Chapter 16
Robotics in Early Childhood Education:
Developing a Framework for Classroom Activities

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ABSTRACT

Robotics is a very promising tool and a highly innovative field that brings a new dimension in educational settings. Educational robotics is recognized as a valuable means for cultivating 21st-century skills, having the potential to promote learning, cognitive and social development, and preschoolers' engagement with STEM topics in a playful way. Nevertheless, the absence of a well-articulated pedagogy of teaching robotics and with robotics impacts the clarity of its guidelines, scope, and objectives. There is a lack of frameworks for teaching robotics in early childhood education, especially one that includes objectives and teaching methods in a balanced way. This is the challenge that the current chapter aims to address: to outline the initial orientations of a framework that includes educational robotics objectives and appropriate teaching methods for early childhood education.

INTRODUCTION

Robotics is a very promising tool and a highly innovative field that brings a new dimension in educational settings. Educational robotics is recognized as a valuable means for cultivating 21st century skills, having the potential to promote learning, cognitive and social development and preschoolers' engage-

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ment with STEM topics in a playful way. In line with contemporary early childhood philosophy, which emphasizes authentic learning, engaging, heuristic and inquiry-based learning environments (Sukani & Karim, 2018), robotics seem to be a valuable asset for preschool teaching. What is more, robots' tangible characteristics permit developmentally appropriate approaches in young children's learning, encouraging a deeper understanding of abstract concepts, through hands-on, meaningful experiences (McNeil & Jarvin, 2007). Nevertheless, the use of robotics in early childhood education is integrated at a slow pace in contrast to upper education levels (Demo et al, 2012), due to the complexity of the robotics kits that are available and the lack of guiding frameworks for designing and applying educational robotics activities (Bers, 2008; Missirli & Komis, 2014). This chapter aims to contribute to this challenge by providing a framework to facilitate educators in the implementation of developmentally appropriate robotics activities. Specifically, it attempts to outline educational robotics' appropriate teaching methods and objectives.

The chapter is structured as follows: i) a background that provides a short overview on the landscape of educational robotics and highlights current issues, problems, and trends that lead to the objective of this chapter, ii) a framework that attempts to map educational robotics objectives, and to outline teaching methods that are in line with ICT and robotics underlying theories specific to early childhood education. Indicative examples from classroom practice are also provided, iii) concluding remarks that include recommendations, solutions, future research directions and conclusion.

BACKGROUND

In the last decades the educational community has shown a strong interest in robotics. Since 1967, when LOGO computer programming language was introduced, robotics has gradually been incorporated in K-12 Education, especially in STEM and interdisciplinary approaches. The launch of Lego MINDSTORMS, stemming from the collaboration of MIT Media Lab and Lego Group, is considered a milestone that influenced the market's interest in robotics and the "maker movement" (Anwards et al., 2019). Nowadays, a wide spectrum of educational robotics material for young children is available (Stanton et al., 2017), with programming languages to move beyond screen-based environments, acquiring tangible characteristics (Kaifai & Burke, 2014) that embrace the developmental needs of young children. Young tinkerers have access to 1) programming toys: with electronic physical enacting agents that are programmed through tangible manipulatives, e.g., Coding Express, 2) programming board games: digital enacting agents that are programmed with tangible manipulatives, e.g., Kids First Coding & Robotics, 3) programming concept practicing applications/websites, e.g., ScratchJr, and 4) Robotic kits: electronic physical enacting agents that are not connected with separate tangible manipulatives or are programmed through digital screen, e.g. LEGO WeDo 2.0 (Ching et al., 2018).

Robotics kits are an increasingly popular tool for young children's familiarization with computer science in a hands-on way, experimenting with sensors and motors (Bers, 2008; Bers & Sullivan, 2019). Also known as robotics manipulatives, robotics kits are defined as tools with which students can create, build, and/or program, enhancing technological fluency (Bers, 2008; Fernaeus et al., 2010). There are various kits, each one supports different activities and learning styles (Rusk et al., 2008), like preconstructed robotic systems (e.g., Bee-bot) and systems that provide children the opportunity to engage in the construction of the robot (e.g., Lego Education WeDo 2.0) (Misirli & Komis, 2014).

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