Challenges in an Emerging Country: A Digital Divide Case Using Robotics

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***Abstract*— This digital divide case is sponsored by UNESCO and Brazilian Education Ministry as a pilot-project science and technology democratization initiative named RoboEdu. The main role is to allow that high school students can be the first technologies contacts using computers and robotics experiments due them low profile families remuneration. The initiative uses education interactions as main engine to guarantee the math and physics studies understanding and to reach the best cognitives practices approaching to the ideal pedagogic model. The teacher needs technical support also cause the language used must be translate to a simple vocabulary where students achieve the learning goals. The educator essential role starts to be several possibilities of knowledge generation not mattering anymore who knows technologies but through the part of the involved ones into orientation, participation and exchange of experiences. When the teachers and students are engaged on these activities pertaining to school evasion is reduced drastically**

Keywords-component: digital divide; robotics; technologies; educational learning

I. Introduction

This article describes the development of the activities under the RoboEdu project, which allows students from the public network to have their first contact with computers and robots, interacting during classes of Math and Physics, that deal with subjects from the practical experiments, in a more curious and questioning manner formatter will need to create these components, incorporating the applicable criteria that follow.

The use of tools that allow the improvement of the topics addressed by the educators is a key factor on the quality of learning at the schools. Educational, or Pedagogic, Robotics, is a strategy of exposure of the knowledge and takes the practice of the individual, by fixing issues by assembling and adapting equipments and models that shall present moves, such as robots.

This learning environment is characterized by the use of robotic systems, which allow students to build systems composed by a physical part (hardware), that constitutes the robot's structure, and programs (software) that sets the interaction of the knowledge acquired at the classroom and their behavior.

In this context, suggestions of unconventional learning present themselves for students and teachers of the public institutions, from practice to theory and from theory to practice, showing gaps of knowledge not explored until then, and, moreover, it allows these students that, many times, are poor, both socially and economically, the contact with state of the art technology, that ends up allowing curiosity and knowledge to act as stimulants.

II. Justification

In this pilot project, the learning stimulus focus on the involvement of the students in the activities related to studies performed in the classroom, applied through the simulation of throws in a basketball game, using the KickRobot software, and handling and controlling of robots physically composed, before their pairs or classmates, generating, this way, a more effective participation of the involved with a focus on the best work resulting of a team performance.

According to Resnick, when a person is committed into building something that is significant to the person itself, or to the people around, the building of knowledge happens in a more effective way. When the student is involved in building and modeling robots, this student starts to have a greater sense of care in the relation with this object, different than it would be if the student had received the robot already assembled. In this manner, the students are prone to explore and make deep connections with scientific concepts based on the activities performed [1].

Under the scope of digital divide it is necessary, besides making teachers and students familiar with the technologies of robots and computers, give support on the aspects related with the language or way of communicating this topics, the method employed during the demonstration of assembling, modeling and proper use of the different tools (hardware) involved and a proper environment to learning, among other social and cultural aspects, that intertwine the daily life of students with low income.

III. Digital Divide

The exclusion is mainly through the environment in which they socialize. The barriers may be present many difficulties such as access to technology, or a basic premise, the food. If the body is not nourished, strong and tuned barriers become insurmountable. Arises the need to help the company to break the problems encountered and form a virtuous cycle with a focus on social and digital divide.

The inclusion can not simply access to equipment or technology, but support for the formation of citizen and professional opportunities that will climb in the labor market. According to Paulo Freire [2], the inclusion should enable the inclusion of individuals with critical historical process, and create conditions for people to master the subject contents, the educational process must allow people to become aware of their potential, to become autonomous and able to free themselves from oppression in order to decide and choose - education should be a liberating action.

These activities have the potential to become the mind works, that is, showing how a person thinks, performs an activity and includes the realization of that done. Profits are able to go forward, learning and continuous production of new artefatos.A digital inclusion can then be identified when the individual is recognized as someone who will be able, who can believe in yourself, that is, increased self-esteem through the use of information technology and communications.

IV. Educational Robotics

Educational robotics, or pedagogic robotics, is being used as a learning tool that allows the development of activities as stimulation tool to the creativity of students, due to the dynamic, interactive and even playful nature, further on, it serves as a motivator on the concern of students about traditional education.

Robotics have a great deal of potential as an interdisciplinary tool, seeing that the construction of a new mechanism, or the solution of a new problem, frequently exceed the classroom [3]. In the natural attempt of searching for a solution, the student questions the teachers of other disciplines that may help finding the best way for the solution of the problem [4].

