Edutainment Robotics as Learning Tool

Eleonora Bilotta, Lorella Gabriele, Rocco Servidio, and Assunta Tavernise

Department of Linguistics, University of Calabria, via P. Bucci, Cube 17/B, 87036 Arcavacata di Rende, Cosenza, Italy
{bilotta, lgabriele, servidio, tavernise}@unical.it

Abstract. Many constructivist technologies allow students to improve problem-solving strategies and learning in educational settings, encouraging teamwork and creativeness. Hence, in didactic contexts, the building, design and programming of Lego® MindStorms™ robots entertain students, stimulating technological and social factors. In this paper, we investigated the knowledge acquisition of a Lego Robotics system in University students, who had to create a robot able to take part in a race and avoid an obstacle placed in an arena. The learners’ documentation of each phase of the task (reports, schemes, photos and videos) was analyzed as cognitive fingerprints of subjects’ mental activities.

Keywords: Learning and Instruction; Lego; Edutainment Robotics; Cognitive strategies; Constructivism.

1 Introduction

Over recent decades, a number of robot construction kits for edutainment applications have been designed to improve and increase interaction between users and robotics artifacts [1], [2], [3], [4]. As Lund and Pagliarini assert [5] some robots have a static morphology (e.g. Furby), while others have one which is variable (e.g. Lego® MindStorms™, FischerTechnic robot). The robots with a variable morphology, give the user the opportunity to build, plan and program different kinds of robotics artifacts. This latter Edutainment Robotic kit has been built in accordance with learning principles derived from Piaget and Vygotskij’s theories [6], [7], [8] of cognitive development, as revised by Papert [9], which portray learning as the acquisition or ‘construction’ of knowledge through observation of the effects of one’s actions on the world [10]. The constructivist approach promotes a kind of learning in which the educator does not transfer information, but is rather a facilitator of learning, leading the working group, and so the learner enhances his/her knowledge through the manipulation and construction of physical objects.

With regard to specific artefacts, numerous researchers endorse Robotics as an educational tool [11], [12], [13], [14], [15], [16], [17], with a quantity of literature devoted solely to using the Lego MindStorms kit [18, 19, 20, 21], at levels ranging from primary school to University [22], [23], [24], [25], [26], [27], [28]. There are reports of improved performance in Mathematics, Physics, and Engineering courses resulting from educational Robotics projects [29], [30], although most of the evidence is based on the reports of teachers achieving positive outcomes through individual initiatives [31].
Moreover, Johnson [32] argues that Robotics offers special educational leverage, because it is multi-disciplinary field involving a synthesis of many technical topics, including Mathematics and Physics, Design and Innovation, Electronics, Computer Science and Programming, and Psychology. Research results suggest that the pedagogical value of robots lies in making them work, through using or extending knowledge to identify problems, and argues that robots are a particularly motivating technology because they are concrete, complex, and relate to deep human needs.

In effect, by constructing physical agents together with the code to control them, students have a unique opportunity to tackle many central issues directly, including the interaction between hardware and software, space complexity in terms of the memory limitations of the robot’s controller, and time complexity in terms of the speed of the robot’s action decisions. Furthermore, the robot theme provides a strong incentive to learning because students desire to see the success of their invention [12]. Moreover, many researchers underline the positive results in the rehabilitation of autism and cognitive deficits using interactive robots [33], [34].

Another application for Edutainment Robotics is represented by RoboCup [35]. The World-Wide RobCup Championship is a large international competition that aims at involving all sorts of research in Robotics and Artificial Intelligence. It has been developed with the initial idea that the stimulus of competition encourages the integration of different technologies which, once optimized for the engaging and pleasant game of football, may be transferred to significant, practical problems for industry. The RoboCup Championship involves participants in the challenges of competition, as well as in the development of educational skills [36], [37]. Finally, it can be stated that robots are a particularly motivating technology and that the use of Robotics tools in teaching contexts offers the opportunity to build a bridge between entertainment and education [38].

In this paper, we present the results of an empirical research project with university students the purpose of which was to investigate cognitive strategies using the Lego MindStorms robotics kit.

The paper is organized as follows. In section two, we present a description of the research objective. In section three, we describe the subjects. The robot laboratory organization is described in section four. In section five, we describe the materials used. Section six focuses on methods of results analysis. Finally, in sections seven and eight we present analysis of the results and some conclusions.

2 Objectives

Our research aimed at investigating the learning process by using Edutainment Robotics. In particular, we analyzed the cognitive abilities of the University students involved in the Lego robot construction, related to:

- Planning strategies – students are expected to use the Constructopedia (a guide with different examples of robot Lego projects) to plan their robots, by modifying little functional parts of their artefacts. For example, students could use little wheels if large wheels prevented good performance.
- Programming strategies – students should learn to define and manage robot behavior in relation to the final task.