Chemistry and Robots

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Abstract. *The last decennium was the decennium of computer science, but now we are approaching a new era of new machines, called robots. We these thoughts in mind we had started, about 3 years ago, a very successful pedagogic experience, based on learning by doing robots, and participating on robotics competition. In this communication we will show that this pedagogic approach allowed for an significant increase of student's self-esteem, an increase for the motivation and the study for other subjects rather than robotics. The national and international competitions established in a increase number of countries, gives to students new challenges and unique opportunities to learn by doing, and co fraternize with other students and teachers. In a world more and more competitive is necessary to have a multidisciplinary knowledge, and in this competitions for doing a competitive robot it's necessary to the student to obtain skills, on electronics, mechanics, physics, maths, chemistry, and lots of more subjects…*

Keywords. Robotics, Science Education, Hands-on experiments, New Pedagogic approaches

1. Introduction

NID (Investigation and Development Department) of the Vocational School Gustave Eiffel was created in the beginning of the year of 2004. One of the objectives of this department is to promote in our school the pedagogic approach of constructivism. In this approach the learning process is centred in the process of building or constructing something [1]. We had chosen the area of robotics as the centre of our projects, by the simples reasons that this area covers a lots of subjects and there are well established events at national and international level. For this kind of pedagogic approach to have success is necessary to exist some strong incentives. One of the incentives was the participation of the project build in robotics competitions, were our teams obtained some significant prizes at national and international level. One of the most important was the a second position on Dance competition in Padua, on Robocup Junior 2003, when we were the first Portuguese team to participate on Robocup. This prize opens the doors for more projects and allowed to create a structure to support a larger number of students to participate. Actually there are more than that 30 students directly involved in the activities of the group, but many more indirectly. In 2004 on Lisbon, we were the schools with more teams present all over the world on Robocup Junior. In this competition we had win the competition of Rescue and another second place on Dance.

However more important than the prizes, was the fact that this results brought a new life and new way of teaching in our school. In 2004, we began to involve in this project some mathematics, physics and chemistry teachers. Why this areas? Because these are subjects were the Portuguese students traditionally have major difficulties. Through the calculation of components and structures for the robots, in the case of the mathematics and physical, of special effects in the case of the chemistry, we get a significant increase of interest from students for these areas. More with the objective to enlarge and to consolidate this project we had established partnerships with English and German schools for 2006, through a Comenius I project for the development of soccer robots. It's our intention to expand this kind of projects in our school and create new partnerships with other European schools in the area of robotics and chemistry. In this communication we intend to demonstrate that it is possible to join these two areas of the knowledge in an easy attractive and easy way for secondary level students. By joining together robotics and chemistry, we can achieve in an innovative way a greater motivation from the students for the study of a group of matters extremely vast, covered by this two areas.

2. Learning with robots

We had organize our electronics course in a way that the students have is first contact with robotics immediately in the first year of their courses. This is done by showing them some movies and put then in contact with older students that already participated on robotics competitions. Some of then start immediately to build some very simple robots using Kits like Mindstorm [2] from Lego or even by doing something in the robots from students from last years. One of the most important things that we obtain with the construction of an robot is that, is obligatory to the students to work in group to achieve the goal of a competitive robot. But there are many more aspects that we had win by promoting this pedagogic experience on our school. Nominally:

- A greater motivation who leads to better school classifications… and not only on the disciplines directly connected with the area of electronics!
- A better and practical understanding of the subjects taught on the electronics courses;
- A great success, in the terms of the appetence by the students to stay in the school and participate on school activities;

But this kind of project has not only advantages from the point of view of the students… Indeed:

- The teachers win immense in his relationship with the students. One of my colleagues after one competition told me: "What you are doing with this kids, is the dream of any teacher!". Sometimes they are more friends than students

- But the school as an identity wins a lot. The very good work that is done many times is not recognized simply because is to known. With the participations and prizes win in robotic competitions, the interest of the social communication has increased and took to a series of interviews and actuations on TC. This publicity, and we don't have to pay!

By this three experience we can conclude that this practical approach with the goal of competition is one of the best way to increase in the students the appetence for learning new matters and to develop their skills in a wide range of subjects, like mathematics, physics, mechanics electronic, actuators , sensors, programming, IA, etc..

2.1 Type of Robotics Competitions

The robotics competitons are organized at a national event, in Portugal the "Festival Nacional de Robótica", and at a international level the Robocup. In the two types of events, the competitions are divided in senior leagues (students with more than 19 years old) and junior leagues. There are basically three types of robotics competitions: Soccer, Rescue and Dance.

In soccer there two robots on field with the dimensions of 122cmby183cm with the floor painted with a greyscale. The ball is a very special kind of ball that emits infrareds for an easy detection by the robots.

Figure 1. Soccer Game, Robocup 2004

In rescue the robot must follow a black line and identify some "victims" with two different colours placed randomly across the line. All of this competition have the intuit to introduce the students to the world of robotics. The same kind of competitions exist in the senior league but with a great level of difficulty.

