An Experience of 6 Years in Educational Robotics

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Abstract. *In this article we discuss the experiments conducted by researchers from the laboratory NatalNet of the Federal University of Rio Grande do Norte, involving robotics in education, that were developed during six years of activities. Educational robotics classes were ministered for approximately 1,500 children and adolescents, in addition to teacher training courses for the use of robotics in the classroom. The robotics workshops were held with heterogeneous groups to show that this learning methodology is able to adapt to any type and group age of students.*

1. Introduction

The technological innovations of the last few decades have brought many revolutions, especially in the telecommunications and computing. Education has been following these developments which gave rise to the field of educational technology. Among the most current educational tools, we can mention the use of robots in the classroom.

The use of robotics for educational purposes is called educational robotics. We consider robotics as the control of electronic mechanisms through a computer. This electronic device becomes a machine capable of interacting with the environment, performing actions previously defined. We assume in this paper that educational robotics is the term used to characterize learning environments that gather scrap materials or mounting kits [DIEB 2013].

This paper aims to contribute to this new field that is built today, reporting and presenting positive and negative aspects of our experience of six years with educational robotics. We made a brief literature review on the tools needed to implement educational robotics. We conducted a study of the tools necessary for the practice of educational robotics in education technology as supportive of social and digital inclusion, analyzing their strengths and weaknesses.

2. Educational Robotics

Educational robotics is a learning environment that stands out for show, in practice, theoretical concepts, and develop cognitive and psychomotor aspects of the students as investigative thinking, logical reasoning, creativity, development of scientific method, improvement of motor and others [Zilli 2004, Miranda et al. 2010].

For the creation of robotic prototypes, the students can use robotics kits, which are used in the framework of education, and include a set of sensors, motors, wires, connectors, mounting modules, controller and software for control and programming. Different

types of hardware (robotics kits) can be used, and they can be classified into three main categories: commercial kits, scrap kits and kits with commercial components.

3. The Experiments

The team of the laboratory NatalNet develops, since 2006, researches related to the field of educational robotics, involving the development of tools such as specific software and hardware for robotics education, and the creation of classes with the aim of disseminating robotics among students and teachers.

Were given educational robotics workshops for approximately 1,500 children and adolescents, as well as teacher training courses. Based on the pedagogical proposal drafted by the group, the student learns through play to creatively put together a robot prototype and then program it, by developing intuitively logical reasoning.

The teaching methodology used in the development of robotics classes described in this paper follows the RoboEduc methodology [Silva 2009], and consists of the following steps:

- The organization of the workshops;
- The production of resources to be used;
- The conducting of the workshops;
  - Create the context;
  - Use mediators elements;
  - Assembling robotic prototypes;
  - Using software.
- The evaluation of the whole process.

The classes are divided into three modules. The first, introductory, brings the theme: robotics and it's application, explaining the emergence of robotics, and parts of the robot and its functions, showing the kits that are going to be used. The second module is directed to building and programming a robot teaching concepts of teamwork, free and directed assembly, and the use of the software R-Educ, a software developed by this team that allows the programming of robots using a simple and intuitive programming language [Barros 2011]. In the third module is promoted a competition among students through the free construction of a robot, which enables the resumption of the concepts learned during the classes.

During the class, the teach presents a situation, allowing the development of the scientific method to create robots that solve the given problem. The classes serves an average of students from four to fifteen years old.

3.1. Ascendino de Almeida Middle School

The experiments that started in 2006 benefited the Municipal Middle School Ascendino de Almeida, located in the city of Natal, Rio Grande do Norte. Fifteen classes were implemented with twenty-four children in the 4th and 5th year of primary education school, with an average age 8-10 years. The goal was to insert them digitally, using robots and computers as a tool.

In this experiment we conducted two different surveys. One of them was dedicated to the development of pedagogical activities related to robotics and other oriented to the development of the software R-Educ.

The activities not only addressed the concepts of robotics and assembly or control of robots, but also concepts that were taught at school, like mathematics (Solving arithmetic problems), geography (Reading and location on maps, regions of their country, transportation facilities) and portuguese (Reading and writing texts).

In 2007 we continued with workshops at the School Ascendino de Almeida, performing twenty workshops throughout the year with new students. The workshops had a workload of one hour and five minutes. According to the teachers, after the entry of robotics in the lives of these students, they became more attentive, logical reasoning showed significant improvements. One teacher noted that students participating in the robotics were more responsible and committed to the activities in the classroom.

