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ROBOTICS IN EDUCATION, AN APPROACH TO TECHNICAL SUBJECTS BASED IN PROJECTS

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ABSTRACT
This work aims to explore the effect of work based on projects graded at different levels of complexity in the area of knowledge of robotics. The method will increase the capabilities acquired by students, develop the metacognitive processes required to solve a project-based learning and analyzing their critical thinking. The study is focused on students of any education level and the methodology used consisted in the definition of a "problem" that had to be solved by the students used project-based method. Results will be measured in a group of secondary school students and the possibilities offered by this method will be discussed and compared to other systems of "traditional teaching", obtaining conclusions that could be extrapolated to other technical areas.
Keywords: Robotics, Project-based learning, Critical thinking, Students capabilities

INTRODUCTION

This educational project pursues to improve the academic results of the students specially (but not only) in secondary schools by means of the motivation that provides them the project-based learning (Anderman & Midgley, 1998).

Besides, by introducing problems related to robotics field in the project, it is possible to create inquiry-based educational environments that encourage student curiosity, engagement, persistence, respect for evidence, and sense of responsibility (Brewster & Fager, 2000).

The main objectives of the experience are:

a) To raise different practical teaching cases using an educational robot.

b) To see how students value various valid solution alternatives for the same problem.

c) To analyze the possibilities and educational potential that robotic assemblies with LegoMindStorm (the system used for the experience) have.

d) To analyze the advantages of this system versus “traditional” teaching methods.

The methodology used consisted in the definition of a “problem” that had to be solved by the students. In it, students are asked to make an assembly that should make a number of functions using pieces of the robot. Defined problems have been graded at different levels of complexity increasing the capabilities acquired by students. Results have been the approach and realization of several robotics projects of different levels of complexity, detailing in each one of them all the particularities and features. The result will be measured in a group of secondary school pupils and the possibilities offered by this method will be discussed and compared to other systems of "traditional teaching", obtaining conclusions that could be extrapolated to other areas of technical knowledge.

Methodology

In this experience, we search to describe the features that characterize the learning built by students participating in a class with a teaching robot. In a 4th(K-12 students) course of secondary school, in a group of 20 students of the subject Technology it was taught six lessons where the contents that were going to work were exposed briefly, explaining the tools being used, items, etc. It is important to note that this study seeks to see how involved are the students throughout the experiment in group and individually, and see the knowledge gained at the end of the experience (Walker, A. & Leary, H, 2009).

After this period, class was divided into groups of four students and directions were given to each one. The directions included what is the functionality of a robot that had to be constructed by the group. They have a great variety of pieces, sensors, motors, wheels and other components of LegoMindStorms. The construction of the robot with the given features is done by applying mathematics, physics, etc. learned in the lessons and by means of experimentation and discovery. Teacher is available at any time to answer and help with questions.

Example of a case of study

As an example, we will show one of the projects proposed to one group of students and the products obtained as part of the learning process. It consists in the construction of an automatically guided vehicle with light, contact and sound sensors. The vehicle must follow a black line using the information given by the sensors and if it finds an obstacle or receives certain inputs (sounds) it will answer to those inputs using programmed functions.

Educational objectives

Introduce students in the field of robotics, seeing its relations with mechanics, electronics, electricity, mathematics, physics, etc.

- Discover the use of some basic sensors and its usefulness in some specific cases
- Learn concepts of basic programming, as well as design and construction.
- Assess the existence of different solutions for a same problem.
- Assess the problems that appear in the assembly and see how it can be solved with the available items.

Robot design

Students began the robot assembly evaluating several solutions and seeing what were the viable by adjusting the operation asked.

Problems found and implemented solutions

Although students founded many problems and with a great variety, as an example, we show two very interesting, which forced the students to reflect on different aspects.

At the time of making the assembly, a rear wheel was set on the back part of the vehicle, but it was noted that it generated problems in turns. After asking the teacher, and assess some alternatives, students decided to modify the design including in the final solution a plastic sphere inside of a cage that allows the vehicle to turn in the desired place more accurately.

Also the students noticed that if they placed the sound sensor close to the motors, the work of the sensor was affected by the sound of the engines and activated the programmed routines. To fix it, the sensor was placed as far as possible to the motors. So, the sensor could detect the sound emitted by user (to activate programmed routines) from any position.

Programation of routine of operation

Robot programation was made with LEGO tool called Mindstorms. This tool has an easy interface, with blocks of functions that can be drop to the working area to make the program (figure 1).

