Robotics as an innovative method for education

2 EK Peiraia

In collaboration with: Gottfried Wilhelm Leibniz Universität Hannover (Germany), Emphasys Centre, Cyprus Computer Society (Cyprus), Civic (UK), CDIMM (Romania), WIDE (Luxembourg) and IES Maria Moliner (Spain)

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Psychologists and educators such as J. Piaget, S. Papert and Dewey, Freynet and Freire argue that learning, especially today, cannot be based on or be limited in the collection of information and the transfer of ideas and values from the teacher to the student. On the contrary, learning should take place through the exchange of ideas, experimentation and interaction with the surrounding environment, the collection of experiences and the particular personal processing by each individual. The elements required for a successful knowledge transfer are self-regulation and negotiation. According to S. Papert, the powerful learning tool is the active involvement of the student in the investigation of the problem (Ackermann, 2001).

Educational robotics is a relatively recent learning approach. Through the construction of robots, children cultivate their imagination, develop their motor skills, learn to be creative, to solve problems, to focus their attention and to work in teams. But apart from the abilities offered by Educational Robotics to our students, it puts them in touch with a technology field where construction kits are booming. These packages include microprocessors, sensors, motors and other machines that can be used to build robotic structures with the help of building materials. They are usually accompanied by the appropriate software that allows their behavior to be programmed. Sometimes they are of a research nature and sometimes commercial. These systems, as well as the actions that can be developed through them, are in the field of Information and Communication Technologies (ICT), and in particular in Educational Robotics (Komis, 2004).

Manufacturing is at the core of educational robotics. Manufacturing involves both the construction of the hardware of the robot and the programming of its behavior. The construction is in this case Construction is, in this case, the means by which learning is conducted. The idea of 'learning by making' or 'learning through design' is at the heart of the constructionism philosophy that initially inspired the construction of educational robotics tools. This pedagogical approach, developed by Papert and his colleagues (Papert, 1991, 2000), aims to form a framework for the use of ICT in the educational process capable of causing substantial changes in the way teachers teach and learners learn. (Ackermann, 2001). The student's experience, knowledge, and needs are expressed through construction (Resnick & Ocko, 1991). The needs of a project are the reason for testing ideas and bringing out new ones, while the realization of construction is the field in which these ideas are exploited and acquired. Manufacturing is the tool through which ideas are organized and they acquire content and connection with the natural world (Brown, Collins, & Duguid, 1989). Mechanical constructions can introduce interesting ideas into the curriculum, such as those of the physical constraints posed by the actual behavior of a robot, the continuous improvement of a construct, the complexity and interpenetration of real problems (Turbak & Berg, 2002).

Educational robotics is an innovative learning methodology that combines elements of main sciences (physics, engineering), modern information technologies (software development, artificial intelligence) and studies of human behavior. Engaging students in robotics creates two activities, one constructive and one programming. Technical construction is created by students using a variety of manufacturing materials such as Lego Mind Storms, Arduino, Raspberry and others. In a worksheet they record their ideas in a variety of ways such as free text, pseudocode or logical diagram. Through the computer they visualize the behavior of the robotic entity. Learning can be treated as entertainment with the use of robots, as it is a fun creative teaching method for learning basic programming concepts.

Another subject of Educational Robotics is the development of code, in order to facilate the preparation of children for the contact with new technologies. The educational dynamics of robotics lead students to compose a mechanical entity (eg a car model) and direct it with the help of a simple and easy-to-use programming environment.

Designing activities with robotic constructs is associated with completing a project to solve a problem. The work stages, which will become phases of a single task, can be repeated in a cyclical manner or overlap.

The introduction of robotics into the "digital school" is supported by the latest learning theories that the creation of new knowledge is more effective when students are involved in making products that have a personal meaning for themselves. Through activities that will be developed in schools, children will have opportunities to express themselves through self-discovery and creativity, to guide the design of their own structures, to test their own robotic models and to share their ideas in one collaborative learning environment.

In addition, educational robotics is an interesting and enjoyable activity that enables the student to get involved in the action and to understand the concepts of the natural sciences in a pleasant way.

A) Children when designing, constructing and programming robots have the opportunity to learn by playing and develop skills

Robotics, on the one hand, is a fun and interesting activity that enables the learner to get involved with the action, on the other hand it can be used at all levels of education to teach various concepts, notably in the physical sciences and other disciplines.

- Physics (motion study, friction effect study, force relationship study, energy transfer etc.)
- Mathematics and Geometry (proportions, distance measurement, understanding of basic geometric properties such as perimeter etc.)
- Engineering (manufacturing, testing and evaluation of mechanical solutions etc.)
- Technology (technological literacy etc.)
- History (eg with the construction of a catapult robot - Archimedes - children have the opportunity to get to know the development of technology at that time as well as the work and personality of Archimedes etc.)

So, it promotes the combination of concepts from different areas of knowledge (technology, art, environment, society, mathematics, science) with thematic projects (syntheses) etc.

Educational robotics has a positive impact on the emotional (self-esteem, self-esteem) and social (socialization, demobilization) in addition to the cognitive domain.

