

Teaching Robotics through the Inquiry Based Science Education approach

Elisa Buselli¹, Francesca Cecchi¹, Paolo Dario¹, Luca Sebastiani²

¹ The BioRobotics Institute, Scuola Superiore Sant'Anna, Italy

² Institute of Life Sciences, Scuola Superiore Sant'Anna, Italy

Abstract. This work presents a new approach for teaching robotics with the aim of feeding curiosity in the students and of encouraging autonomous exploration. The activity is based on the IBSE method, a constructionist approach focused on the observation of phenomena and on practical experiments rather than on theoretical lessons. Secondary and high school students are involved in didactic activities based on this method, in which they can use robotic kits to learn about the principles behind these technologies.

Keywords: Educational Robotics, Inquiry Based Science Education, 5E Model.

1 Introduction

In the last decade robotic education has gained a lot of attention, a great number of initiatives had been developed and several types of robotic kits are now available; i.e. Lego Mindstorms, developed as an expression of the “constructionist learning” ideas of Papert [1]. Despite this wide interest, only few schools have included robotics in their standard *curricula*. There is still an open debate on what is the best method to teach robotics, how to introduce this subject in school *curricula* and how to feed curiosity in youngster for technology.

2 The IBSE Approach in Educational Robotics

The aim of the present work is to introduce a new approach in the robotics education in order to feed students' curiosity. The proposed activity is based on the IBSE method (Inquiry Based Science Education), encouraged by the European Commission [2]. It is based on the constructionist approach and it is focused on observations of phenomena and practical experiments rather than on theoretical lessons; it is a way to encourage youngsters to be protagonist in problem solving and scientific method rather than passive learners. Robots represent technological artifacts and let the students produce facts, collect data and derive concepts [3]. A pilot study is currently running in four classes of secondary/high school (11-19 years old) in Tuscany. A total of 98 students are involved in didactic activity, in which they use robotic kits and learn about the principles behind these technologies. The work includes lessons for the students taken by the researchers, training meetings for the school teachers and psychological questionnaires aimed at evaluating the outcomes. Our approach is

based on the 5E model [4], which includes five phases through which the students can approach a scientific problem: Engage, Explore, Explain, Elaborate and Evaluate. This approach well fits with technological education and more specifically with robotics. The Engage makes connections between past and present learning experiences and feed curiosity. Students are faced with the question: “What is a robot?”, a brainstorming is conducted thinking at movies and books, but also introducing real world examples. During the Explore learners actively carry on experiments: they are involved in physically assembling and programming a robot (RoboDesigner and Lego Mindstorm) and using the on-board sensors. The Explain helps students explicate the concepts they have been exploring and lets teachers introduce definitions: students focus their attention on the main components of robots and on the functional principles of sensors and actuators. In the Elaborate, learners develop deeper understanding of concepts applying the knowledge to new experiences in daily life. Finally, in the Evaluate learners are encouraged to assess their abilities and lets teachers evaluate students’ skill development: the final robots are evaluated, focusing on both the results and the abilities acquired. The same method was used for teaching other school subjects. For example, the equation of motion and the relationship between space, velocity and time was derived by carrying on classroom experiences with robots moving at different velocity. Another example is the study of the optics laws by using a light/color sensor. The students show a strong enthusiasm in using robotic tools, thus it could be an effective means to transmit scientific contents. A possible critical point is the need of training programs for teachers, who are often not confident with robotics, in order to reinforce their educational competences with specific technological skills.

3 Conclusions

A method is presented to improve the teaching of robotics. Classes of robotics are carried on in four schools following the 5E Model of the IBSE method. This approach gives emphasis to engaging students to concept, feeding their curiosity, encouraging autonomous exploration and experimental activities to discover concept and theory.

Acknowledgments. This work was realized in the framework of the ACARISS project, funded by the Regione Toscana - PAR FAS 2007-2013, azione 1.1.a.3, Fondo per le Aree Sottoutilizzate, Delibera CIPE 166/2007.

References

1. Papert, S., Harel, I.: Constructionism. Ablex Publishing Corporation (1991)
2. Rocard, M., Csermely, P., Jorde, D., Lenzen, D., Walberg-Henriksson, H., Hemmo, V.: A Renewed Pedagogy for the Future of Europe – ISBN 978-92-79-05659-8 (2007)
3. Demo B., Moro M., Pina A., Arlegui J.: Discussing about IBSE, Constructivism and Robotics in (and out of the) Schools, Proc. of Cosntructionism Int. Conference, Paris (2010)
4. Bybee, R.W.: Achieving scientific literacy: From purposes to practices. Heinemann, Portsmouth, UK (1997)