Experimenting and validating didactical activities in the third year of primary school enhanced by robotics technology

Paola Lo Savio[1], Valentina Scaldaferro[1], Alda Baldan[1],
Emanuele Menegatti[2], Michele Moro[2]

[1] Scuola Primaria D. Manin– Padova, Italy
{paola.losavio, valentina.scaldaferro, alda.baldan}@gmail.com
[2] Dipartimento di Ingegneria dell'Informazione, University of Padova
Via Gradenigo 6/A-B – I 35131 Padova, Italy
{emg, mike}@dei.unipd.it

Abstract. This paper describe our experience of a robotic-enhanced didactical activity with 3rd grade pupils. The activity was not aimed at introducing robotics as a new subject but at reinforcing concepts and tools learned within different subjects, (e.g., mathematics, geometry, technology, etc.) though the activity was contextualized in the geography curriculum. The methodology, the detailed content of the activities, and the evaluation of the performances of the pupils are presented.

Keywords: Educational robotics, Primary education, Lego Mindstorms, Constructionism, Learning by discovery.

1 Rationale: developmental age, from 6 to 11

Primary school pupils experience a period of 5 years (from 6 to 11) in which bursts of growth occur and they reach significant milestones of maturity from multiple points of view: physical, relational, emotional, cognitive [1]. The story of life looses its imaginative connotation and gradually, around 8 years old, it moves to a more realistic view. At the same time the ability to read evolves together with a more aware and appropriate use of different languages in their specific disciplines, gradually gaining a greater capacity for abstraction. Meanwhile they develop and refine fine mobility skills. Even self-centeredness gives way, in these years, to the recognition of the other, his needs, his abilities and his point of view [2]. To achieve all this it is inevitable to pass through comparisons, exchanges and, more often, conflicts. They learn to be in a group, they adopt behaviors and relationships adequate to live in the school-community; they learn to work together, in pairs and/or in small groups, to collaborate for achieving a common goal or for solving rather complex tasks [3]. These are called 'social skills' and they are not innate. When teachers consider important not to ignore these aspects in the development of pupils and they aim at improving these cross-skills during the teaching of their disciplines and behind, they should ask the students to work on these and reinforced them in many ways and in many occasions. In this paper we propose a robotic enhanced activity aiming at

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support the development of all these cross-skills. We designed an activity, exploiting the LEGO Mindstorm NXT robot, which aims at reinforcing these cross skills and the cooperative learning skills in the framework of constructionism [4].

2 The experience

Organization: Recipients were pupils about 8 years old, attending two 3rd grade classes of 21 students each. We used Lego Mindstorm NXT (7 for the construction phase, only 5 during the programming phase for a better management of the groups), with the support of a IWB (Interactive White Board) equipped classroom and a computer lab with 11 workstations.

Methodology: The didactical activity was designed following the guidelines of the Terecop project [5]. It had its focus on geography, but was developed in an interdisciplinary way and it also proved as a valuable opportunity to develop social skills. 1h and half was dedicate to the construction phase of the robot (about 70% of the groups completely finish the work within this time) and 5 meetings of 1h and half, divided into two rounds, for programming the robot at the computer and testing it in the lab. The basic elements of the project were: *Interdisciplinarity,* the focus was on geography and road safety education, but technology, computer science, mathematics and physics was involved as well; *Problem-solving,* i.e. fostering in pupils an attitude of problem-solving valorizing the try-and-error approach, and promoting an active knowledge process; *Co-responsibility and reciprocity,* team work makes pupils relate dialectically to the classmates, agreeing on solutions or strategies to accomplish the tasks.

Structure: the frequent practical experience with the robot, were accompanied by body syntonic actions, to achieve a conceptualization/abstraction of the topic. Means used for achieving the knowledge goals were: free drawings, generation of keywords, flow charts, mental maps. For every topic three steps were implemented: presentation of the topic by the teacher with the support of the expert; reinforcement of the argument describing similar situations; a reflection and a cognitive reprocessing involving the entire class, guided by the teacher, to clarify, fix and explain better the activity, share difficulties and successes. **Implemented robotics activities**: pupils learnt how to build and program a robot, by constructing the NXT LEGO in the basic Tribot configuration. First, they programmed the motion of the robot using LEGO NXT-G programming environment and pre-programmed blocks (4 blocks: move forward, stop, turn left, turn right (of fixed preset quantities). They created sequences of commands in order to make the

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robot moving along a path on a grid respecting the traffic signs which where placed by the teacher on the grid. Later, the use of sensors was introduced. Using a sonar sensor, the robot could stop in front of obstacles. Using a light sensor, the robot could distinguish between red and green cardboard, simulating a traffic light. The use of sensors enabled to introduce the basic blocks of LEGO NXT-G and their usage: first the sensors' blocks and then also the WHILE and IF blocks. In the end, the pre-programmed blocks where abandoned and the pupils realized a fully reactive behavior of line following by programming the robot using the NXT-G blocks for controlling the motors and the sensors.

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