Chapter 13
Educational Robotic Competitions: Methodology, Practical Appliance, and Experience

Diego E. Galvez-Aranda
Texas A&M University, USA

Mauricio P. Galvez-Legua
https://orcid.org/0000-0002-4845-4218
Universidad Nacional de Ingeniería, Peru

ABSTRACT

In this chapter, the authors present a methodology for the formation and preparation of teams in order to participate in educational robotics competitions composed of five stages: recruitment, training, team conformation and preparation, prototyping, and competition day. The chapter begins with an introduction to educational robotics applied in schools and its use to implement design-based learning, followed by a description of the characteristics of the educational robotics kits and a brief description of the 5PER methodology used in the fourth stage, prototyping, with a description of the main robotics competencies worldwide. The five stages methodology is presented in detailed so it can be replicated by other educators around the world. The exposed methodology is based on the experience of the authors in the preparation of equipment to participate in various robotics competitions at the Faculty of Electrical and Electronic Engineering of the Universidad Nacional de Ingenieria Lima, Peru.

INTRODUCTION

Research is one of the great challenges faced by today's students in order to grow in their field of action. Research gives us freedom of knowledge, the power to develop our own industry. Technological independence is possible if each professional develops research processes in their own areas. Two key aspects

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in research are the access of the information and the equipment. Nowadays any student independently of university or school, can access information, which is currently available in great volume thanks to internet. Regarding equipment, several schools are implementing laboratories where the student can experiment and test their ideas.

In this scenario, Educational Robotics (ER) have been growing in the last years until becoming one of the most popular activities in schools from K-12 to graduate level.(Arís & Orcos, 2019; Eguchi, 2010) The development of the ER have been influenced by several authors and theories, starting from the **constructivism** theory of Jean Piaget in the 1960s,(Wadsworth, 1996) passing through the **constructionism** of Seymour Pappert in the 1990s,(Harel & Papert, 1991) reaching the **connectivism** of George Siemens in 2004, which is a pedagogical perspective that explains the effect that technology has had on the way we currently live, communicate and learn.

In this chapter, the authors are not going to explain in detail the development of ER because it is not the goal of the chapter. However, the definition of ER must be clear. Different definitions can be found in the literature;(Angel-Fernandez & Vincze, 2018; Eguchi, 2014; Mikropoulos & Bellou, 2013) and the authors have synthesized them as: ER is a learning environment that allows the understanding of abstract concepts (mathematics, geometry, programming, etc.), as well as physical concepts of our environment (structures, forces, speed, center of gravity, etc.) through the construction of prototypes. ER stimulates imagination, creativity, motivation, concentration, and manual skills in students when solving challenges. ER has the main virtue of serving as an interface between the logical world and the physical world and it does so in a playful way. The main goal of ER is not to make the students learn about robotics, that is one only of the benefits. The ER must be understood as a learning environment. (Alimisis, 2013) Nowadays most of school programs includes ER lessons indicating the growth of this field.(Eguchi, 2007)

ER kits are currently a powerful piece of equipment that allows students to design and implement robotic models that behave in a predefined way. ER allows students to "build their ideas." In the words of Mitchel Resnick, the goal of an ER kit is to design things that will allow kids to design things. (Resnick & Silverman, 2005) An ER kit carry out programming that interacts with the physical world, so that the programs "move things" and do not remain only in the sphere of the abstract or virtual environment. This interaction with the real world allows the student to approach research and take an interest in the career courses. The control system based on a microcontroller is a key element in an ER kit, thanks to it, students can build prototypes that go from static structures to dynamic machines, exhibiting a certain behavior and interacting with the real world. The control system is a programmable device, that allows to "embed" formulas and algorithms that "define" the prototype behavior. In general, an ER kit, is a tool that encouraged innovation, creativity, and imagination.

Besides the application of ER in formal learning environments, classroom, another great application of ER that are being widely used are the robotic competitions. Thanks to the increasing influence of ER in school around the world, robotics competitions and events have also increased locally as well as internationally. Different kind of competitions are hosted all around the world, where students develop different kind of robots to solve a series of challenges.

In this chapter the authors present a methodology for the selection, training, and preparation of teams with a view on participation in robotics championships through the use of educational robotics kits. The methodology could help teachers from different school and universities around the world to elaborate a good program in the preparation of student teams for a robotic competition. The practical application of this methodology occurred for 3 years, from 2012 to 2014, with students from the electrical engineer-