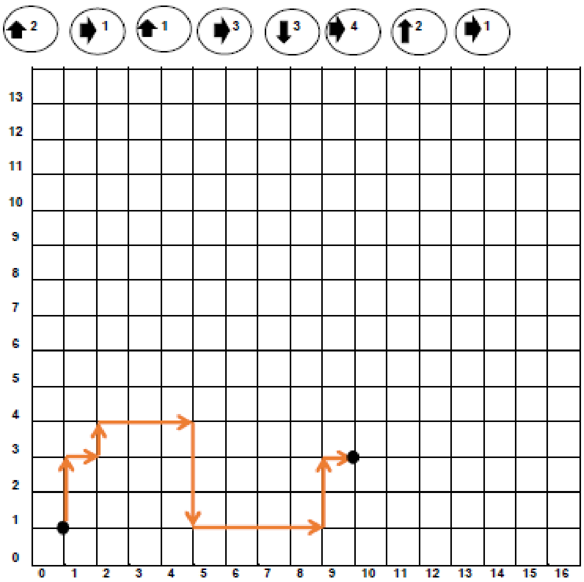


Fig. 10. Creation of a pyramid with several layers of the Cartesian plane.

3.3 Encourage children to recognize different directionalities and angles.

Children's spatial vision can be encouraged by movements that go from forward or backward, as well as angles by moving their body in different directions from left to right, to encourage visual space and programming, so that they have an emphasis on systems engineering, they are given a direction by means of an arrow that points in 4 directions (up, down, left, right), after each direction they are given a value which they must trace the route in the Cartesian plane, this will allow them not only the movement of each one, it will also give them the necessary learning for the movement of objects in the plane. Looking at figure 11, you can see the route that they must follow to complete this mission of activity 3, which was developed by all the groups.



Routes created in the Cartesian plane for the location of objects.

3.4 Programming the e-vehicle

The programming of the vehicle is by means of a bigtrak of the company Zeon which has in its upper part a board with buttons that give us the movements and directions (Figure 12). This vehicle performs the routes through 16 programmable steps with directional instructions.

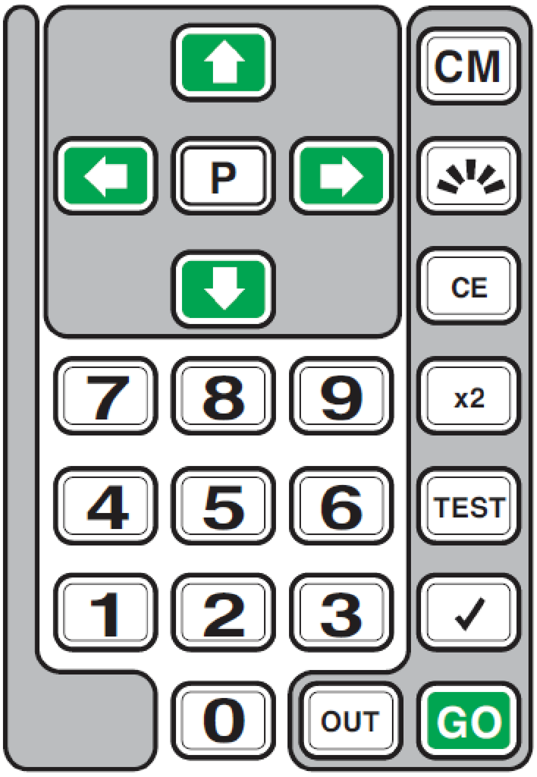


Fig. 12. Programming board. Source: [16]

Each forward or backward movement is approximately 33 to 50 cm, according to the surface where it is placed. To make a 33 cm forward movement, first press the forward direction key followed by the value 1 and then the GO key, if you want to move 66 cm forward and then back to the same position, press the forward key two steps and then the backward key with two steps (Figure 13).

