ROBÔ-EDU: EDUCATIONAL ROBOTICS STIMULATING THE INVOLVEMENT OF ELEMENTARY SCHOOL PUBLIC SCHOOL STUDENTS IN TECHNOLOGICAL INITIATION

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Abstract

When used correctly, Educational Robotics is an effective tool for young people to develop skills related to Computational Thinking, such as logical reasoning, concentration, creativity, teamwork, critical thinking, organization, among others, enabling interdisciplinarity as a pedagogical practice. Those who have this opportunity from an early age have greater potential and are more likely to learn. They also begin to dominate technological resources and, with that, can stand out in the career they choose in the future. Therefore, this paper presents the ROBÔ-EDU project, which aims to provide Elementary School students from public schools in the Brazilian State of Amazonas with contact with practices associated with the application of Educational Robotics in order to stimulate the interest of these students in joining in careers in the Technological area. Among the results obtained in the project were the training of qualified teachers and students for the application and multiplication of the practice of Educational Robotics in the classroom and the training of students in the application of Computational Thinking and programming in Robotics to solve problems. These trainings took place at the Federal Institute of Amazonas Campus Manaus Distrito Industrial (IFAM CMDI), using the LEGO® Mindstorms® EV3 Kit. We noticed motivated students in the area of Robotics and associated technological areas after the training, in addition to being interested in studying at the IFAM CMDI, which is another relevant result within this proposal

Keywords: Educational Robotics, Computational Thinking, Elementary School.

1 INTRODUCTION

The growing technological advance has given rise to an increasing demand for professionals in the Technological areas. To meet this demand, it is extremely important to train specialized human resources, promoted through undergraduate courses in the areas of Engineering and Technology. In this sense, there has been a concern to provide basic education students, particularly those from the Brazilian public school system, with a greater interest in careers in these areas, aiming to meet the needs of the world of work.

An initiative that has been adopted as an alternative to increase engagement in technological careers is the work with Educational Robotics (ER). RE has been gaining strength in recent years. Because it is the application of Robotics in the pedagogical area, it promotes learning in a dynamic and stimulating way, given that it offers diversified conditions for contextualization and discussion, which lead the student to greater involvement, through intuitive actions and creative solutions to real-world problems.

Currently, the vast majority of basic education students do not have the opportunity to work in contexts that promote and stimulate Computational Thinking (CT). Observing this reality, in this article we present the ROBÔ-EDU project. This project contributes to the improvement of the teaching-learning process of themes present in the school routine, through the use of ER, since it addresses the fundamentals of Computer Science with applications in day-to-day for problem solving in several areas of knowledge, enabling interdisciplinarity as a pedagogical practice.

Therefore, when used correctly, technology is an effective tool for students to develop CT-related skills and competencies. Those who have this opportunity from an early age have greater potential and are more likely to learn. They also begin to master technological resources and, with that, can stand out in the career they choose in the future [1].

The ROBÔ-EDU project aims to provide Elementary School students from schools in the state and municipal education networks of the Brazilian State of Amazonas with contact with practices associated with the application of ER in order to stimulate the interest of these students in entering careers in technological area. The project included 4 municipalities in the State of Amazonas, where there is at least

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one Campus of the Federal Institute of Amazonas (IFAM). The municipalities covered were: Manaus, Presidente Figueiredo, Parintins and Tefé. This article will explain about the experiences that took place in Manaus. Manaus is the capital of the State of Amazonas and the main financial, corporate and economic center of the Northern Region of Brazil. It is a historic port city located in the center of the largest rainforest in the world. With strong economic growth, it seeks to meet the needs of qualified professionals who contribute to the development - not only of the capital, but also of the state and the country. In it is located the IFAM Campus Manaus Distrito Industrial (IFAM CMDI), in the Industrial Pole of Manaus.

With this ROBÔ-EDU project, we seek to reach students from public schools in Amazonas, enrolled in the last two years of Elementary School, providing an environment that encourages the development and/or improvement of CT skills, such as: logical reasoning, critical thinking, decision making, ability to recognize patterns and solve problems, in addition to motivating them to enroll in technical courses offered by the Federal Education Network and, later, to enter careers focused on the technological areas.

