Chapter 5
Computational Thinking and Robotics in Kindergarten:
An Implemented Educational Scenario

Evgenia Roussou
Directorate of Primary Education of Piraeus, Greece

ABSTRACT

Ever since technology became an integral part of human life, a range of new concepts have surfaced. Computational thinking (CT) has been extensively discussed in the last 15 years and has been gaining popularity in the educational world. Following an overview of the basic literature published on this evasive new concept, an attempt is made to outline the connection between computational thinking and programming with emphasis on tangible programming of educational robots. An implemented educational programme, which attests to the positive impact of robotics on the acquisition of computational thinking skills in early childhood, is presented and evaluated. The study took place in a typical Greek kindergarten in 2017 and focused on the development of particular aspects of computational thinking with the use of a programmable floor robot.

INTRODUCTION

Technology is rapidly evolving and bombarding our world with inventions that change people's lifestyles, requiring flexibility and constant adaptation of our skills. And while in everyday life, on an individual level, this flexibility is perhaps possible, education meets enormous difficulties: it takes copious study, effective planning, long-term research and pilot implementation of new programs before the official Curricula can be updated. However, current developments are cataclysmic therefore, the global scientific and academic community in collaboration with policy makers are making special efforts to speed up the process so that schools will provide students with the necessary 21st century skills. Collaboration, communication and thinking skills are at the heart of modern educational pursuits. Einstein's famous view that we cannot solve problems using the same way of thinking we had when we created them, just

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highlights the need to expand and develop new aspects of human thought. This chapter aims to present an educational scenario which was designed and implemented in a typical kindergarten classroom, as part of a Master's Thesis case study. A detailed description of all robotic activities, together with analytical information on student response and behavior is provided. Available research data indicate that using the robot in a developmentally appropriate, playful way leads to remarkable increase in the kindergartners' targeted computational skills, which is consistent with the findings of similar international studies. Moreover, student observation offers interesting insights on the impact of an educational robotics program on young children's social skills and interactions.

BACKGROUND

Computational Thinking (CT)

Prensky (2001: 1) proposed the insightful term *digital natives* to describe the *"generation born and raised in an environment where digital media is ubiquitous"* which results in fundamental differences in the way students think and process information; differences that educators are just beginning to comprehend. In 2006, Karl Fisch pinpointed one of the greatest challenges educational systems face nowadays: *"We are currently preparing students for jobs and technologies that don't yet exist in order to solve problems we don't even know are problems yet"*. His inspirational video has had more than 21 million views on YouTube and triggered spirited discussions among educators worldwide.

Modern School Curricula around the world are gradually including the development of Computational Thinking (CT), a term coined by Wing (2006: 33) when she stated that *"computational thinking involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science"*. Although CT has various definitions, it is widely accepted that it *"encompasses a broad of analytic and problem-solving skills, dispositions, habits, and approaches used in computer science"* (Sullivan & Bers 2015: 5). The British Royal Society (2012: 29) defines CT as *"the process of recognizing aspects of computation in the world that surrounds us, and applying tools and techniques from Computer Science to understand and reason about both natural and artificial systems and processes"*, based on Papert's views (1980, 1991) that computers enable children to develop procedural thinking (i.e. CT) through programming and solving problems - by generating ideas, analyzing problems and explaining the relations between problems and their solutions. Scientists have since tried to further clarify the concept of CT but consensus has not been reached yet; nevertheless, there is academic agreement that CT is a thinking process, therefore not dependent on technology, and it involves specific problem-solving skills which can be used by a computer, a human or a combination of both (Bocconi, Chioccariello, Dettori, Ferrari & Engelhardt, 2016). According to Perković, Settle, Hwang & Jones (2010), CT also offers new ways of understanding natural and social phenomena and promotes creativity and innovation. Therefore, attempts have been made to introduce activities for the development of CT skills even in primary education as it is considered equally important with the traditional three R's (reading, writing, arithmetic).