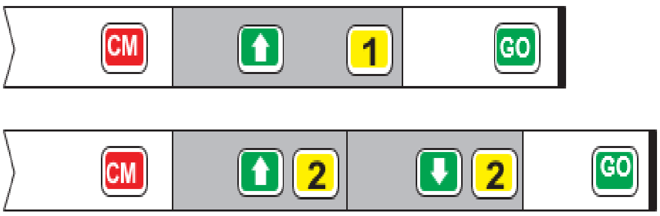


Fig. 13. Forward and backward keys. Source: [16]

To turn left and right, you follow the values of the hands of a clock so that if you want to turn right 45 degrees, you must press the key to the right followed by the value 15 (Figure 14).

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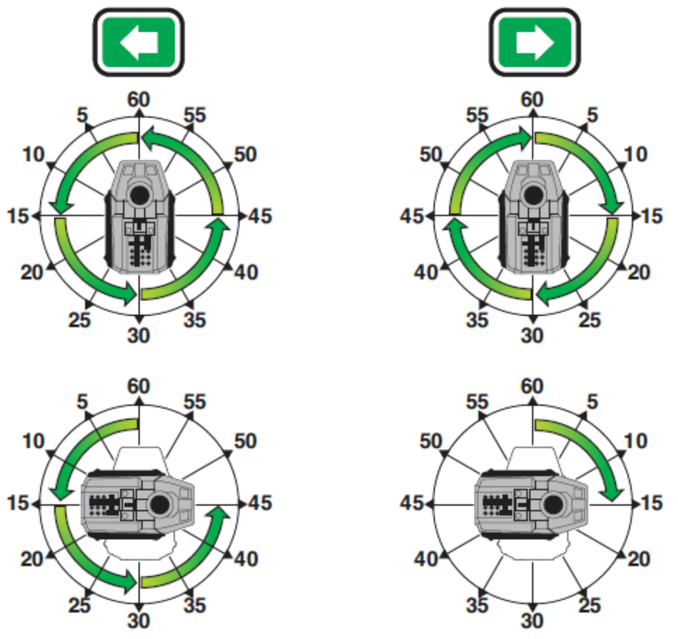

Fig. 14. Steering angles. Source: [16]

Figure 15 shows the final test route, with which they are asked if they are ready to carry out the mission of driving the vehicle with its distance and turning angles, observing that with so few instructions they are already prepared, this is because the activities from 1 to 3, have achieved that each child is prepared to understand the geometry and movement of the car, in addition to the programming through different steps with each directional instructions.

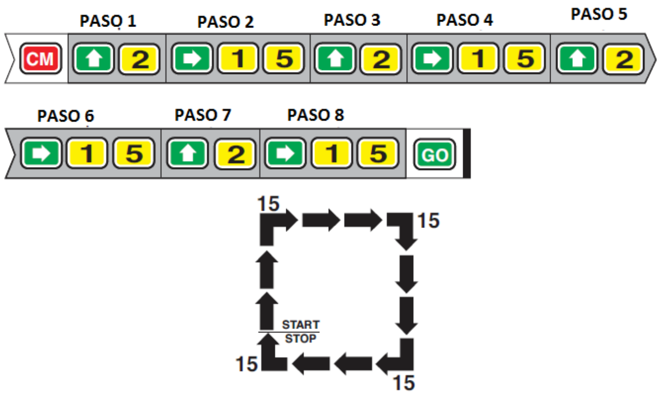

Fig. 15. Test route, forming a rectangle to return to the starting position. Source: [16]

To complete the activity 4 a mission is created, in which they must complete the route traced for the car and by means of a distance meter and the angles of turn to know the distance and orientation of the car. In figure 16 you can see the route to be found, which must be completed with a maximum of 16 instructions.