2 METHODOLOGY

2.1 Theoretical Background

This project has as its principle Project-Based Learning (PBL) and the integration of Maker Culture for the development of CT in students, which aims to encourage teamwork, collaboration, planning, research, decision-making processes decision-making, as well as interaction between peers in a lively atmosphere that allows managing conflicts and respecting ideas, opinions and the search for a common result [1].

However, to make this immersion possible, it is necessary to integrate known methodology techniques in the educational environment, as well as the reference of the FIRST® LEGO® Education methodology [2], which divides the learning experiences into four phases, which are: Contextualize, Build, Analyze and Continue.

In the Contextualize phase, a connection is established between previous knowledge that the student has and new knowledge. At this moment, the student gets in touch with the theme he will work with in the next phase and the educator invites the student to participate in the practical activity, which will be done in this stage.

The Build phase develops activities related to contextualization. Active learning involves two types of construction: physical and mental construction. That is, when children construct artifacts in the “real” world, they simultaneously construct knowledge in the mind. The process of physical construction of models will provide a fertile learning environment for the mediation process to be carried out by the educator, who will negotiate conflicts, listen to different ideas and opinions for the same proposed problems and provide guidance regarding the rational and effective use of technology and the acquisition of new knowledge.

In the Analyze phase, students are led to think about how their constructions work, experimenting, observing, analyzing, correcting possible errors and thus validating the project. By analyzing what was done, they have the opportunity to deepen their knowledge. As a result, they develop connections between previous knowledge and new experiences.

Finally, in the Continue phase, students are invited to solve a problem situation. Thus, the student remains in a state of intrinsic motivation, making the teaching and learning process cyclical and continuous.

In the context of the phases defined in the LEGO® Education methodology, the Mediated Learning experience stands out. This learning model defines an interaction between those who teach and those who learn, that is, the mediator of this model interposes and selects external stimuli and acts as a learning facilitator.

In turn, IFAM, throughout its experiences in projects, has been applying these learning models and generating diversified expertise [1] [3] [4], because with each application, it provides personified performances, where the key concepts in this journey are present in the pillars of technological education.

Therefore, this project proposes a learning cycle that applies teaching-learning methodologies per project, permeated by the concepts presented in the model of Mediated learning experiences, using dynamic environments of Culture Maker with educational tools that provide opportunities for technological initiation. This, in turn, is strongly linked to the learning by doing moment, in which students apply scientific methods to structure research and solve problems from scenarios using tools, languages and techniques in order to develop their skills.

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The application of the technological initiation foreseen in this proposal was through ER, which approaches problem-situation scenarios in a playful and challenging way. In addition, it provides five advantages that we can highlight that generate contributions in adding Robotics in the teaching-learning process, namely:

- Turn learning into a motivating moment, making the principles of science and technology more accessible;
- Allow experiences through physical equipment and learning obtained through real-world simulations;
- Propose to the student the management of their feelings and expression, knowing how to communicate, verbalizing their knowledge and experiences, thus developing the ability to argue and generate their critical sense;
- Develop reasoning and logic in the construction of algorithms and programs to control mechanisms, in addition to being a builder of inventions through mechanical design;
- Generate interdisciplinarity through the integration of concepts from the most diverse areas involved, for example Mathematics, Physics, Electronics, Mechanics and Architecture.

With this context, we emphasize that for the execution of this project we used LEGO® Mindstorms® EV3 kits. This kit was chosen because it is considered a reference kit in ER that stands out both for its playful nature and for presenting significant free dynamics, freedom and flexibility for the assembly of mechanical structures for different contexts. In addition, this kit is the most used in Robotics competitions in Brazil.

2.2 Activities Done

Initially, 70 students from the school served by our project, the Brigadeiro João Camarão Telles Ribeiro State School, were selected. After selecting the 70 students by the school team, in 2 groups of 35 each, who are students in the last 2 years of Elementary School, we trained the students and 3 teachers who accompanied them.