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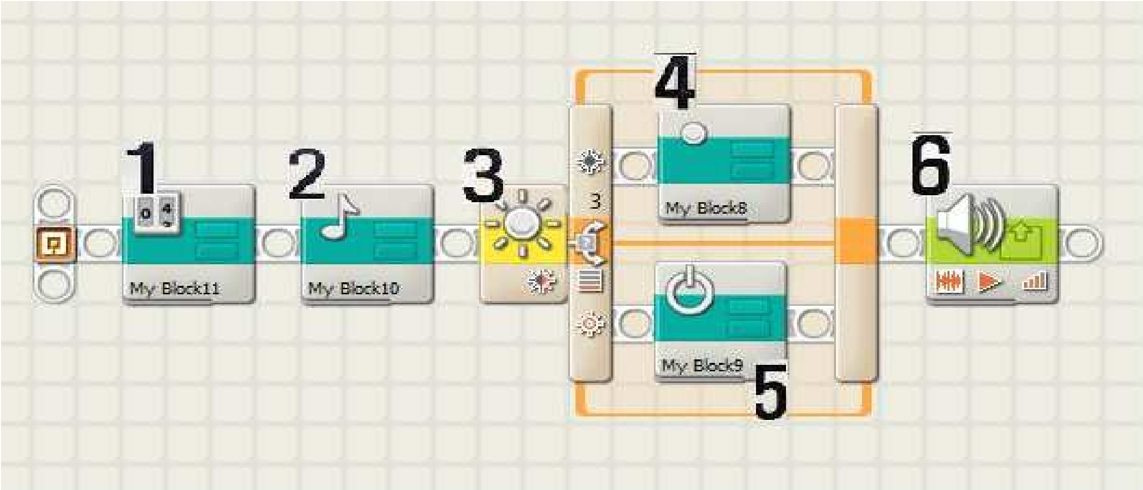

Figure 1. Blocks of functions of the project.

Construction of the robot
Finally, the configuration of the robot was:

Figure 2. Robot.

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The main parts of the robot are: (1) servomotors, (2) contact sensor, (3) sound sensor, (4) light sensor, (5) control unit with program storage, (6) rear sphere.

The robot sequence

One of the solutions found by one of the groups was the following (Figure 3):

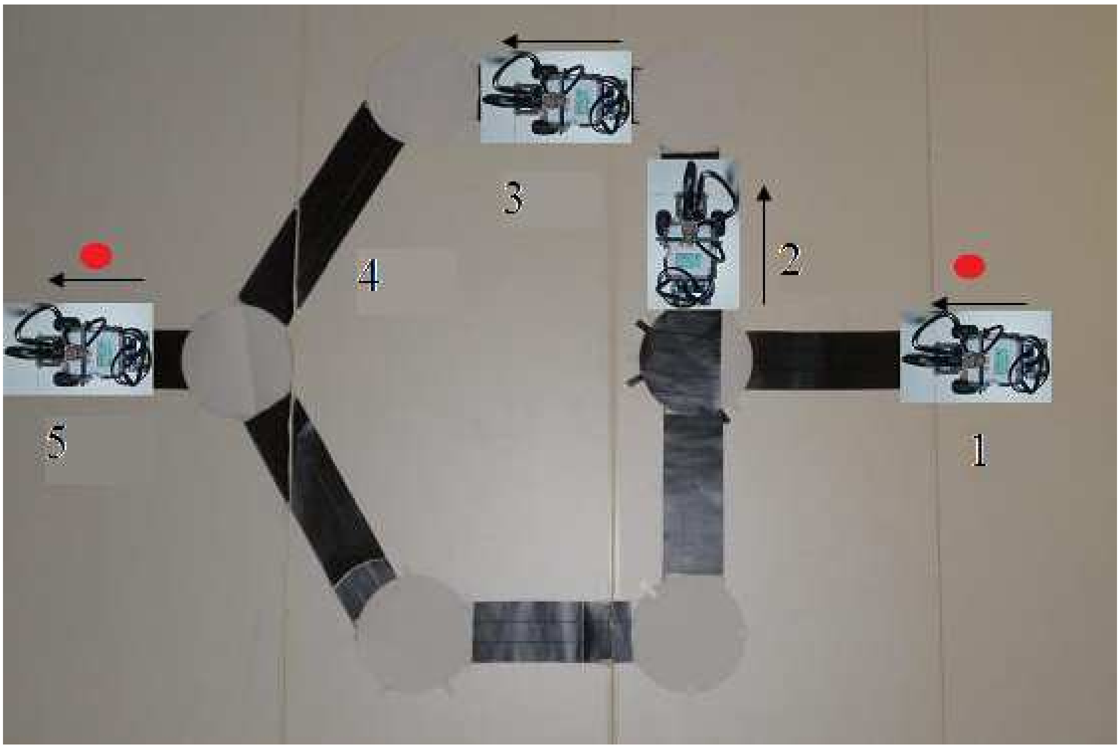

Figure 3. Assembly done by one group of students: operation when second base is black.

