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EDUCATIONAL ROBOTICS: A METHODOLOGY TO DEVELOP COMPETENCES

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Abstract

Educational robotics, that is the teaching methodology that involves the use of robotics to generate competences in regular curricula, has the aim to involve students of all ages, from kindergarten to high school, in the study of scientific and technological subjects with a new approach.

Learning emerges from cooperative working, from a new role of the teacher, who becomes simply a facilitator of the learning process. Educational robotics introduces a new concept of error, considered as an incentive to do better. Robotics involves students with different cultures, linguistic heritage, age, learning styles. Educational robotics is extremely inclusive: talented students and students with learning difficulties can easily work together in designing, engineering and programming small robots. Moreover students can show their different kind of intelligences, their abilities.

Educational robotics can easily find a place in traditional math and science curricula to develop key competences: it increases learning motivation, the use of a proper language, the growing of mathematical, scientific and digital skills, helps to develop entrepreneurship.

Keywords: *educational robotics, Key Competences, learning by doing, teaching methodology, learning methodology*

Key Competences

Key competences for Lifelong Learning are a combination of knowledge, skills and attitudes appropriate to the Key-TTT, ref. No504605-LLP-1-2009-1-BG-COMENIUS-CMP

context, as identified by the European Parliament:

- **communication in the mother tongue;**
- **communication in foreign languages;**
- **mathematical competence and basic competences in science and technology;**
- **digital competence;**
- **learning to learn;**
- **social and civic competences;**
- **spirit of initiative and entrepreneurship;**
- **cultural awareness and expression.**

They are particularly necessary for personal fulfilment and development, social inclusion, active citizenship and employment. Infact, these skills are based on three fundamental aspects of the life of each person:

- **self fulfilment and personal development (cultural capital);**
- **active citizenship and integration (social capital);**
- **the employability (human capital).**

How can the educational robotics develop these skills?

The use of educational robotics as a teaching method encourages students in guided discovery and in problem solving; students get used to work in groups to solve problems, find solutions and verify the results.

Introduction to Robotics

Robotics is an area that is acquiring increasing scientific, economic and cultural importance and is one of the keys of the industrial and cultural revolution.

Robotics in the past has been used in industrial applications that have produced programmed machines to perform physical tasks only. Currently, robotics has produced technologies that have made the most interesting perspectives and interdisciplinary studies possible. These machines are not only able to perform tasks, but also to promote social relationships and complex cognitive functions.

After the Papert turtle (1984) and Handy Board designed by Fred Martin (Martin, 2000), different robotic systems have been developed in recent years. Some of these, such as the LEGO® MINDSTORMS construction kit, allow the user to design and build many robots with different behaviors. In recent years, robotics has also been experienced in education in particular in cooperative learning. Robotics becomes educational robotics, it is necessary for motivating, learning and promoting the attainment of skills at different school levels, even in disability situations. In kindergarten, for example, educational robotics is helpful in supporting the usual play activities while at the other school levels (primary, secondary of first and second grade) educational robotics is important for learning of science and beyond. The application of robotics to school represents an opportunity for innovation and improvement of traditional teaching, but also a challenge for teachers who must develop new skills.

Robots are commonly associated with games. Robots indeed, go beyond the recreational aspect, and they can combine the reconstruction of the knowledge they got during the various school activities, with creation, invention and new keys in the revival of the concepts and techniques acquired. In this way it is possible to achieve multiple types of intelligences that characterize our pupils: linguistic, logical-mathematical, interpersonal, just to name a few.

Educational robotics as a teaching tool

In Italian schools of all type and level there are numerous teachers utilizing the design, conception, construction and programming of robots as a teaching tool capable of consolidating or facilitating the comprehension of curricular disciplinary concepts. The experiences conducted by the partner schools of the Robotics School in numerous national and international projects serve as proof of how today for teachers and innovative scholastic administrations, educational robotics is a tool for learning to all effects. There are various ways of introducing educational robotics in the relevant lessons, but each method respects certain universal learning values which can be reassumed in the key competencies at European level.

Kits utilized in schools and in the various experiences

Lego Mindstorm® NXT is the most popular kit used in the first and second grade secondary schools, (it is also widely used in the final years of primary school (from 8 to 10 years). The kit presents various sensors (sound, touch, ultrasound, light) which enable the creation of various interdisciplinary projects. The great flexibility at programming level allows this kit to be utilized both in primary schools through the iconic language created by

National Instruments NXT-G up until the final years of the vocational schools where more complex languages such as C++, Java and LabView are introduced. The great flexibility and solidity of this kit makes it the most commonly used in schools.