With regard to the selection of IFAM CMDI volunteer students to act as monitors, they were chosen by the project coordinator, among the students of the technical courses, who had specific skills in digital technologies, and who had already participated, demonstrably, in projects of the technological areas.

The technical team of IFAM CMDI project was responsible for preparing a short training course, given to students and accompanying teachers. These trainings considered the infrastructure and organization adopted by FIRST® LEGO® LEAGUE (FLL), in order to adapt them to the reality of the project.

Training took place at Rivelino Lima Makerspace at IFAM CMDI. These trainings were held for 5 days, 4 hours a day, for a period of 1 week for each class of 35 students, totalizing 2 weeks. Each class was divided into 4 teams of around 8 or 9 students, as we had 4 LEGO® kits available. Even so, the students managed to participate. Thus, this proposal complied with the planning of the project's classes, which provided that each beneficiary student should be attended to at least 20 hours of activities. The classes were also promoted in order to contemplate methodologies and didactics different from the conventional model already offered by the regular education system, with a main focus on practical activities.

In each week, the programmatic content was:

- Conceptualization of Robotics (1 hour);
- Presentation of the LEGO® MINDSTORMS EV3 Kit and Assembly of the Educator Robot (2 hours);
- Introduction to Brick EV3 and LEGO® MINDSTORMS EV3 Software (1 hour);
- Moving the Robot in a Straight Line (2 hours);
- Carrying out curves (2 hours);
- Touch Sensor (2 hours);
- Color Sensor (2 hours);
- Ultrasonic Sensor (2 hours);
- Edge Follower and Line Follower (6 hours);

Fig. 1 shows the beginning of the Educational Robotics training, with students from the Brigadeiro João Camarão Telles Ribeiro State School being received and receiving instructions on how the classes

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would be. Fig. 2 presents the students assembling the EV3 robot and programming it, while in Fig. 3 a student is preparing his robot to go up a ramp, in addition to performing the line-following robot challenge. In Figure 4, a student is programming a robot in the EV3 software by block diagram so that the robot performs more complex tasks. In these activities, the competences and abilities of Computational Thinking developed in the students were implicit, who were motivated.

Figure 1. Start of training.

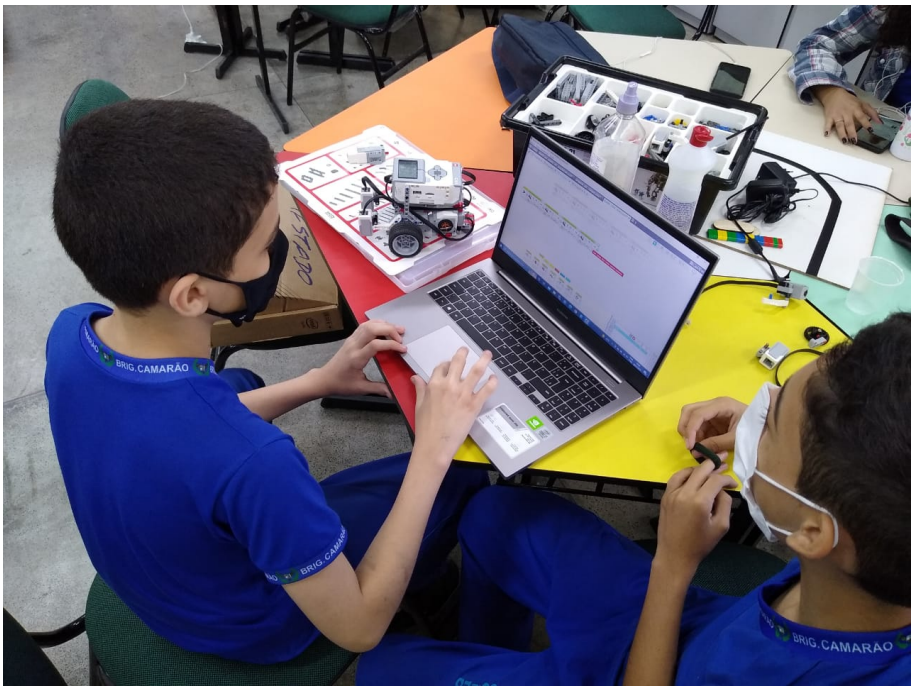

Figure 2. Students assembling and programming the EV3 robot.

