First National Robotics Competition in Public High Schools to Promote Innovation and Technological Education

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Abstract: The technological competitions trigger special interest in students who study diverse scientific disciplines .The reached goals by those who participate in individual system or in groups represent significant learning process and the improvement of cognitive skills particularly in problem solving approach. Moreover, the learned lessons of dealing with a national robotics competition are published to warranty success on technologic educative experience. As a matter of fact , this innovating educative experience marks the students' life understanding that if they believe in what they are doing, they can overcome any obstacle.

Keywords: Education, technological competition, robotics

1 Introduction

In the last years, technological competitions have been positioned as an attractive educative alternative for those who study robotics and other scientific disciplines. It is through these types of experiences that we hope to stimulate and build up new initiatives that influence education in an effort to improve its quality.

The Omar Dengo Foundation (ODF) of Costa Rica, in conjunction with the Ministry of Public Education, has been implementing the National Program for Educational Informatics MEP-FOD (PRONIE) for the past 25 years, serving as pioneers in Latin America and the Caribbean in the area of educational programs supported by the use of digital technologies. As a result, we understand the importance of offering these types of experiences to students from less favored social sectors, in order to offer alternatives that strengthen new learning processes.

Thanks to ODF´s acquired experience in the accomplishment of this type of proposals in education and technology, the Ministry of Public Education financed the acquisition of robotics equipment to develop a national robotics competition in public high schools that implemented robotics programs and have been working on them for at least two years.

The main objective of this project was to enhance educative robotics with a challenging and creative approach that allows the students to acquire new knowledge and evaluate their abilities according to the improvement of technological skills and problem-solving. This initiative was significant for those who participated due to the challenges associated with preparing and participating in their first technological competition with other educational institutions from different geographic locations.

The accomplishments achieved during this contest left us remarkable lessons, which we have shared within this document in the hopes that it will be helpful to those who wish to design or to implement initiatives that enhance innovative and technology-based education.

2 The importance of robotics competitions

Technological competitions allow students to [1,2]:

- To analyze by means of research the best solutions to their challenges.
- To develop effective robot designs to solve the problems.
- To promote more abilities in areas like engineering, programming, mechanics, electronics, algorithms and design.
- To enhance tolerance to learning by error.
- To create a healthy collaborative environment between team members.
- To work hard as scientists in subjects related to robotics.

After considering these advantages and the positive impact they could have on the students' lives, it was easy to make the decision to participate.

3 Development of a competition model

Before settling on a competition model that could be effectively developed in any educative center in the country, the ODF studied competitions of greater world-wide recognition in the junior category. In fact, we cautiously analyzed the regulations around each of the following aspects: the robotic equipment, professional training teacher profiles, geographic locations, national curriculum schedule and marketing.

Considering this previous study, it was decided that the First Lego League (FLL) fulfilled the conditions that were necessary for the model which we wished to develop in our country. Nevertheless, it was necessary to make some adjustments and adaptations in order to typify as significant approach into the Costa Rican educational context, with reliable problems for the students who would participate.

The fact that Costa Rica is well-known for its interest in preserving natural resources led us to the idea of linking technological competitions to challenges to protect our nature. This project, called *Green Game* [3], had an ecological theme. Contenders had to design and program autonomous robots to solve environmental missions: (Fig. 1)

1. To protect nature.
2. To collect solid waste
3. To plant and water trees.
4. To transport and deposit toxic waste.
5. To use clean energies.
6. To fix solar panels.