Robotics, then, take the role of the bridge that makes possible the restoration or boarders previously established, acting as an element of cohesion within the curriculum. According to Simões, [5] the main pedagogic advantages of robotics are:

- It transforms learning in to something motivating, making principles of Science and Technology accessible to students;
- It allows testing on physical equipments what was learned using model programs that simulate the real world;
- It helps overcoming limits of communication, allowing the student to vocalize the knowledge and experiences, developing the capacity to argue;
- It develops the reasoning and logic in the construction of algorithms and programs to control mechanisms;
- It favors the interdisciplinary interaction, promoting integration of concepts from areas such as: math, physics, electronics, mechanic and architecture.

V. Learning Environment

During the development of this pilot project we tried to insert precepts that are named by UNESCO's Jacques Delors Report, a study recommended by the United Nations, as the four pillars of education. This study gathered the main features of the 21st century worker, with grounds on globalization and technological advances, and, furthermore, it has an observation on the need of development of the values and competencies of the students.

Mainly, in what connects to the pillars, it is applied on the project:

- Learning to learn: where we exploit the awakening of the pleasure of knowing, comprehending, discovering, building and rebuilding knowledge, having curiosity;
- Learning to do: developing competencies and abilities that bring about the application of technology in modern life;
- Learning to be: taking the student to the development of new logics and creativity, whole development of personality through self esteem, self determination, self realization and personal sensibility;
- Learning to live together: aspects that show the comprehension and respect to values and culture, developing the perception of interdependency, capacity of administrating conflicts and appreciation of people.

The proposed environment of learning is based on the application of the knowledge acquired by the students and supported by the teachers of the disciplines of math and physics through the use of educative robotics for practical measurement of the topics developed in class.

The proposed environment is based on the implementation of a competition of pedagogic robots using the software developed and named KickRobot.

VI. KickRobot

The KickRobot application is based on the competition among students that use pedagogic robots on an adapted competition of basketball. This competition focuses on the throw (kick) of balls at a virtual hoop, where the motto is the application of mathematical theorems and physics' formulas to achieve the goal, converting the throws in to points (Figure 1).

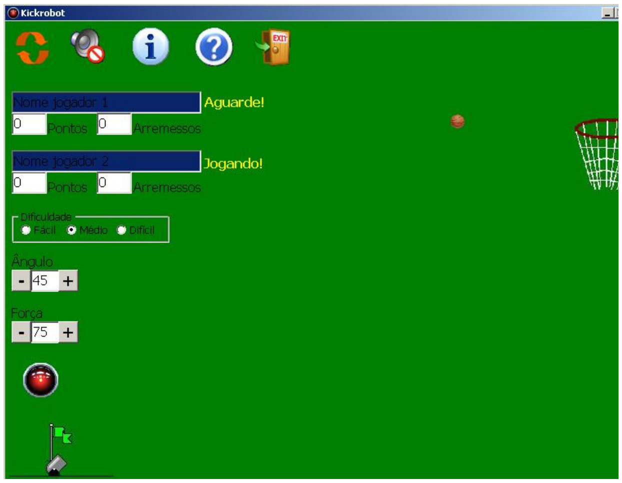

Figure 1. Basketball Court used in the KickRobot application

All the scores from the participants are registered and the five bets scorers will have their names registered at the gallery of players, what will promote the clash among students (Figure 2).

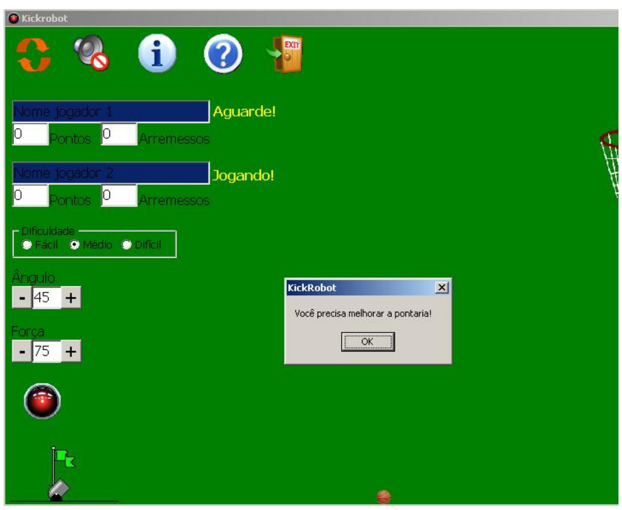

Figure 2. Cannon from the KickRobot application

The throws will be based on studies involving vectors, mechanics and trigonometry, and will be performed by the pedagogic robots in cannon format (Figure 3).

