A Methodological Proposal for the Training of Teachers in Educational Robotics

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Abstract. *This article introduces a methodological proposal for the training of teachers in Educational Robotics that has been experimented at a fundamental school at the Northeast Brazil. The introduced methodology is organized ranging from elementary concepts of robotics to the assembly and programming of three different types of hardware specific to educational robotics. Teachers have been trained in a short-course with this methodology and applied the methodology in their classes after training.*

1. Introduction

The increasing advance of new technologies allows us to bring the classroom closer to the technological world, making the teaching and learning model more interactive and motivating. This concept came to be studied by [Cuban 1986], professor of education at Stanford University with the work entitled "Teachers and Machines: The Use of Technology in the Classroom Since 1920". The professor studied the introduction of radio, film, TV and computer in American schools.

With all this advancement of technologies and studies dedicated to them, we come to witness a new and increasingly adept technological society that needs follow-up, generating an awareness of the need to include in the school curricula the skills and abilities to deal with the new technologies, allied to the disciplines taught in the classroom. In this context, as technologies inserted in schools, they begin to cooperate in the specialization of knowledge, to become interdisciplinary and transdisciplinary classes, as well as to make access to information easier.

Faced with this, a new challenge is emerging in education and the role of the teacher in facing this new challenge is to make this meeting of technology in the school environment as attractive as possible. We know that traditional methods of teaching, already well established, and the fear of testing the new, cause a delay in this progress. When realizing this situation it becomes evident that the main process of qualification should begin with teachers, as the precursors of knowledge.

Knowing the importance of the teacher as mediator of knowledge and collaborator in the exchange of scientific and cultural information, a training course for teachers was organized with the objective of introducing the methodology of educational robotics in the classroom. For this, a team of five specialists in educational robotics developed an one week course for teachers of Escola Estadual Presidente Kennedy.

The course ranges from elementary concepts of robotics to assembly and programming of three different types of hardware specific to educational robotics. The classes had the participation of 12 teachers, among them were teachers of various series and areas, all willing to apply the new methodology proposed in their classroom. In the course of this article will be reported the step-by-step of the training process and the teachers' reports of the course and how this methodology can help them to apply robotics in the classroom.

2. Educational Robotics

We can characterize educational robotics as a learning environment composed of manipulable prototypes fitted with sensors, motors, controllers and computer software. These artifacts are called pedagogical robots, which have the function of interacting with the external environment by performing programmed actions [Zanatta 2013, Silva 2008].

The use of robots allows students to demonstrate and prove their own ideas, creating an active participation between students and teachers [Okada and Santos 2014]. According to [Zilli 2004], the main advantages of the use of educational robotics are: stimulation of research, promotion of creativity, organized work, elaboration of hypotheses based on error, collaborative learning and others.

Educational robotics workshops can involve a range of topics, from ethics and social responsibility issues to topics inherent to curricular components, always addressed in a playful and engaging way to students.

3. W-Educ

There are several commercial robotics kits, such as LEGO MindStorms, VEX, among others, as well as kits that make use of the free robotics paradigm or robotics with electronic components. With this diversity of kits, if the teacher wishes to use another kit, it would be necessary that the studant learn a new language and use a new programming environment [de Lima Sá 2016]. This would make it very difficult to use robotics in classrooms, because whenever it was necessary to make use of a new robotics kit, it would require new workshops for teaching how to use it.

In view of this difficulty, we used the W-Educ web programming environment. According to SÃ¡ (2016), greatly facilitates the diffusion of educational robotics in the educational environment because it is a new dynamic, open and free web tool that does not require installation of softwares and uses an easy-to-learn universal language called R-Educ.

4. Teacher Training Process

Although educational robotics is a promising tool for the academic field, teaching still presents difficulties for diffusing it. Teachers in general were not properly trained to teach their students how to assemble and program their robots.

In order to solve this problem, educational robotics workshops were organized with the teaching of public schools in Natal/RN. Teachers, regardless of their academic background, were able to teach robotics to students in a fun and dynamic way, using low-cost tools such as W-educ, to facilitate learning.