In this project, the robot operation is as follows:

The robot starts motion in point 1 and using the light sensor, the robot follows the black line until the first base. After detection of the light sensor that the base is black, robot is waiting to receive an audio signal (received by the audio sensor) that makes it turn 90º to the right. The robot continues moving (2) until an audio signal is received by the audio sensor and makes the robot turn 90 ° to the left and continues moving (3). Again, with another audio signal, the robot turns 60 ° to the left and continues forward to the next base (4). When the light sensor detects that the base is white, the robot stands and performs a rotation of 60 º to the right and it continues until a sound signal makes the program ends and, therefore, the motion (5). Next figure (Figure 4) shows the operation proposed by other group of students:

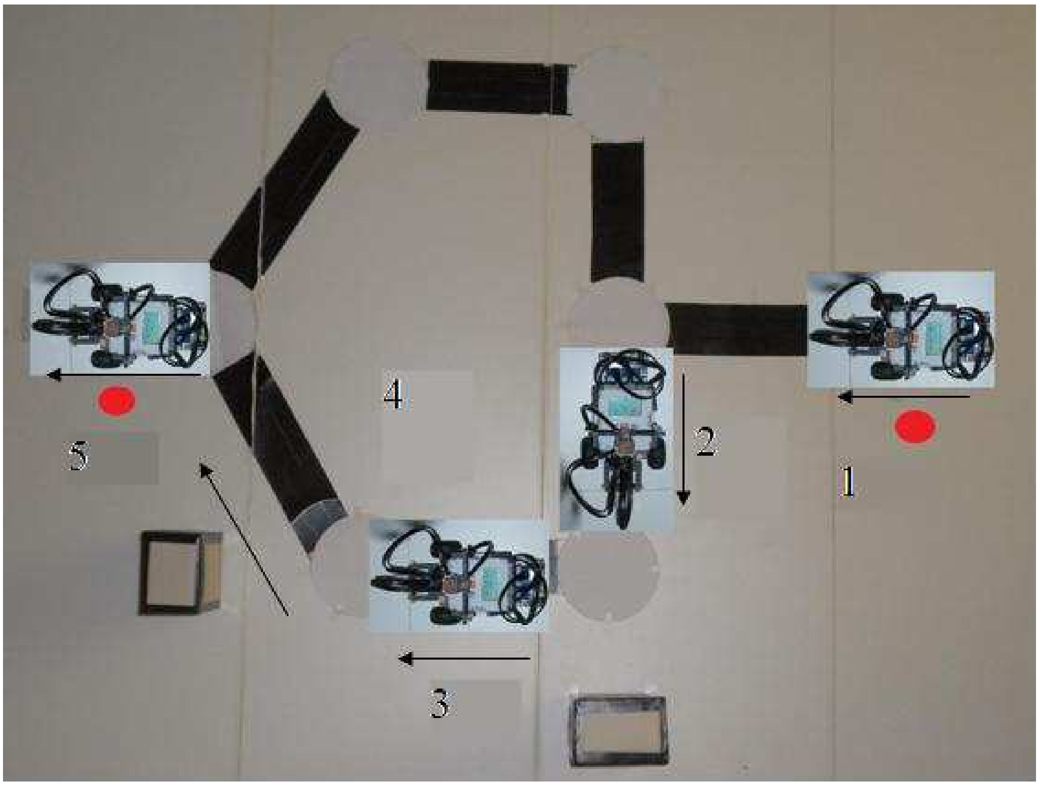

Figure 4. Assembly done by one group of students: operation when second base is white.

In point 1 the robot is at the starting point. After detecting that the base is white (light sensor) sends a signal indicating the path to choose andkeeps waiting to receive the audio signal (audio sensor) to turn 90 ° to the left and move forward. When the robot contacts the wall (touch sensor), back and performs a clockwise rotation of 60 ° and continues moving forward. When it detects that the base is white (light sensor), it is positioned and performs a rotation of 60 ° to the left and then the robot continues until it detects the following white base (light sensor), ending the program with an audio signal made by the user.

Results and evaluation

This methodology has been used in two different schools during 2 years. These projects have been used with groups of 20 students of 4th degree of secondary school in Technology subject. In them, we have evaluated some different levels: The perception of students, academic results and teachers feelings. A brief questionnaire was made to evaluate students' perceptions. The test was made to 80 students and the results were:

Table 1. Results of the questionnaire

Questions to students	Yes	No	No answer
1. Does the project incorporate revision and reflection?	78	0	2
2. Is the project focus on significant content useful for the “real life”?	65	7	8
3. Has the project allowed to make some choices about the products created guided by the theacher?	80	0	0
4. Has the project encourage you to make a process of asking questions, using resources and develop your own learning?	80	0	0
5. Do you think this method is positive to improve your skills and knowledge?	75	1	4

Besides, academic results were better compared with previous years and teachers said that they were encouraged by the method. Teachers were also satisfied with the experience and they showed their interest to continue with the method in the subject.

Discussion

So, after the work is done, one of the questions that arise is “What is the best way to involve students and achieve the best results, not only academicals but also in skill useful for real life: project method learning or traditional method?”.

Traditional learning method is based in the lessons explained by a teacher in a classroom, using blackboard, books and so on, and alternating them with the realization of exercises and test. Doesn´t matter if the students are “bad” or “good”, the risk of boring is very high and even in the case they achieve the desired results, practice is so poor and it is not easy include some real cases in explanations.

Opposite, we can say that project method learning is based in two principles: experimentation and discovery. It is known that students use to understand and remember all those concepts acquired by experience. Implications of students in making the project are very high usually and with a few theoretical explanations, all the knowledge is getting by doing, learning in most cases, more than with traditional methods. So, an adequate mixture of both methods will give us, without any doubt, the best results both academicals and experimentals, but a good training of teachers will be essential to adapt their practice to new generations.

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