In addition, with the help of robotics in teaching, the teacher can focus on developing other 21st-century critical skills (soft skills):

- Teamwork
- problem solving (analysis, design, implementation, testing and experimentation, evaluation)

- innovation
- project management (time management, project and resource allocation etc.)
- programming
- communication skills
- valuable mental skills (analytical and synthetic thinking, creativity, critical thinking, etc.)
- etc.

The vision of robotics is for all students to develop these skills, which in the context of globalization are an urgent need to prepare citizens of the world who can make a positive contribution on a global scale.

B) Robotics changes the traditional nature of teaching

Educational robotics combines learning with play and thus turns education into a fun activity - after all, learning is made easier, faster, and more meaningful when combined with play. The game aspect of programmable robots is an important factor of positive motivation and drive, especially in primary education.

It favors the development of research interest. Educational robotics empowers children to act as scientists - inventors and discover their own innovative ideas and solutions. It actively engages students in their learning by solving authentic problems. It actively engages students in their learning by solving original problems. It supports exploratory learning and enhances students' exploratory attitude. It motivates students to study science and technology.

Robotics involves students in situations that require them to apply mathematics and science rather than simply studying them. Because understanding is more than learning, it is learning and knowing how to apply what you know in this context.

Educational robotics provides learners with opportunities to solve personal problems for themselves by manipulating and constructing real or virtual objects. The knowledge that comes from problematic situations gives students the opportunity to develop a strong conceptual basis for rebuilding their knowledge at a later time. It allows for free expression and the development of creativity and imagination.

Through manufacturing it poses real problems and provides immediate feedback.

It allows the acquisition of knowledge and skills related to many disciplines (and thus the promotion of interdisciplinary and interdisciplinary approaches).

It enables potential intuitive awareness of complex phenomena, such as the relationship between speed, time and movement.

It can also be used as a "scaffolding" to conquer more complex concepts such as dynamic systems in Biology etc.

Through interdisciplinary educational activities, it is also possible to develop incentives for learning in other subjects (Mathematics, Physics, etc.).

It builds on the collaboration and interaction of individuals and groups and the promotion of thought through cognitive and socio-cognitive conflicts.

Communication and verbal expression of ideas through teamwork are cultivated when students are forced to explain their ideas and thoughts.

It supports experiential learning.

It is embedded in the pedagogical approach in the context of classical constructivism (Piaget, 1972), and in particular constructionism (Papert, 1991). The constructivist concept of learning argues that the learning environment should provide authentic activities embedded in real-world problem-solving processes, encourage expression and personal involvement in the learning process, and support social interaction. In addition, "constructionism" argues that learners build knowledge more effectively when they are actively involved in the design and construction of (manual and digital) real objects that make sense for themselves whether they are sand castles or LEGO constructions and programs. computers (Papert, 1991).

Learning to analyze, plan, and then execute (through a machine) processes is a high level of intellectual competence - one of the great types of tasks that psychologists call problem solving. Facilitates learning programming.

Robotic construction planning creates a whole new interface for students with the following features:

(a) It is strongly motivating, and therefore of paramount importance for teaching

(b) Robot behavior programming results from the transfer of existing and already known behaviors from living organisms

(c) Favor the test - error strategy, which is familiar even to elementary school students

(d) Demonstrates acceptable approaches and solutions and not one single right solution since one behavior can be attributed in many ways

(e) Supports metacognitive learning processes, since programming activity leads to the creation, analysis and externalization of mental processes. This effort is metacognitive in that it forces us to think about the way we think and act.

References

Ackermann, E. (2001), Piaget's constructivism, Papert's constructionism: What's the difference?, Retrieved 22/9/2008 from MIT OpenCourseWare Media Arts and Sciences Web site, http://ocw.mit.edu/OcwWeb/Media-Arts-and-Sciences/MAS-962Spring2003/Readings.

Brown, J., Collins, A. & Duguid, P. (1989), Situated Cognition and the Culture of Learning, Educational Researcher, 18(1), 32 – 42.

Papert, S. (1991). Situating Constructivism, In Papert, S. & Harel, I. (eds.), Constructionism, New Jersey:Ablex Publishing Corporation, 1 – 11.

Papert, S. (2000), What's the big idea: Towards a pedagogy of idea power, IBM Systems Journal, 39(3 – 4).

Resnick, M. & Ocko, S. (1991), Lego/LogoLearning Through and About Design, In Papert, S. & Harel, I. (eds.), Constructionism, New Jersey:Ablex Publishing Corporation, 141 – 150.

Turbak, F. & Berg, R. (2002), Robotic Design Studio: Exploring the big ideas of engineering, Liberal Arts Enviroment, Journal of Science Education and Technology, 11(3), 237 – 253.

Κόμης, Β. (2004), Εισαγωγή στις εκπαιδευτικές εφαρμογές των ΤΠΕ, Αθήνα: Εκδόσεις Νέων Τεχνολογιών.

Κυνηγός, Χ. & Φράγκου, Σ. (2000), Παιδαγωγική Αξιοποίηση της Τεχνολογίας Ελέγχου στη Τάξη, Στο Κόμης, Β. (επιμ.): Πρακτικά του 2ου Πανελλήνιου Συνεδρίου με Διεθνή Συμμετοχή "Οι Τεχνολογίες της Πληροφορίας και της Επικοινωνίας στην Εκπαίδευση", Πάτρα, 265 – 274.