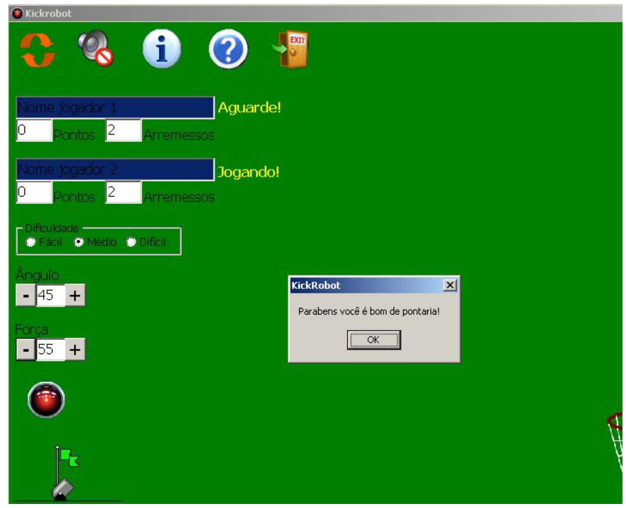

Figure 3. Hit of the "target"

So that it is possible to perform a precise throw, it is necessary to establish values based on the physical and mathematical experiment that used premises that involve concepts of projectile throws, vector analysis of movement, trajectory equations and parabolas (Figure 4 and 5).

Figure 4. Online Help

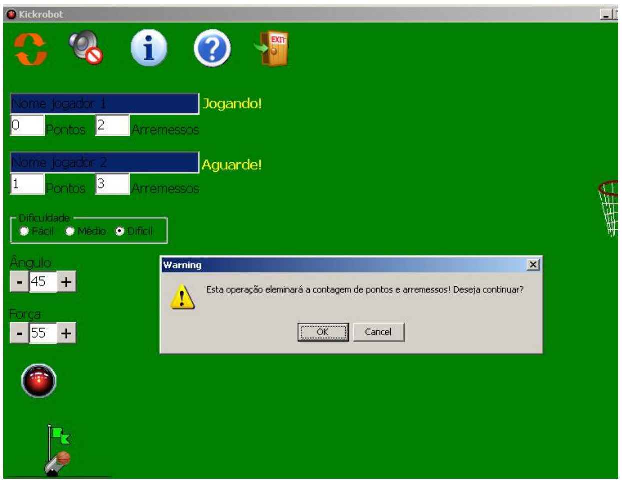

Figure 5. Finalization or Game Restart

VII. Physical-Mathematical Experiment

The principal of the involved study implemented refers to the theory of projectiles. At the implementation formulas applied on shooting allow us to observe the behavior of the projectiles on real experiments.

A projectile is an object that suffers an strength at a determined period of time, that we may call impulse. This impulse causes a variation of the target that we are willing to hit. One of the forces directly involved with the impulse is gravity.

At the experiment we will perform the throw to a target not on the same level; this way, settings will have to be applied. Principles that were developed originally out of Brazil, namely the measuring system that uses feet, instead of meters. Therefore, acceleration in the English system is g=32.2 ft/s², converting to the metric system we have g=9,8 m/s².

The movement performed by the ball is bi-dimensional and can be analyzed separately as two simple movements, one going horizontal (axis X) and other going vertical (axis Y).

From the movements, we have the formulas for the speed (Figure 6):

$$\vec{v} = \vec{v}_0 + \vec{a}t$$

E posição:

$$\vec{r} = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$$

Onde:

$\vec{v} = v_x\hat{i} + v_y\hat{j}$ velocidade;

$\vec{v}_0 = v_{0x}\hat{i} + v_{0y}\hat{j}$ velocidade inicial;

$\vec{r} = x\hat{i} + y\hat{j}$ posição;

$\vec{r}_0 = x_0\hat{i} + y_0\hat{j}$ posição inicial;

$\vec{a} = a_x\hat{i} + a_y\hat{j}$ aceleração.

Figure 6. Formulas used by the KickRobot software

Writing the bi-dimensional movement as two one-dimensional movements will give us, for the horizontal direction (X) and for the vertical direction (Y), the following equations for speed and angular position (Figure 7):

$$x = x_0 + v_{0x}t$$

$$y = y_0 + v_{0y}t - \frac{1}{2}gt^2$$

Figure 7. Formulas used on the axis X and Y by the KickRobot software

This way, the student must notice that there is a direct relation between the initial speed and the maximum distance that the ball can reach according to the amount of speed indicated, as we see in Figure 8.