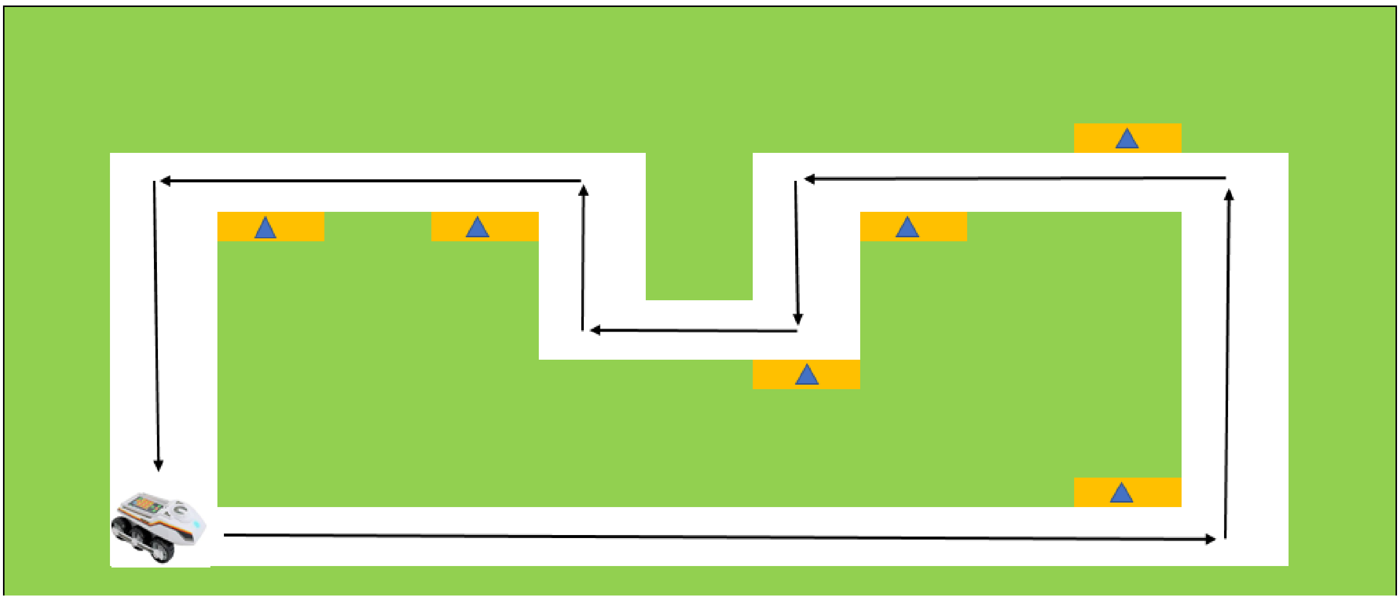

Fig. 16. Mission to be accomplished by means of steering instructions and turning angles.

In figure 17 and 18, you can see the starting position and the first 3 steps of instructions coming from the forward keys with a value of 5 for a total of 163 cm, left turn with a value of 15 and forward key.

Fig. 17. Starting point

Fig. 18. Situation of the vehicle with 3 instructions carried out

The groups were formed with 2 and 3 participants, and each group had a methodology of solution to find the routes, some used the measuring instrument, others did it by trial and error. It was also possible to know that many participants could memorize the 15 instructions to fulfill the missions without the need to write them down on a sheet or notebook, which exercised their memory, they also created new routes and went step by step, while others performed all the steps before starting the mission. Regarding geometry with angles, it was determined that they had no problems with angles and that the activities of location in the Cartesian plane gave them the tools to accomplish the mission in a short time (Figures 19 and 20). It can also be determined that the children, from an early age, carry out their activities in steps similar to the programming instructions, which is something innate in them, because of the way in which they were able to accomplish the mission.

Fig. 19. Participants at the point of departure

Fig. 20. Participants solving an angle of rotation

Finally all groups submitted the schedule in Table 5 with 15 scheduling steps, and were evaluated by demonstrating that the route was effective with the vehicles (Table 5).

Table 5. Mission programming instructions

Steps	Arrow	Value
1	⇧	5
2	⇦	15
3	⇧	2
4	⇦	15
5	⇧	2
6	⇦	15
7	⇧	1
8	⇨	15

9	↑	1
10	→	15
11	↑	1
12	←	15
13	↑	2
14	←	15
15	↑	2

4. CONCLUSION

The results show a very innovative learning and own of each participant, creativity is marked by the design and construction, and the implementation of new routes with programmable steps, where they are motivated to perform strategies based on more didactic tools. The interest is due to the two clearly marked approaches, one within the classroom and the other with the practice of the knowledge acquired through the didactic tools. When the children see the technological tools that will allow them to play, they are motivated to develop and solve the problems in their classroom correctly and quickly, so that they can move on to the stage of practice through games.

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