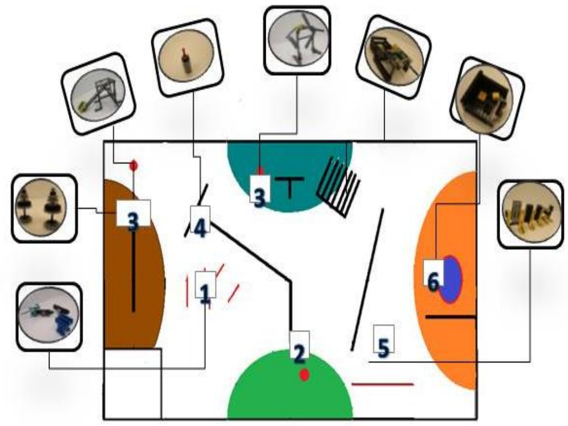

Fig. 1 First National robotics competition
"Green Game" Missions Diagram
(Source: ODF 2010)

4 Organization of the competition

Each participating institution was offered a professional training process in which they were skilled to handle the robotic equipment destined to perform the competition. In this case, they learned to construct and program autonomous robots using NXT LEGO Mindstorms sets. Moreover, the competition regulations were explained to them in order to be aware of them during their students' practices for the competition. In fact, during their practices they had to: respect rules, learn permissible strategies in order to solve the missions, identify behaviors to win or to lose points, be familiar with the robot's characteristics such as weight and robots dimension, represent the working roles of each member of the team (Captain 1 and Captain 2), and finally evaluate the awarding contest methodology.

Each Institution received six complete NXT sets (LEGO Mindstorms 9797, 9695, 9794), one contest field where they had to practice (Game field based on FLL area 2010). Furthermore, each institution was responsible for working on a strategy that better accomplished the missions. Some students preferred to solve each mission separately; others grouped two or three missions together so that robots accomplished them through a single execution.

A group of four high schools made it to the final, where there were a total of 48 students. Two high schools came from to the southern region of the country and the other two belonged to the central region. Each high school could decide if they registered their teams as a single team (twelve participants) or as three separate teams (four students each).

As part of the methodological support that ODF gave to these participating high schools, there were pedagogical visits to evaluate the level of mission progress that they had obtained. In addition, the use of blogs, email, videoconferencing and calls were offered as a way to respond to students' doubts and inquiries.

We found important circumstances related to the team members' attitude that made this experience more successful than other ones. For example, some teams received more support from the mentor because of their high level of commitment throughout the project. This meant access to extra robotics lessons, more study time in order to achieve better solutions with robots, repeating the design in order to improve the competition missions, studying the sections of the programs to debug them, as well as other actions that required much effort, interest and perseverance.

Finally, the essential strategy for all teams was focused on constructing the most efficient autonomous robot, able to solve the missions in less than in five minutes. This assignment became the main focus of the work done by the competition teams.

5 Development of the competition

The competition was defined in two rounds: one would take place in the morning and the other one in the afternoon. Each team would have five minutes to solve the missions, and they had two extra minutes that could be used if needed. After the team´s registration and lodging were complete, there was a conference between the captains of each team, in order to reach agreements and to clarify doubts. This reunion offered a space to relax and share doubts between themselves. It was the moment in which they began to cross over into the competition experience. At that time, a public lottery was prepared to determine the order of the competition, in which each captain would take a number to know the position. Once it was established, teams were given time to organize themselves before initiating the competition´s rounds. After that, teams could no longer modify the robots or programs, which would guarantee a fair participation for all.
In the first round, teams were nervous about facing an audience in a contest field. Their inability to manage their feelings and focus solely on solving missions was unfortunate and resulted in the teams' failure to solve more than three missions. Nevertheless, for afternoon rounds the teams´ performance increased positively and many teams succeed in completing more than six missions. Finally, the winning team was associated to the one that planned the best strategy in saving time and collecting easy points, during the two previous rounds.

6 Findings

6.1 Pedagogical

A strong preference for design and construction over programming is evident, since the latter requires more patience and sometimes they miss details and lack concentration. In contrast, students interviewed agreed that they prefer to construct because it requires less attention and more creativity.