In the training process, we seek to develop competencies and enable professionals to acquire the knowledge and skills to perform with excellence what is proposed. This training process was applied at the Escola Estadual Presidente Kennedy, founded in 1908. It houses about 600 elementary students with a team of 39 professionals, 29 of whom are staff members and 10 are trainees.

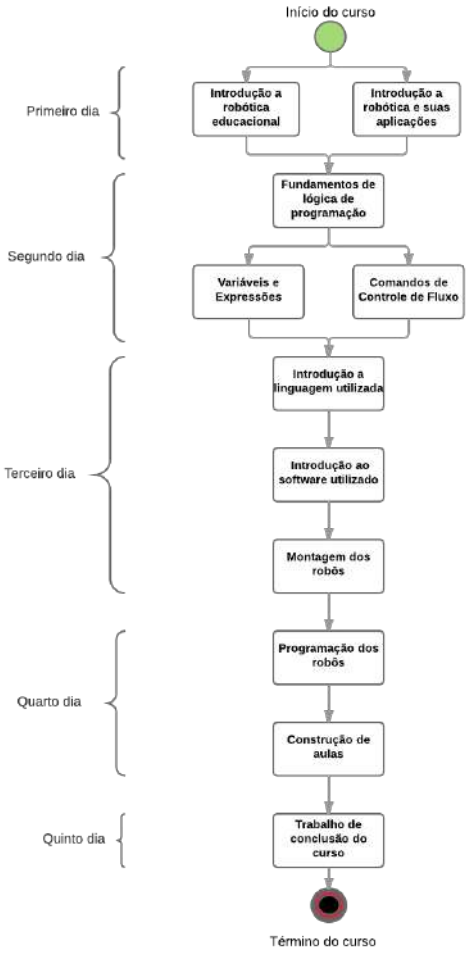

Figura 1. Course Schedule

The training course was attended by 12 teachers, Most of the teachers who participated in the course never had contact with robotics or even heard about it, highlighting the barrier that still exists between the classroom and the new technologies. The training processes took place in the computer lab of the school with a duration of one week in the morning and evening hours, totaling 30 hours. In order to make the course motivational and didactic we base the course in three main pillars:

- Elaboration of lesson plans;
- Teacher training process;

- Evaluation of the results of the training course.

Thinking about the first pillar mentioned previously and the difficulty of adhering to new methodologies, the lesson plan of the training course was developed thinking about the best way to pass the methodology of educational robotics to the teachers. The flowchart of Figure 1 describes the step-by-step of the course.

The classes began with an introduction of the concepts of robotics and educational robotics, as well as their applications in the day to day with the aim of presenting and familiarizing teachers in this new area. In Figure 2 we can observe the first theoretical class of the training.

Figura 2. Educational Robotics Training Course

Following the course schedule, we moved on to the second day with the presentation of the fundamentals of programming logic, listed in Table 1, and the other concepts needed to start the code construction process, a more delicate course step due to Teachers' lack of familiarity with the new programming-related definitions. In this step we introduce the concepts alternating with practical examples, making the understanding more efficient.

Tabela 1. Chronogram of Concepts Addressed in Classroom

Fundamentals of programming logic
Repetition control structure
Conditional control structure
Logical operators
Arithmetic operators
Introduction to pseudocode

The third day was subdivided into three stages, starting with the introduction of the language and then the software used, for the training course we operate with the R-Educ language and the W-Educ web environment, respectively. After the introduction of the new tools, we moved on to the first practical part of the course, the assembly

of the robots. To begin the assembly the teachers attended a brief presentation on the educational robotic kits, which addressed the qualities, functionalities and applicability of each kit. The kits available for the course were:

- LEGO MINDSTORMS NXT;
- LEGO MINDSTORMS EV3;
- M-bot v 1.1.

For the assembly process we divided the class into small groups with three and four teachers, after forming each group chose a kit to start the assembly, which was aided by a manual.

