A Robotic Irrigation System: motivating basic school students to science

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Abstract. *The active involvement of our students, from early ages, in the study of science requires a constant motivational effort. Robotics is an actual subject rather appealing to our youngsters. On the other hand interdisciplinary approaches are possible in different science subjects using robots or robotics systems or concepts. In the frames of the 2nd Portuguese "Hands-on Science" science fair a group of basic school students was suggested to develop a science fair project using a robotic kit. In this communication we will present our approach and how the students developed their activities and the results achieved. The student's motivation to work by themselves on their spare time, their enthusiasm, commitment, success and also the difficulties faced are analyzed. We will show that projects such as this one allow the positive involvement and interaction of students with science. Even heterogeneous groups can work successfully with this kind science fair projects.*

Keywords. Hands-on, robotics, science fair.

1. Introduction:

The active involvement of students in the learning process trough hands-on activities is one of the most effective methods to motivate and engage students on science learning [1]. On present days it is already recognized that even in informal environments students can developed skills that allow them to establish a relationship between cognitive, affective and social knowledge [2].

One way to involve students into science and to teach them problem solving skills is by developing Science Fair' projects. This kind of activities involve actively the students on their learning process resulting in scientific relevant results that furthermore can be shared with other students that will learn with it [3]. A good involvement of the student in this kind of activities may lead to a sound career choice on a science field [4] but only if the project is of students interest [5].

In the same lines learning through robotics projects also reveals students potential at a large range of ages [6]. It can be used to stimulate and engage students to school, but it can also be used to teach concepts [7] and develop different kind of skills that can be useful to students development [6,7].

2. 2nd Science Fair Hands-on Science

At the beginning of the school year of 2011-2012, the students of Colégio do Minho were invited to participate at the 2nd Hands-on Science Science Fair. Students had to develop a project in an investigative perspective on a field of their choice. The project was to be developed by students on their spare time.

In this communication we will describe the process that a heterogeneous group of students from 8th grade (ages between 13 – 14 years old) followed to develop an interdisciplinary project involving robotics physics and biology. The project was developed autonomously on student's spare time with only minor guidance.

3. The project description:

When the idea to participate on the science fair was presented the student's enthusiasm was immediate. However some vivid discussion arose on the project subject to be chosen.

The group of students whose work is reported here started with the idea of building a car moved by solar energy. However only one of the members was excited with the idea and after two weeks they started given up on their project. They were then advised to perform more research and to find a common field of interest. A common area of interest merged almost immediately for the four students: robotics.

This specific group was constituted of four boys with ages between 13 and 14 years old. But the most interesting was the fact that these four boys despite belonging to the same class they usually have different interest, different postures in classes and very different learning rhythms. One of the students of the group was one of the best student's of the class and the other two were students with major learning difficulties. Interestingly the student that immediately revealed himself as the leader was one of the less motivated in classes (including at science classes). The most important common characteristics was the fact that they all wanted to develop a project based on robotics despite none of them had any previous experience on the field.

They started to work during weekends and during their lunch time at school, all by themselves. The only help they had was by providing them the material and a space at school where they could work by themselves.

They started to build the robots trying to construct different structures to understand more about the Lego Mindstorm robotic system they employed. They also learned robot programming by themselves.

After three months, the students already had made some progress. However something was missing: a real objective for their science fair project - challenge of finding an application of their robots.

After a few ideas they establish as their primordial goal to build a robotic irrigation system (as can be seen on Figure 1).

Figure 1 - Students preparing their project

The soil to be irrigated was placed on wooden base made of 3 corridors. The robot moved forwards and backwards on the central corridor and, on the back of the robot, they built the irrigation system. For that, they put two bottles of water linked by straws and fixed two larger straws to the bottles, one for each corridor. One of the straws had larger holes to allow the irrigation of some vegetables that needed a larger quantity of water. The holes on the other straw were smaller hey planted flowers that needed less water.

The irrigation system only worked if they remove the cork of the bottle. However, they quickly understand that they needed a larger water deposit, and also to increase the pressure at the straws. They try to use a larger bottle but the stability of the robot was compromised. Therefore a second bottle was connected to the first. This bottle was used as a reserve and was only used when the first bottle was low on water (Figure 2).

Figure 2 - The irrigation system.

The students revealed a large enthusiasm on construction of the robot and the irrigation system. However at first they didn't showed interest on understanding the physics principles that explain the operation of their irrigation system neither the specific knowledge associated to the plants/legumes they were to water and that select for their garden. Some time was need for them to realize that they have to perform more research in order to improve their project… They were encouraged to speak with science teachers and understand little more about the different kind of plants and flowers and the necessities of each one.

After the project finished the students were encouraged to present their project to their colleagues also ear possible questions and doubts and to practice their presentation at the fair.

At the science fair their work was very successfully presented. Visitors revealed interest on seeing and learn about their project. They were even interviewed by a national TV news station, which made them very proud. Despite all the success from the feedback of colleague's and visitors they end up realizing that they could have explored more the physics and the biology aspects related to their project improving it.

4. The impact on students:

The involvement of this group of students in their project brought several advantages. One of the most important was the fact that spite being such a heterogeneous group they were able to resolve all their conflicts and work together. It was extremely interesting to see this group of students change their lunch time habits, which they usually used to play with their friends, and started to work on their project on a closed room in a much focused way. They also worked on weekend and holydays at home with the help of their parents.

It was important to notice that these students were able to learn new science concepts related to their projects. However, in this case, the most important was the enthusiasm they showed during physics classes, specially, the "leader" that until then never before participated voluntarily in the classes and was constantly distracted.

The motivation was so large that the students already asked to participate on next year' science fair edition and wanted to begin setting up a robotics club at their school.

5. Conclusions

The involvement of students with hands-on activities such as robotics on the development of projects to participate at science fairs allows them to gain important competencies and positively change their attitude towards science and the school. They acquire skills on material handling and other techniques very useful for their day life and to science classes. They gain the ability to do presentations to the general public and to discuss science. They learn how to work and handle group conflicts.

The simple visit to a science fair can engage students on concept learning as they see projects developed by their pears. This further which motivates them to a more active involvement in their learning process.

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7. References

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