3.2. Center for Early Childhood Education (NEI)

Continuing the experiments in the second half of 2008 we conducted workshops fortnightly over a period of six months, benefiting the Center for Early Childhood Education (NEI) of the Federal University of Rio Grande do Norte. The workshops have been applied to students of stage five of the childhood school.

In these workshops we tested satisfactorily the first module of the software R-Educ and validate our methodology applied to it. With the workshops, contributed to the cognitive development of these children, introducing concepts that they would not have access in their regular classes as related to basic robotics, mechanical physics and computer science.

3.3. ProDocência Program

Also in the second half of 2008 we worked with teacher training, from the ProDocência Program, Program Degree Consolidation. This program provided an opportunity to conduct one short course lasting eight hours in the city of Currais Novos, on the state of Rio Grande do Norte.

This short course was attended by sixteen undergraduate students in the courses of physics, tourism, administration and mathematics. Were exposed on total three examples of educational robotics workshops, which had as theme informatics, mathematics and recycling.

In reports, project participants highlight the different ways in which interdisciplinary knowledge is transmitted, the teaching methodology, the tools used, and the teaching techniques they have learned, that can be applied when they are teaching their own classes.

3.4. Company RoboEduc

At the beginning of 2009 was created a company called RoboEduc, through the announcement of the Center for Application of Technologies in Automation of the Federal University of Rio Grande do Norte, aiming to teach classes of educational robotics in the state of Rio Grande do Norte. In its first year, the company served an average of fifty students between 4-15 years. By the year 2012, the company had already served about 200 students.

Through a continuous observation is possible to assess students, analyzing participation, attendance, understanding of content and performance in group. The results on the learning and motivation are based on reports prepared by the teachers.

According to one of the teachers, the methodology used by the company RoboEduc contributed to promote group work wich contributed to improvements in attitude and behavior of some students. Teachers find that through the activities the student develops the ability to think and research, making them critical and reflective citizens, sharpening the imagination and creativity.

Reports from teachers perceive the existence of a relationship between classes of robotics and content of some subjects, thus demonstrating the potential of robotics as interdisciplinary tool, since the search for knowledge afforded by the use and construction of robotic prototypes goes beyond the walls of school, where the use of technological resources are presented as a new tool in the teaching-learning process.

3.5. Extension Program ProExt

In the second half of 2010 we participated in the Extension Program ProExt, an extension project in order to present the methodology of educational robotics as well as the technologies developed for teachers of higher education in public universities with campuses in the state of Rio Grande do Norte.

Two meetings were held in different cities, each with a duration of two days. Although the meeting was intended only for teachers, there was participation of many children who were interested in learning robotics.

Teachers reported interest in the methodology and in particular on the tools presented. Described that educational robotics can also be used to assist them in the classroom for higher education in order to encourage students, especially in the disciplines of programming and robotics.

4. Results

During the development of the robotics classes mentioned before, it was made a survey with the teachers involved in order to analyze the robotics classes by the point of view of the teacher. The survey was conducted with a group of 34 teachers, involving not only teachers of primary, secondary and higher education, as well as graduate students in the field of engineering that teach educational robotics.

Research has shown that approximately 40% of teachers teach in public schools, while 30% of students attend public schools. The increased presence of students and teachers in private schools is reflected in a large number of classes created from the company RoboEduc. However, if we consider only the other initiatives of the group, there is a greater presence of teachers and students of public institutions.

Regarding the number of students per class, this value varies greatly depending on the activity to be performed and the age of the participants. As the groups formed over the years were well heterogeneous, there were situations where the classes were smaller, with less than 5 students, while in other cases there were approximately 40 students. Figure 1 shows the graph that describes the result of this research, in which one can see

that a number 6-10 students was the most common number of participants in a class of educational robotics.

The graph in Figure 2 reports the advents that robotics provides when inserted in the educational environment. The teachers, for the most part, indicated that educational robotics helps improve interdisciplinarity, creativity, teamwork, motivation to learn, among others. According to reports, educational robotics is a way of modifying the archaic posture of teaching in schools and assists the teaching of new topics and themes already known in a pleasant way, as a new tool to assist learning.

The research also questions the inclusion of robotics as a tool in the pedagogical practice of teachers (Figure 3). Although there is interest, due to difficulties such as learning a new tool and develop new learning environments, some teachers have rejected the inclusion of educational robotics, although robotics is characterized as a facilitator in the process of teaching and learning.