On the fourth day we started in the morning the development of the codes, through small exercises teachers were challenged to solve several problems using the knowledge about programming addressed in previous classes. During the process of building the codes, the difficulty levels of activities increased as teachers completed the challenges. The afternoon was set aside to provide teachers a workshop about the process of developing educational robotics classes. This workshop worked, in practice, what teachers face in the classroom. The workshop dealt with how to plan a lesson and how to link curricular content with educational robotics. First teachers were led to think about the curricular subjects that could be associated with robotics and what the subject in robotics could be worked on with that particular subject, Some of the examples in Table 2 were quoted.

Tabela 2. Content Association

Curricular Subjects	Robotics
Physics	Sensors
Mathematics	Montors
Portuguese	Assembly
History	Remote Control
Art	Basic Programming
Sciences	Foundation

After selecting the contents it is necessary to develop the class according to the age of the students. Defining these variables we move to the assembly of the lesson from according to the proposed methodology.

For the last day of the training, we propose a work of conclusion of the course that consisted of preparing a lesson on a certain subject using the methodology of educational robotics. The teachers had to choose a subject to be worked in the classroom and then develop the lesson with the new methodology, specifying the curricular discipline used, the topic in the robotics that would be associated and the level to which it would be destined to the classroom.

5. Results and Experiences

During the course, we applied questionnaires with the objective of evaluating the progress of teachers and the efficiency of the course. We applied a questionnaire at the beginning and another at the end of the course.Both questionnaires were identical and contained the following questions:

- Q1 - Do you know what is a robot?
- Q2 - Do you know what is robotics?
- Q3 - Do you know what is educational robotics?
- Q4 - Do you know what is programming?
- Q5 - Do you know what is programming language?
- Q6 - Have you already program?
- Q7 - Do you intend to use educational robotics in your classroom?
- Q8 - Do you think that educational robotics may favor the process of teaching and learning?

These were answered by ticking yes, no, I do not know or more or less. The questionnaires also contained discursive questions for teachers to conceptualize what was robot, robotics, educational robotics and programming according to what they already knew, as well as a more subjective question: Q9 - What is your expectations about the teacher training process?.

The second questionnaire presented some additional questions regarding the course process and the teacher's expectations regarding the application of the new methodology addressed in the training process: Q9 - What kind of activities do you think can be developed using educational robotics?; Q10 - What were your greatest difficulties?; Q11 - What are your expectations for the application of educational robotics in the classroom?.

After compiling and analyzing the results obtained through the questionnaires, we verified that some of the teachers did not know about educational robotics and some of the basic concepts in this area. As shown in the graph of Figure 3 we can see the deficiency of teachers in these concepts that are fundamental to working with the new methodology.

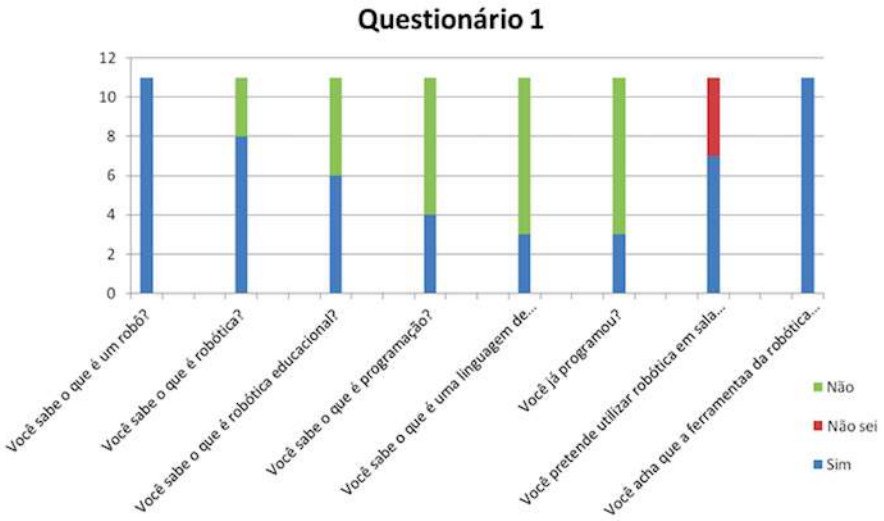

Figura 3. Graph with the Results of the First Questionnaire

These results were converted after the training process, as we can see in Figure 4, teachers began to understand the fundamental concepts and later were able to pass this knowledge to the students.

