

# Let's Learn Robotics and Chemistry Together!

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**Abstract.** *This is a brief outline of the projects developed on our center of development and investigation of our school: Gustave Eiffel located on the city of Amadora, very near Lisbon, the capital of Portugal. We had started, about 3 years ago, a very successful pedagogic experience, based on learning by making robots, and participating on robotics competitions. In this communication we will show that this pedagogic approach allowed for a significant increase of students' self-esteem, an increase for the motivation and the study for other subjects rather than robotics. The national and international competitions established in an increasing number of countries gives new challenges to students and unique opportunities of "learning by doing" and co-fraternize with other students and teachers. In a world more and more competitive it is necessary to have a multidisciplinary knowledge, and in these competitions for doing a competitive robot it is necessary for the student to obtain skills, on electronics, mechanics, physics, maths, chemistry, and a lots 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 simple reasons that this area covers a lot of subjects and there are well established events at

national and international level. For this kind of pedagogic approach to have success it is necessary some strong incentives to exist. One of the motivations 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 the Dance competition in Padua, in Robocup Junior 2003, when we were the first Portuguese team to participate on Robocup. This prize opened 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 30 students directly involved in the activities of the group, but many more indirectly. In 2004 in Lisbon, we were the schools with more teams present all over the world on Robocup Junior. In this competition we had won the competition of Rescue and another second place on Dance.

However, more important than the prizes, was the fact that these 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 these areas? Because these are subjects were the Portuguese students have traditionally major difficulties. Through the calculation of components and structures for the robots, in the case of the mathematics and physics, 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 knowledge in an 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 these two areas.

## 2. Learning with robots

We have organized 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 had already participated in robotics competitions. Some of them 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 a robot is that, it is compulsory to the students to work in a group to achieve the goal of a competitive robot. But, there are many more aspects that we have gained by promoting this pedagogic experience in our school. Nominally:

- A greater motivation which 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 appetite 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 gain immensely 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 it is known. With the participations and prizes won in robotic competitions, the interest of the social communication has increased and took to a series of interviews and actuations on TC. This is publicity, and we don't have to pay!

By these three experiences we can conclude that this practical approach with the goal of competition is one of the best way to increase the

students' the appetite 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 competitions 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 who are 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 a field with the dimensions of 122cm by 183cm 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 these competitions have the intention to introduce students to the world of robotics. The same kind of competitions exists in the senior league, but with a greater level of difficulty. The Rescue competition tries to recreate some conditions that could happen on a disaster scenario, were it will be very dangerous or even impossible to the humans to be present.

It's our intention to present one of our rescue robots and show on the science fair how this competition works at the secondary teaching level.



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 10m x 5m (6m x 4m in 2005, for the robots) synchronised with a music chosen by the team. The students could dance with the robots, but not touch them.

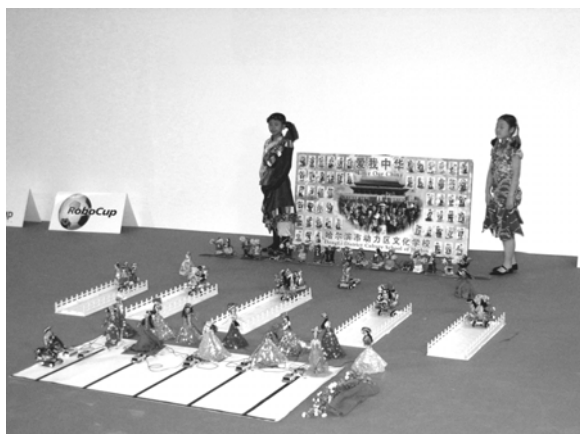


Figure 3. Dance competition, Robocup 2004

### 3. Robots and Chemistry

The project "Robots and Chemistry" that we will present on 2<sup>nd</sup> 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 area 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 Prometheus, when he gave the fire to the humans, and the peoples' fascination for the fire.

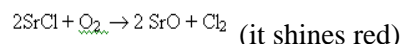
Since immemorial times, the man wanted to dominate the fire... But, the art of the pyrotechnics, just as we meet it today, was born with the discovery of the black gunpowder, in

China in the IX century (in spite of some references many years before, to the "Greek" Fire).

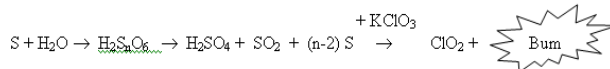
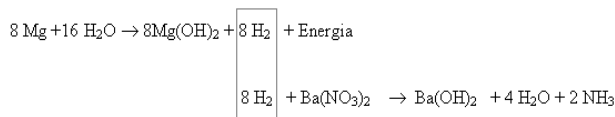
Nowadays, the most recent pyrotechnic technology is used to do spectacles full of light and colour, a lot of times happening in simultaneous with music and... with our dance robots.

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

The fireworks are 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:



However, there 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 sulphur:



The introduction of polymers in this area, revolutionized the manufacture techniques of 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 the chemist and metallurgist Alexander Parkes, who 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”**

We will try to show one of our projects “The Pyramidal Dragon” in the science fair of the 2<sup>nd</sup> HSci Conference in Crete. It is our intention to show some special effects that we use on this project.

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



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

#### **4. Acknowledgments**

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#### **5. References**

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- [3] [www.robocup.org](http://www.robocup.org)