Lego WeDo[®] is destined for pre-school and primary school students. It contains two sensors (infra-red and tilt) and is connected directly to the computer for power. This kit allows the introduction of complex programming concepts such as the cycle or basic mathematical concepts. The iconic programming language allows a fast and intuitive approach to programming, the organization of the software allows the introduction of individual construction within a narrative structure that motivates children to the creation of small differently shaped robots: monkeys, crocodiles, children etc. The strength of the kit is the strong link with the narration within which the robot created is to act.

Educational robotics at school: the key competences

The key competencies identified by the European Commission for the Life Long Learning are those described hereafter. Thanks to the highlighting of the various key competences it will be possible to understand how robotics can become an official teaching tool for motivating students of all ages in the study of the various subjects.

Communication in the mother tongue

Designing, building and assembling robots signifies having to share ideas, drawings; it means collaborating, team-working. Robots are objects which cannot be built alone but require continuous exchange of ideas among the members of the group with the various intelligences that emerge during construction and problem solving. The comparison with diversity enables the improvement of the communicative skills of the students who must communicate their own ideas clearly and synthetically at many levels, through many means of communication: design, technical text and oral communication.

Communication in foreign languages.

Educational robotics projects foresee the need for students to compete in a world that does not use Italian for the sharing of information, but English. In order to be able to conduct research and be able to build robots, students are often obliged to compete with foreign languages. In some projects utilizing educational robotics, numerous video conference link-ups were held (often using Interactive Whiteboards). These enabled Italian students to collaborate with their foreign counterparts on a common task dedicated to the design of the robots. In this case, the robots become a catalyser for communication capable of motivating young people to study a common theme: robots.

Mathematical competency and basic competencies in science and technology

The obvious link between robotics and mathematical, scientific and technological disciplines often makes it more difficult to understand how radically the lessons of these subjects can change from the methodological and process point of view with the introduction of the use of robots. In every type and level of school it is possible to utilize programmable robots to enable the students to re-process abstract concepts, facilitating the connection with reality. Educational robotics enables the mediation of the scientific contents from various points of view, comprehensible to different intelligences. Furthermore, the conception of error changes radically: the error is no longer seen as a judgment but as an incentive to change one's own skills. In this way the Galilean point of view is recovered, the scientific method does not foresee abstract alone (in schools today mathematics is very abstract), but continuous experimenting, capable of modifying our abstract. Installing a relation between the world and abstract may enable students understand better not only scientific subjects.

Digital competency

This key competency is evidently linked with educational robotics. In order to program robots it is necessary to use computers and to be able to dynamically document the robot activities it is necessary utilize the various digital communication tools in the best way. This means that educational robotics gives a 360° possibility for the creative use of the computer.

Learning to learn

Working on robots is not conducted by the teacher in a traditional way; the teacher has the task of coordinating the various activities and "discoveries" so as to be able to consolidate certain curricular concepts. His or her role is not to provide skills dogmatically. The design/construction/programming of the robot enables the students to represent the world independently, to be able build their own aware and explicit way of learning, to be able to create a learning process linked to observation, experimentation, abstract and theorization in a continuous cycle that foresees that each stage intervenes with the other.

Social and civic competencies

Robotic technologies are the technologies of the future, introducing robotics in these years is like introducing IT in the Eighties - it has a great civil value for the future of the students. In addition, having to work in a group and the need to have to accept different intelligences from each member allows the students to recognize differences and accept them to improve the work of the group. Recognizing and collaborating with diversity are two components of the social aspects that educational robotics contributes to developing. Thanks to projects monitored, for example, by the School of Robotics of Genua, there are many cases of integration of children with cognitive issues within the work of the class.

Sense of initiative and entrepreneurship

Educational robotics enables the stimulation of the students' creativity in designing new robots with new functions and new programs. The sense of initiative and entrepreneurship is experienced by participants in the lessons on many different levels, enabling the students to develop different entrepreneurial strategies:

- exposure of their own ideas during the robot design;
- listening to and sharing the ideas of others;
- management and self-organization of the group;
- exposure of their own solutions at programming level;
- shared problem-solving.

Cultural awareness and expression

In the other key competencies, if the advantages linked to the method or the technology are highlighted, this key competency requires the aptitude to be expressed not from a technical point of view but creatively and expressively. Also in this case there are many students who re-process the robot idea creating innovative and aesthetic designs and personalization of the robot. The personalization of the teaching tool allows for greater involvement of the students and enables greater expression of their own aptitudes.

Conclusions

Today we speak about educational robotics as an instrument that can be used as a learning tool or a teaching methodology; maybe in a few years educational robotics will blossom up as a new learning methodology.

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