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Blockino: a Tool with an Emphasis on Educational Robotics Assisting the Teaching of Programming Logic

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Abstract: For entering students in Computer Science, in addition to having affinity with the area, it is highly necessary to acquire knowledge in Programming Logic. However, not all entering students in the technical or graduation courses find it easy to learn this subject. As an attempt to contribute to change this reality, the creation of a tool called Blockino has been developed. Blockino includes the concept of Educational Robotics, helping the teachers and professors in the process of construction of knowledge in programming logic through the use of a programming language in the blocks with robots.

Keywords: blockino, educational robotics, programming logic

1. Introduction

The market of technology demands for more qualified professionals every year, and unfortunately in Brazil there is a lack of qualified workforce to meet this demand. According to González (2013), the country has an average percentage of 87% of evasion in the courses of this area. This happens due to a weak mathematic and logic basis in the Brazilian elementary schools, leading to an ever harder effort from the universities. The Federal Institution of Education, Science and Technology of Maranhão (IFMA) offers technical courses and graduation courses in the area of computing science, and it is currently experiencing a high rate of school evasion. The professors from the Computer Science Academic Department have identified that among the main factors related to the school evasion is a major difficulty in the subject Programming Logic, which is the first contact of the entering student with computing science.

A proposal for the solution of this problem is to seek a more interactive learning process in the subject of Programming Logic. Technology, especially Educational Robotics, is a strong tool to go deeper in the learning process. According to Zilli (2004), this technology helps to develop a range of skills such as logical thinking, tests and hypothesis formulation, applying theories developed from specific activities, problem solving through analysing hits and misses, among others.

Accordingly, the present work aims to validate a tool called Blockino, that consists into a mobile application using visual programming based in blocks, in order to manipulate the robot through bluetooth technology, facilitating the first contact of the entering student with programming logic, in a more dynamic way. The tool has been used as an experiment with a group of entering students of the Technician Course of Computing Science at IFMA.

This article is structured in the following manner: the section 2 defines the proposed tool and how it was conceived; the section 3 presents the experiment carried with the tool; and the last section presents the concluding remarks and future intentions for the continuity of the tool.

2. Educational Robotics

The discussion regarding the Information and Communication Technologies (TICs) in the educational environment has been going on for years, and has as main goal to improve the teaching quality in the learning environments. It is important to highlight that although there are so many ideas and proposals, there is a supremacy of tools designed exclusively for software development (Sampaio, Miranda Borges, 2010). However, Sampaio, Miranda and Borges (2010) state that many efforts are made to change this reality. Within the proposals, the insertion of robotic in the educational system is a very strong one, as it stimulates construction of knowledge inside the classrooms and promotes student’s motivation. This educational component provides a more ludic and challenging environment for the students, that are subjected to find solutions to specific problem situations.

The proposal to use robotics in educational environments was developed by the researcher from the MIT Computer Science and Artificial Intelligence Laboratory, Seymour Papert, who advocates the use of computer as a pedagogical tool. His defence is based in the constructivist theory by Piaget, that aims to explain human intelligence emphasizing the relationship of a person with the environment during the process of human cognitive development. Stem from this theory, Papert idealizes an adaptation called Constructionism, which is different from Jean Piaget’s Constructivism, and it is based in building knowledge through concrete experiences, stating that the learning process is built in parallel with previous knowledge designed in practical experiments (Zilli, 2004).

Educational Robotics (also known as Pedagogical Robotics), uses industrial robotics, as construction, automation and robot-devices control, in a learning environment, in order to teach the learning concepts. According to the Brazilian Education Interactive Dictionary (DIEB), the term Educational Robotic can be understood as a learning environment that embraces mechanic artifacts which are organized in a set to make a functional model controlled via software. Thus, programming is used to somehow facilitate a proper operation for the idealized model.

The University of Joensuu, in Finland, has a project called Children Club, which consists in an environment where children between 10 and 14 years old participate in experiments with pedagogical robots in laboratories, under the supervision of their mentors, who are students from the university. The assessment of this experiment showed that the use of pedagogical robotics, if compared to the traditional methodologies, promotes a more motivational, fun and dynamic learning, consisting in learning based in problem-solving, overcoming the traditional methods. This pedagogical robotics workshops are characterized by many different forms and objects, but in general, they hold a learning process in which the students are subjected to reading instructions and manuals to use reach their goals, or experiment spontaneous construction and robotic prototype programming (Eronen et al., 2002).