Among the difficulties encountered in the integration of educational robotics in schools, some teachers mentioned the high cost of implementation, linked to the use of software mostly in a foreign language. In addition, many stressed the need for people with training in educational robotics to teach the classes.

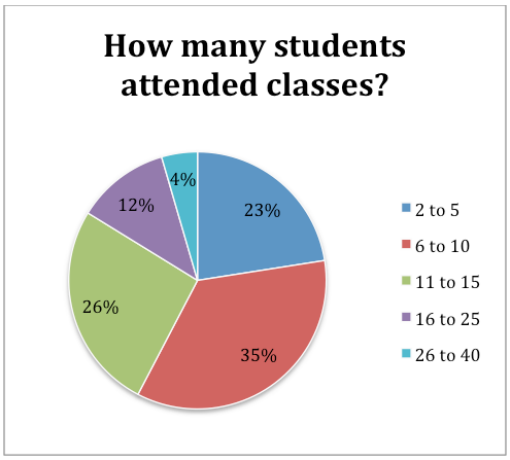

Figure 1. Quantity of students in robotics classes.

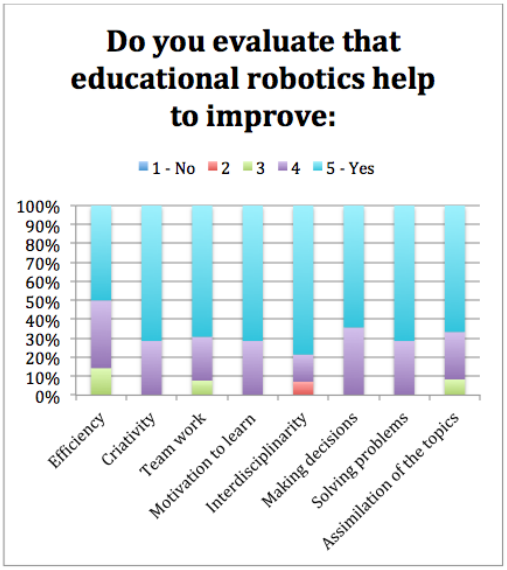

Figure 2. Advantages of educational robotics.

5. Conclusion

The educational robotics allows the teachers to establish a rich and interdisciplinary learning environment, that is able to contribute to the development of creativity, investigative thinking, logical reasoning and motor coordination. This learning environment stands to show, in practice, theoretical concepts and develop cognitive and psychomotor aspects of the students.

The group of the laboratory NatalNet, of the Federal University of Rio Grande do Norte, works with educational robotics since 2006, developing technologies and applying the methodology of teaching in educational robotics classes. The teaching methodology is

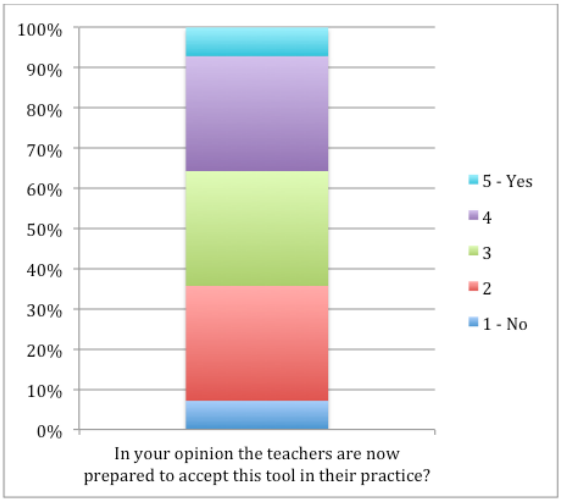

Figure 3. Opinion of teachers regarding the insertion of educational robotics.

basically composed of four distinct points, ranging from the structure of the class, which includes defining the theme and structure of the class, until the final evaluation of the whole process.

During the 6 years of experience, this team has participated in several initiatives for implementation of educational robotics, among which stand out the experiments at the Municipal School Ascendino de Almeida, the Center for Early Childhood Education, the Program ProDocência, the Company RoboEduc and the Extension Program ProExt.

In all cases were done research with the teachers involved. In some cases, the school teachers do not ministered classes, yet they participated in the whole process, and were included in the survey. The results showed that teachers classify educational robotics as an environment that is beneficial to student learning, benefits such as creativity, aid in decision making, improvement in problem solving and assimilation issues, among others.

Teachers also reported problems that may complicate the insertion of robotics in Brazilian schools, such as the high cost of robotics kits and the need for skilled professionals to teach the classes.

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