3 years of joint work in educational robotics: the TERECoP project

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Abstract

Over the last decade, at an international level, quite a few efforts have been made to integrate robotics in school education, mainly in science and technology subjects (Alimisis et al. 2005, Dias et al. 2005, Karatrantou et al. 2005, Johnson 2003, Portsmore et al. 2004, Bers and Urrea 2000, Erwin et al. 2000). The introduction of robotics in education is aimed at configuring a learning environment that, enabling learners to control the behavior of a tangible model by means of a virtual environment, will actively involve them in the solution of authentic problems, will enhance learners' research attitudes, will allow learners to make assumptions, carry out experiments and develop their abstracting skills (Resnick et al 1996). However, even though the teacher's role in an effective and productive incorporation of that kind of technology in the educational process is of particular importance, very few teacher further education attempts have been recorded (Bers et al. 2002, Portsmore et al. 2003, Knight and Cyr 2004).

Focused on that direction is the European project 'Teacher Education on Robotics-Enhanced Constructivist Pedagogical Methods" (TERECoP, www.terecop.eu) involving 8 educational institutions from 6 European countries coordinated by ASPETE. The aspiration behind the TERECoP Project was to develop, implement and evaluate a learning methodology inspired from the theory of constructionism (Papert 1980) for introducing robotics in school education. In the framework of the TERECoP project a constructivist methodology for enabling teachers to introduce robotics in their classrooms as learning tool in a constructivist context was designed, implemented and evaluated in pilot training courses held in each of the 6 participating European countries (Alimisis et al, 2007; Alimisis, 2008; Papanikolaou et al, 2008; Arlegui et al, 2008b; Fava et al 2009).

Robotic technologies in a constructionist view are not seen as mere tools, but rather as potential vehicles of new ways of thinking about teaching and learning. Learners in a robotics-enhanced constructionist learning environment build something on their own, preferably a tangible object that they can both touch and find meaningful. Learners are invited to work on experiments or problem-solving with selective use of available resources, according to their own interests, search and learning strategies. They seek solutions to real world problems, based on a technological framework used to engage students' curiosity and initiate motivation (Papert 1992). In addition, learners are expected to acquire skills that they can use well beyond the robotics project, such as problem-solving and teamwork skills, independence, imagination and creativity.

In the TERECoP project we distinguish robotics projects and activities in two separate categories according to the role that robotics play in the learning process:

- Robotics as *learning object*: where robotics is being studied as a subject on its own.

- Robotics as *learning tool*: robotics is proposed as a tool for teaching and learning other school subjects at different school levels. Robotics as learning tool is usually seen as an interdisciplinary, project-based learning activity drawing mostly on Science, Maths, Informatics and Technology and offering major new benefits to education in general at all levels.

Believing in the educator's axiom *"teachers teach as they are taught, not as they are told to teach"*, we designed a training methodology for future and in-service teachers aimed to engage them in robotic activities that they could implement in a creative way with their own students. Keeping line with the proposed use of robotics as a tool for constructivist learning, our course curriculum is meant to train teachers in the very way in which they are expected to educate their school students.

In the frame of the TERECoP project 6 teacher training courses were implemented and evaluated by the TERECoP partnership during October 2007 – June 2008 in Greece, Spain, Czech Republic, Italy, France and Romania by the respective partners with prospective and in-service teachers as trainees. The LEGO Mindstorms NXT system (http://www.legomindstorms.com) was selected among others as an appropriate technological environment that attempts to partner technology with the ideas of constructionism. It offers building materials, sensors connecting a robot with the external environment and programming software with a simple graphical interface intended for the creation of robot behaviours.

The pilot course curriculum (Alimisis et al. 2007) included briefly the following sections (30 hours):

- "breaking the ice" introductory activities and agreement on a "didactic contract"
- robotics as learning object
- Costructivism, Constructionism and project-based learning principles
- robotics as a learning tool

The idea of "learning by design" is central in our pedagogy supported by a project-based learning approach. The learning tasks of the course are organized as small or large scale robotics projects encouraging trainees to design and develop their own products. As Rusk et al (2008) point out, the way robotics is currently introduced in educational settings is unnecessarily narrow and they suggest that designing activities focused on *themes* and not just on *challenges* helps to engage wide and diverse audiences in robotics. In accordance with this idea, the projects proposed in our methodology focus on themes broad enough to give everyone freedom to work on a project according to their interests and are developed around open-ended problems engaging participants not only in "problem solving" but also in "problem finding" (Rusk et al, 2008).

The course evaluation (Papanikolaou et al. 2007) was based on tools, such as:

- Semi-structured interviews, diaries, trainees' group projects and questionnaires

From the evaluation of the 6 courses it appears that the training methodology of the course ensured trainees' active participation, although some of them requested even more activities and fewer presentations. The difficulties mentioned by them are focused on robot programming elements (switches, variables). They stated that the training ma-

terials as well as the training methodology are worth applying either in their school classes with their pupils or in training fellow teachers. The quantitative evaluations for the course ranged between "very good" to "excellent" regarding all the aspects of the course that were evaluated. For the course improvement they propose even more emphasis to the construction work, additional and more complex examples of robotics activities, greater activation of the groups, increased sharing of ideas and projects between trainees via the internet and expansion of that communication to other European teachers.

The knowledge and the experiences gained, and the lessons learnt as well, during the joint action of the TERECoP partnership lasted for three years (2006-2009) will be presented in a book that will appear soon..

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