To Zilli (2004), the arrival of pedagogical robotics helps develop a range of skills such as logical thinking, tests and hypothesis formulation, applying theories developed from concrete activities, problem solving through analysing hits and misses, among others. Therefore, this methodology is available for the teachers, to facilitate the comprehension of more complex topics during expository lectures (Schons, Primaz, Wirth, 2004). The challenges created by the teachers and professors, allow the students to have collaborative and constructive discussions on the topics, engaging and motivating the students to develop practical solutions.

3. Blockino

The Blockino was idealized with objective to create a tool to assist the teaching of the school subject Programming Logic. It is composed by an Android application and using the Google’s Bockly Library, and a small robot made with Arduino electronic prototyping board, suffering direct effects through bluetooth technology.

Figure 1 shows a structure of communication between the elements (Student, Blockino and Robot), that represents all the architecture specifications used in the project, identifying basically three types of views: components, software and hardware.

The components' view describes the scenario to use tool and a communication between the elements involved. So, it is the scenario that students use application in smartphone or tablet and use interface based in blocks, to send commands to handle the robot.

The software's view represents the interaction between the two applications presented in the project, the mobile application and robot embedded programming. The Blockino mobile application, represents the interface of the project user, it is there that student will manipulate blocks programmable to execute functions reflected in robot. The application had its layout structure based in the technologies HTML, CSS and Javascript, with adaptation and integration the Blockly tool to manipulate blocks.

After the interface user was finished, used the Apache Cordova tool to create applications in Android, then allowing to use mobile device with this operational system. Figure 2 shows the main screen of the mobile application.

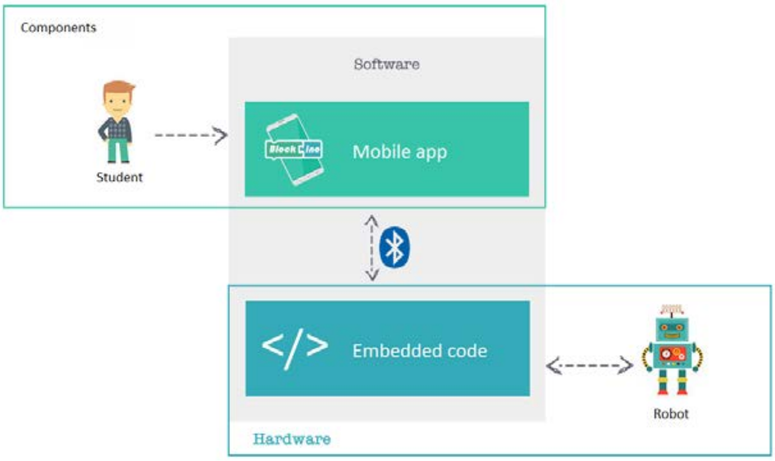

Figure 1. Communications structure between the elements.

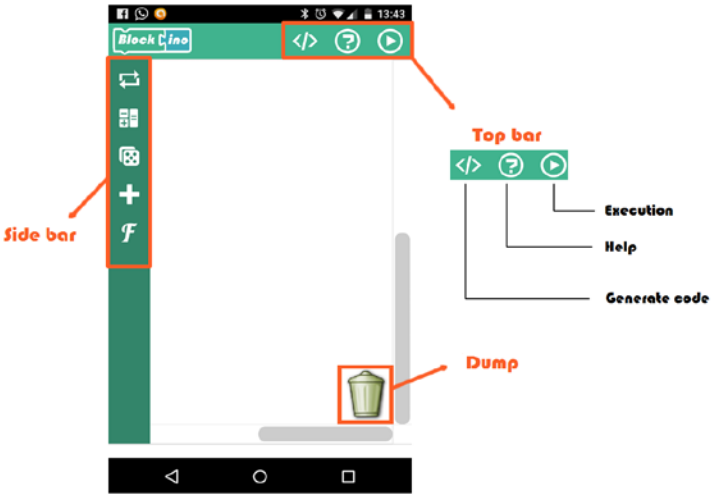

Figure 2. Main screen of the mobile application.