A majority of students agreed that their participation performance improved once they could organize to work as one team, although at the beginning there was difficulty establishing a team identity and they had difficulties accepting productive suggestions or observations, but as they got used to each other they began to share experiences and create true friendships. In a few cases, the mentors had to reassign groups because of students' incompatibility.

The fact that they had to get ready for a competition encouraged them to face their own limits and help them realize that they were able to reach enormous goals. The anxiety caused to them to make mistakes on many occasions, forgetting where to place the robot in the appropriate position or how to run the right program for the corresponding mission. The most significant sensor for this contest was the one involving rotation, used to guarantee the precise distances and turns in each mission. The effort of using a diversity of sensors was demonstrated; however, they did not work successfully. The students explained that their feelings had a definite influence on their performance. As they stood in front of the audience, they became increasingly aware of external factors such as the audience´s noise, supporting mentors, and other the robots' design, increasing their level of pressure. But the most stressful moment came when their strategy began to work against them with regards to time.

During the competition, two strategies were observed: robots that solved individual missions in which students reinitiated the interface in order to find the program for each mission, and robots that used just a single program to accomplish several missions simultaneously. The second strategy was more successful; nevertheless, this strategy requires more programming time and precision conducts.

Students who encountered major problems to get through specific missions explained several factors that did not allow them to obtain better results. In the particular case of the team that placed last, students claimed that that they could not stick to the time frame established for the year due to a number of factors, such as the teachers' lack of time, extracurricular activities and the lack of authorization from the principal to work extra days.

Another team affirmed that they did not save the last version of the programs developed to solve the missions. They claimed that they did not assign someone in specific to create backups of the programming challenges. They explained that at the beginning it was hard to work all together as a team, because most of the time they preferred doing things independently, but at the end they understood that teamwork might be better than working alone and without help.

One of the main lessons learned by the participants in this contest was the need for teamwork. For future competitions, we hope to look for technological contests with unexpected missions that encourage them to shine in their performance, strengthen their collaborative skills, and develop better programming and design skills in a mission that has not been solved before.

6.2 Mentoring and Support

One of the factors that contributed to good coordination between all the supporting mentors and coordinators that participated in the logistic development of the championship was the simulation of the functions they would be performing, especially from those in charge of judging and deciding the winning team.

The logistic coordinators anticipated the need to have a communication channel easily that was easily accessible. The blog and videoconferencing were valuable resources for the professors. Nevertheless, for those who were not "digital natives", there was the opportunity to communicate via text messages via their personal phone.

The constant communication between parents and mentors about the contest´s progress allowed the community to follow the students' performance during the entire competition.

7 Conclusions

The successful participation in a technological competition is no simple task. The investment of both funds and human resources is considerable. Nevertheless, it marks the difference between an innovative educational initiative and that of a traditional conformist educational method.

We were glad to lead the way through this experience in our search to pioneer high-quality education supported by the use of digital technologies. This experience allowed students to test their abilities at the ultimate level and gave participants the skills to better deal with the problems they may face both personally and academically in the future.

Among the lessons learned were: learning to handle pressure, teamwork, mutual respect, leadership abilities, defining a strategy or action plan, and most importantly that there are no limits to what we can if we are persistent, methodical and patient.

8 Bibliography

1. A. Acuña. (2006). Robotics: Creative spaces for developing design skills in children and adolescents in Latin America. Taken from: http://www.fod.ac.cr/robotica/descargas/roboteca/articulos/2007/frida_robotica_desarrollo_corto.pdf el 24-05-2012

2. Bräunl Thomas. (1999). Research Relevance of Mobile Robot Competitions. IEEE Robotics and Automation Magazine, vol. 6, no. 4. pp. 32–37 (6). Taken from: http://robotics.ee.uwa.edu.au/papers/1999-Robot-Competitions.PDF el 20-05-2012

3. Lopez J. Matarrita D. (2010). The Omar Dengo Foundation's Participation in the Latin America Robotics Competition. Available online: http://robosportscostarica.blogspot.com/. May, 2012.