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Figure 3. Student performing ramp-up and line-follower challenges.

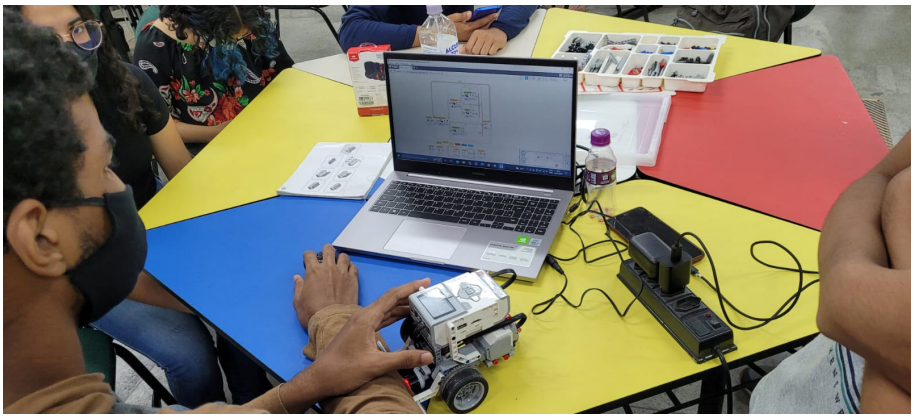

Figure 4. Student performing programming to perform more complex tasks.

At the end of the training, a closure was held and later the students received their certificates for the course taken.

3 RESULTS

The main result obtained in this project was the satisfaction obtained by 70 students and 3 teachers when assembling robots. Everyone saw the potential that Educational Robotics awakens in students and teachers, encouraging them to solve problems, whether through overcoming obstacles, using sensors to identify variables in the environment and performing actions, such as moving faster, involving the processes of problem solving and other skills and competences of Computational Thinking in students. As a consequence, another result obtained was the interest of students in studying at the IFAM CMDI, where 2 students from this course held in 2022 were approved in the local selection process to be students of the IFAM CMDI in the Integrated Technical Course in Industrial Mechatronics from 2023, in High School. Figure 5 shows a student (who is holding the robot) already in 2023 being an IFAM CMDI student, along with other students who were monitors in the ROBÔ-EDU project in 2022.

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Figure 5. Student (holding the robot) who participated in the ROBÔ-EDU project and became a CMDI student, along with students who were project monitors.

We asked these 2 students who from 2023 started their studies at IFAM CMDI and who were students of the ROBÔ-EDU project in 2022 about their impressions regarding the project. They were in the last year of Elementary School during the project period. One of them already had prior knowledge of the LEGO® MINDSTORMS EV3 kit, while the other did not. The students also commented that they liked the infrastructure and the opportunity to have a quality Technical Education. Asked if they believe that ER is important and should be more present in the students' daily lives, the students answered yes, where the first student mentioned that ER stimulates creativity and many areas of the brain and the second said that ER opens up opportunities for personal and professional development, depending on the individual's goals.

The 3 teachers of the students at the Brigadeiro João Camarão Telles Ribeiro State School also liked the project, having an interest in further exploring this area, as well as the Maker Culture.

4 CONCLUSIONS

The ROBÔ-EDU Project carried out at IFAM CMDI allowed more students to become interested in Educational Robotics, in addition to being interested in entering technological areas. The approaches carried out in just one week of classes for each of 2 groups served as a different form of teaching seen by both students and teachers, such as stimulating Computational Thinking and developing their skills and competencies involved, with the aim of solving problem situations. The project was approved by the students and the entry of 2 students from this project later at the IFAM CMDI has shown that Robotics can be an attraction for students to become interested and enter technological careers. As future work, the challenge is to make students create their own robots, whether with 3D printing, CNC laser cutting machines, among others.

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