This screen represents the objective of the application. There are two bars with functionalities icons, one in top, other in the left side and one little garbage in the under right side to discard the blocks that will not be used.

The sidebar contains icons to create the blocks: control blocks, arithmetics, logicals, variables and functions. Among them, only blocks of functions were custom to call the possibilities of robot movement, and all others were used the Google's Blockly tool. Blocks like “walk_forward”, “walk_backward”, “move_right”, “move_left”, “led_up”, “led_off” and “calculate_distance”, are commands that represent movement of robot, and can be grouped to intensify the movement complexity. An example to do the robot walking non stop, can be resolved with a kind of control block - represent the repeat structure - grouped to block “walk_forward”.

On top of the bar there are icons with general functionalities on application: create code, help and execution. The button “generate code”, allows the visualization of code written in text format, with objective to be the alternative to view code. The button “help” shows the application's iconography, and the button “execution” sends commands grouped by bluetooth.

Beyond mobile application, it is necessary an embedded code on the robot, that has as main function to receive and translate the commands sent by the application. Figure 3 shows this translation of commands by programming embedded on robot.

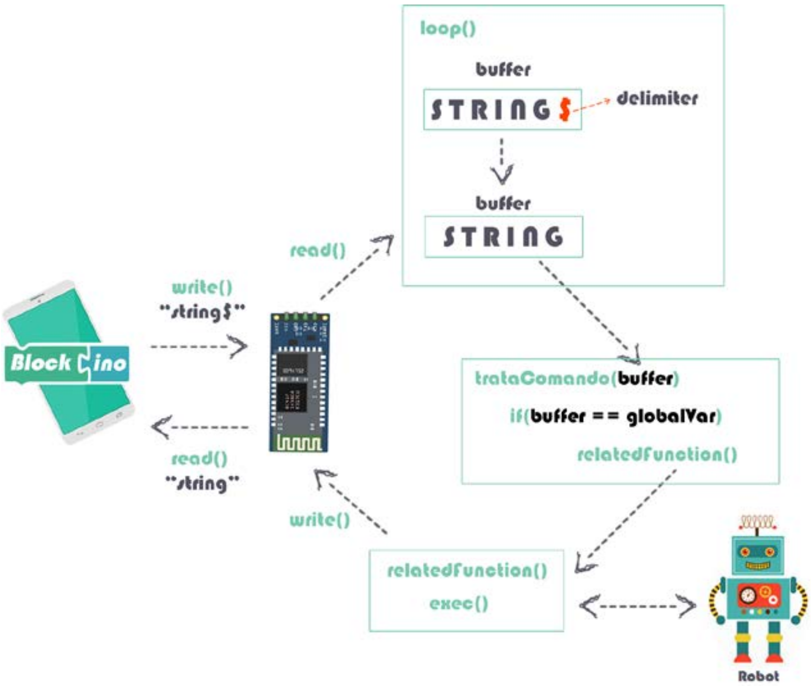

Figure 3. Representation of the interpretation of the commands.

The embedded application is guided exclusively by the loop function that is requested continuously while robot is on in the energy. This function has the objective to read space reserved by bluetooth technology to save the information received. When the loop function finds any string, it slices the received string into small strings according to the delimiter "$", defined previously with function to concatenate more commands in only execution of programmable blocks. These strings separated are analysed by other function, that has the goal of test and connect the string with name of the responsible methods to handle the robot. For example, this function could identify the command "walk_forward", making the robot move forward.

The way the physicals components of project interact define the hardware's vision. At this stage, the user uses a device with operation system Android 2.3 or superior, and a bluetooth connection to send the code. The robot was made with pieces and components compatible to Arduino platform and consist in a vehicle with three wheels, in which two back rears are connected directly to the motors and the front wheel counts for support and guidance. In its structure, there are to supporting basis overlaid to for a better attachment and organization of the other electronic components.