Figure 2. Rescue competition, Robocup 2004

The dance competition is the one that offers more opportunities to make original robots. In this competition the robots must dance on stage with the dimensions of 10mx5m (6mx4m in 2005, for the robots) synchronised with a music chosen by the team. The students could dance with the robots, but not touch them.

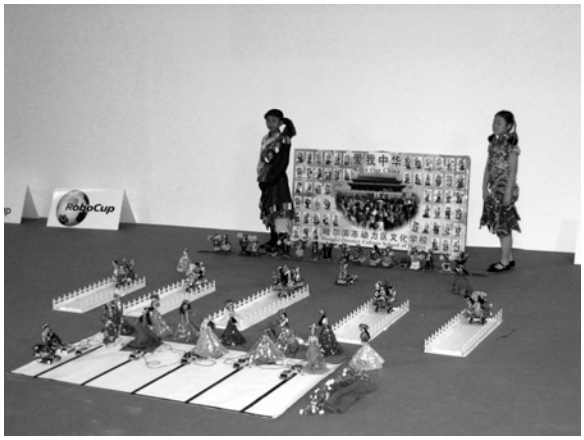

Figure 3. Dance competition, Robocup 2004

3. Robots and Chemistry

The project "Robots and Chemistry" that we will present on 2nd HSCI conference intends to show that it is possible to join these two knowledge areas to motivate the students in their school activities.

This project explores the are of oxidation and reduction reactions to obtain some special effects and apply them to dance robots. This digression on the "chemistry of the fleeting perceptions", begins with the legend of Promised, when he gives the fire to the humans, and the man's fascination for the fire.

Since immemorial times, the man wanted to dominate the fire... But the art of the pyrotechnics, just as we met her today, has born with the discovery of the black gunpowder, in China in the IX century (in spite of some references many years before, to the “Greek” Fire).

Nowadays, the most recent pyrotechnic technology is used to do spectacles full of light and colour, a lot of times happening in simultaneous with music and… with our dance robots.

The amazing of fireworks hides the complexity of the Physical and Chemical reactions that happens on the most simple firework.

The fireworks is basically composed by gunpowder and a salt that it determines the shine and colour of the light produced in the explosion, for instance. By example the use of a strontium salt turns on the emission of red light:

$$2SrCl + O_2 \rightarrow 2\ SrO + Cl_2$$ (it shines red)

However, they can happen undesirable and/or dangerous secondary reactions as, for instance, the hydration of substances hygroscopic or the reaction of the chlorate with the products originated starting from the sulfur:

$$8\ Mg + 16\ H_2O \rightarrow 8Mg(OH)_2 + \boxed{8\ H_2} + \text{Energia}$$

$$8\ H_2 + Ba(NO_3)_2 \rightarrow Ba(OH)_2 + 4\ H_2O + 2\ NH_3$$

$$S + H_2O \rightarrow H_2S_nO_6 \rightarrow H_2SO_4 + SO_2 + (n\text{-}2)\ S \xrightarrow{+\ KClO_3} ClO_2 + \text{Bum}$$

The introduction of polymers in this area, revolutionized the manufacture techniques fireworks, products as the polyvinyl chloride will substitute the traditional and dangerous potassium chlorate. In this project we move many times back to the time of chemist's and metallurgist Alexander Parkes, that is one of the founders of the modern industry of the plastics. One of the substances that we use is cellulose nitrate - substance designated by gunpowder without smoke and used in some special effects in our robots. By recreating this discover and taking advantage of the redox effects of this substance, we can easily motivate our students to more complex experiences.

Figure 3. Some fireworks on public presentation of one of our dance projects “The pyramidal Dragon”

In the same area of oxidation-reduction reactions will be had start last year an cooperation with an company that develops fuel cells. This allows us to show the viability of the hydrogen as a alternative source of energy to the traditional batteries, by using then in our robots.

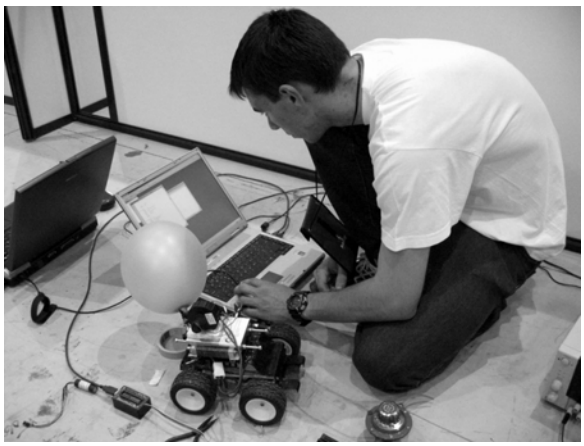

Figure 4. One of our projects powered by hydrogen fuel cells

4. Acknowledges

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5. References

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