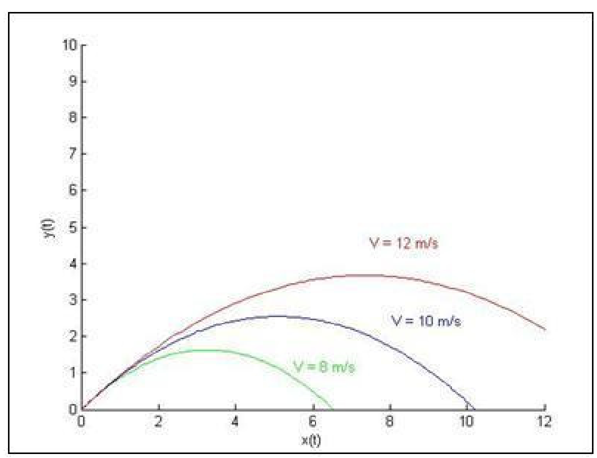

Figure 8. Trajectories with distinct speeds applied on KickRobot

Moreover, the student will notice a straight correspondence between the initial angle and the maximum distance that the ball might reach, related to the value of angle discovered during the experiment, as seen in Figure 9.

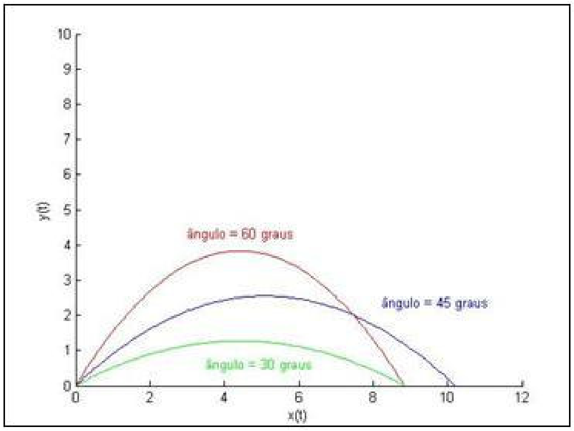

Figure 9. Trajectories with diferent angles applied in KickRobot

VIII. Robot Soccer

The soccer competition among robots uses interconnected devices, working together, allowing the student-players to control their hardware tools. The used devices are: a camera, located on over the field, that captures image and sends it to the computer, where the computer will recognize the ball and all the robots, locating them within the field (Figure 10).

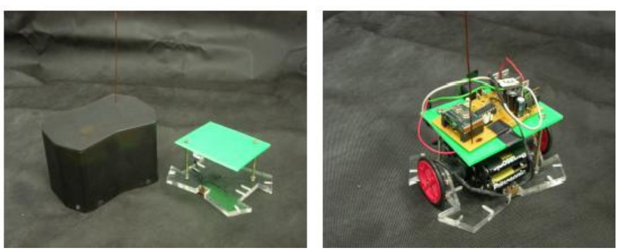

Figure 10. Robots used by the students to play soccer

An artificial inteligence algorithm receives this location and processes the game plan to be employed. After this, the movement coordinates are sent to the robot via radio frequency (RF). Following that, the robots interpret and execute the orders. This way, so that the system is really efficient, advanced techniques on computing, electronics and robotics are used (Figure 11).

Figure 11. Equipments used on the soccer match, with interaction with the students

IX. Conclusion

Through this article, the aim is to present a vision, both, macro and general of the pilot project named RoboEdu and the use of the KickRobot software on the aspects of digital divide and improvement of the knowledge acquired in the classroom. This is one of the first initiatives to spread the technology as a whole throughout the public network, but, mostly, under the scope of computers science on education supported by experiments with robotics.

Two public schools received the initiative, with a total of 50 students selected to take part on the experiments. Initial questionnaires were applied to outline the style of learning of the participants and knowledge about the technologies. The same questionnaires were applied at the end of the project.

After a relative evaluation on the gain of knowledge on technologies by the students, comparing the questionnaires, it's possible to conclude that the objectives were reached, on the aspects of technology, constructivism, and of social and digital inclusion. Around 25% of the students that started this project, identified by the questionnaires as shy students went on to take active part in the group of students that worked effectively and integrated within the teams.

Regarding the teachers involved, they obtained the same stimuli to develop the studies in the classroom, given the tasks defined focusing on the practice overlooking the experiments, that being said, we can say that the initiative contemplated not only students, but also teachers, that, during informal conversations, said that the activities had given them a new found interest for research and compilation of extra-curricular content, that were not a part of the daily activities.

This initiative doesn't end, it's funded continuously, aiming at covering as much students as possible with the experiments in question.

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