Programming Integrated in K-8 Traditional School Curricula

G. Barbara Demo
Informatica Department, University of Torino
c.so Svizzera 185 - 10149 Torino – Italy
barbara@di.unito.it

During 2008/2009 school year several new ICT projects have been initiated in Italian primary and junior high schools aiming at improving pupils achievements particularly in scientific subjects. Explicit aim of some proposals is developing computing competencies such as problem solving and, in general, logical skills thus introducing in schools a conception of computing different from the one in most current projects, normally limited to the use of software applications. Actually, already in school-year 2001-2002, F. Honsell and C. Mirolo promoted one of the first projects aiming at cultivating computing as a science in schools that involved fifteen primary schools in the Friuli Italian region [3]. Yet, only during the current school-year 2008/2009 we had the first nation wide initiatives in schools under this approach. The Italian Kangaroo Association organised the First Italian Kangarou Informatica contest for junior high schools, 5-7 May 2009. A. Lissoni with a group of researchers from the Milano University collected several problems, or as they call them "quesisti", to show in junior high schools what kind of questions computing concerns [4]. Also the Italian Ministry of Instruction, University and Research (MIUR) supported Problem Solving Olympic Games for the first time during the current school-year for the fifth degree of the Italian primary school and the third degree of the junior high school after the initiative of G. Casadei. These projects share the idea that pupils must get used to a structured i.e. algorithmic way of dealing with problems and of solving them. Some of the proposed problems also introduce young students to data structures typical of computing thus showing how properly structuring the data of a problem influences finding a solution. According to the title "Algorithms+DataStructures=Programs" of one of Wirth's books, in these projects pupils acquire programming competencies.

Other researches explicitely address programming in primary and secondary high schools. As an example, in educational robotics, pupils write programs for moving mini robots. We have proposed activities with autonomous mini robots of different types to children in kindergarten, primary and junior high schools. Pupils program by pushing buttons, in pre-writing age, or using different iconic languages or a textual Logo like language within an Integrated Development Environment (IDE) designed and implemented for them in our Departement. An advantage of programming autonomous mini robots is that it offers to pupils problems to be solved (and programmed) that they understand and are interested in solving. Beginning problems with robots are based on making them move in different environments: avoiding obstacles or doing different actions depending on where obstacles are positioned or depending on when a noise is made or similar. These moving-activities are something that young people know quite well by themselves. Teachers do not have to find problems: robots have wheels and, consequently, pupils first of all want to write programs that make them move.

While designing, writing and verifying programs for controlling the motion of mini-robots, schoolchildren and students both acquire programming competences in a young people oriented context and have the chance of concretely manipulating concepts present in their school curriculum with a conctructivistic learning approach. Educational robotics is a learning environment where robot programming activities are integrated into standard subjects rather than being a form of ICT added to school curricula as one more, separate, subject or as a number of (software) tools for practicing topics from standard subjects. Until nowadays, such integration has rarely been present in the proposals for introducing computing technologies in schools, though considered a most fruitful educational usage of computers already in Papert's researches of the 70's.

During last couple of years we could work with k-8 pupils on several topics from traditional curricula. In the following, we mention types of robots used and some curricular components addressed in our activities, distinguished by school levels.

In *kindergarten* we propose robots programmable to go forward, backward, left and right (the same measure of movement) by pushing buttons. We have addressed basic counting competencies and topological problems also with respect to the robot (that is someone different from the child who decides the commands).

In *primary school* we propose both already assembled robots and kits. Pupils program with iconic or textual languages. While designing robot programs we cover measuring, counting, comparing (longer, shorter, as-long-as paths), drawing of geometrical shapes. Also, again while designing or correcting their programs, pupils are naturally introduced to manipulate beginning physics concepts such as speed, time, friction and their relationships. Activities concerning geography have also been performed and a step-by-step methodology has been experimented where learning the textual Logo-like language for robot programming is coordinated with the parallel acquisition of logical and linguistic abilities [1].

In *junior secondary school level* we used several types of kits that pupils assembled in different forms. During 2008/2009 school-year we went from more evident activities such as working with direct and inverse proportionality concepts (typically addressed in this level of schools) to introducing algebraic expressions[2]. This has been done by discussing with pupils how we can write the length of the path covered by the robot during one execution of a program. Our current work concerns the automatic synthesis of the algebraic expressions resulting from the discussions we had

this year in junior high schools. This will be a support for teachers in motivating algebra that pupils often perceive only as a syntactical exercise.

Other activities integrating robotics in standard curricula are carried out by G. diBenedetto and R. Didoni with their Friend-Robot School-Net in Milano area and by researchers involved in the European project "Teacher Education on Robotics-Enhanced Constructivist Pedagogical methods" (TERECoP). Didoni's experiences began around 2001 and nowdays every year their School-Net organises the Robotics Festival [5]. Italian researchers from Padua University and Rovereto Science Museum are involved in the TERECoP project with other seven European countries for developing robotics competencies in teachers in k-12 schools [6].

References

[1] G. Marcianó and G.B. Demo (2007) "Contributing to the Development of Linguistic and Logical Abilities through Robotics", Proc. EuroLogo 2007 Conf., August 2007, p.46.

[2] G. B. Demo, Robot Programming Integrated in a Secondary Junior School Curriculum, Proc. Informatics Education Europe IV Conf., Freiburg, Nov.2009.

[3] F. Honsell, C. Mirolo, Scientific Coordinators, "SeT Project: the information cycle", 2002,

http://www5.indire.it:8080/set/informazione/informazione.htm

[4] A. Lissoni et all., Working for a leap in the general perception of computing, Proc. Informatics Education Europe III Conf., Venice, Dec, 2008.

[5] Robotics School-Net Friend-Robot , in Italian; http://www.amicorobot.net/index.html

[6] TERECoP Project: http://www.terecop.eu/