During the training process we note the teachers very observant and willing to join this new tool in the classroom.

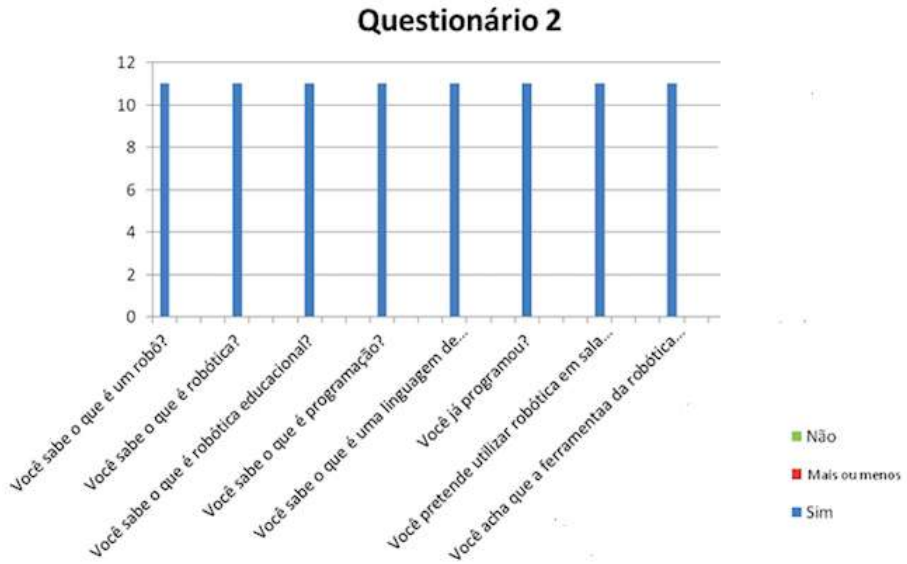

Figura 4. Graph with the Results of the Second Questionnaire

As mentioned in the previous section, on the last day of training we propose a course completion work, with the objective of providing teachers with the experience of elaborating an educational robotics using the proposed methodology. Separated into groups of three, each group began to plan their class following the steps taught in previous classes. At the end of the class preparation period, each group presented the class proposal to the rest of the class, as shown in Figure 5.

Figura 5. Presentation of the Conclusion Work

The classes proposed by the teachers reached the goal of being interdisciplinary, in addition they fulfilled all the methodological proposal given in the course. One of the classes planned by one of the groups related the geography discipline to the programming content. In this class the teachers approached the regional divisions of Brazil, developing a playful and creative class. The goal of the robot was to go through a map with the regions of Brazil arranged in different colors, this way was made by a black line that the

robot had to travel until finding the first region that was represented by the blue color. Following the route the next stop was the region of green color and so on until closing the circuit with all the Brazilian regions. In each region that the robot identified the teacher taught the cultural, social and economic characteristics of the region. In Figure 6 we can see the teachers describing the lesson planning and demonstrating how the robot would be executed in the built model.

Figura 6. Conclusion Work about Brazilian Regions

All groups presented their class proposal and were successful in the final work, although some teachers reported the need for follow-up in their future work using educational robotics. Teachers M.C. and D. made the following comments:

> ”Excellent course, however we need an accompaniment and some meetings to discuss our doubts.”

> ”It was great, so we need an accompaniment so that we can better develop the new activities with our children (at least in the beginning to feel safe) here my thanks to the whole team!”

6. Conclusion

A Methodological Proposal for the Training of Teachers in Educational Robotics was presented in this paper. This methodology was developed by a team of five specialists in educational robotics and applied on an one week course for teachers of Escola Estadual Presidente Kennedy.

The methodology ranged from elementary concepts of robotics to assembly and programming of three different types of hardware specific to educational robotics. This type of workshops for teachers are fundamental for the dissemination and expansion of robotics in schools.

Aiming at this dissemination of robotics in classrooms, we propose as future work to accompany the teachers who participated in the training process. This monitoring is intended to assist teachers in any questions that may be generated, assisting in the use of software and hardware. In addition to stimulating teachers in the application of this new tool, educational robotics.

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