4. Experiment

4.1 Experiment Application

For the development of the Blockino application, researches were made on how to use educational robotics in classroom and extract significant results from the experiment. Therefore, in order to assess the project, the application of a practical-theoretical experiment was applied to students in the second year of IFMA's Computing Science technical high school. These students were invited to participate in the experiment having previous programming knowledge.

In order to encourage collaborative work, four students took part in this experiment which lasted for two hours in two stages: theoretical class and practical class. The experiment started with a brief theoretical explanation regarding the selection and repetition structures which was fundamental to review some concepts and prepare the students for the challenges. In the practical class a short introduction about the Blockino tool was given concerning points such as main objective, browsing characteristics and application usage. The introduction to the tool was made necessary for making it possible the challenges resolution.

In total, five proposed challenges happened as practical activities, accounting: two selection structures, two repetition structures and one final challenge with two themes mixed. Below are three examples of the challenges applied:

a) To create a simple selection structure in which its true logic expression makes the robot walk forward and turn on a LED;
b) To create a *for* repetition structure which makes the robot walk forward and turn left five times starting from value zero for the interaction variable;
c) To create a *for* repetition structure which makes the robot walk forward and turn right five times starting from value two and test if the value is equal to four after each interaction. If the result is true the robot must turn on the LED and walk backward.

At the end of the experiment the students answered an exercise for consolidation of acquired knowledge, filling a questionnaire about usability and acceptability aspects. Below there are examples of the questions used in the exercise:

a) Is the tool visually attractive?
b) Did the tool allow the completion of the desired tasks?
c) Is the tool easy to use?
d) Did the tool enable a fast resolution of the exercises?
e) Are the icons used on the tool familiar?
f) Did you manage to assimilate the presented subjects about programming logic?
g) Can the tool be considered a support for the teaching of Programming Logic?

4.2 Experiment Analysis

The main objective on creating a support tool for the teaching of programming logic was positively considered at the end of the experiment. The teachers involved agreed that the tool could become an alternative resource, making the classes more dynamic, interactive and interesting. Figure 4 represents a graphic generated according to the resolution of the questionnaire applied to students at the end of the experiment.

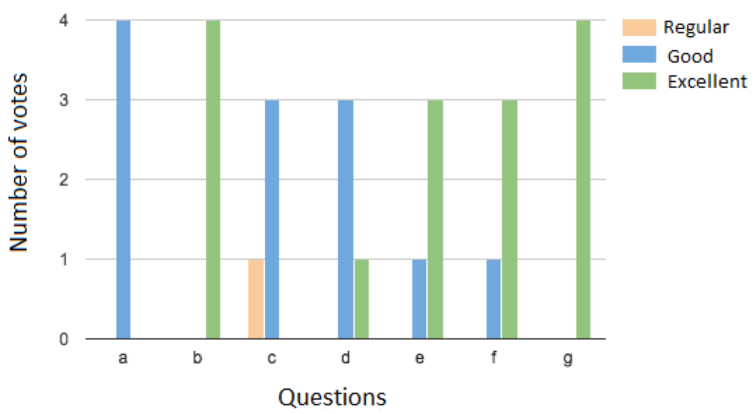

Figure 4. Experiment result.

5. Final Considerations

With the development of the work it was possible to conclude that, seeking alternative teaching techniques to try to increase the reach of learning is a good solution especially for students who demonstrate difficulty in absorbing content. The Blockino tool contemplates the fundamentals of Pedagogical Robotics, which uses robots to streamline the teaching process. The level of interaction of this one becomes greater because it is a tangible experience, and thus has greater chances to arouse more interest on the part of the students. This tool, which integrates elements of block programming and bluetooth communication, has proven to be a viable alternative to assist teachers in the teaching of programming logic, contributing to avoid demotivation and consequently failure rates.

Currently, the possibility of migrating from the mobile application to a web service is being discussed, thus allowing parallel access of users to try to solve the problems presented by the teachers in a more competitive and fun way. The gamification elements can be thought of as an auxiliary tool in student engagement.

As future work, we intend to cover this experiment in a larger group of students and who do not have prior knowledge in programming, including also other fields of education such as undergraduate.

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