Chapter 15
Educational Robotics in Primary Education:
A Systematic Literature Review

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ABSTRACT

The purpose of this chapter is to review the literature referring to the utilization of educational robotics (ER) in primary education. Keyword-based search in particular bibliographic databases returned 21 journal papers for the eight-year period of 2012-2019. The factors that were studied in each of them are as follows: learning environment, area of knowledge/course subjects, pedagogical framework, learning activities, robotic equipment, research methodology, and main findings. The outcomes, among other things, showed that the majority of ER activities took place in a formal learning environment and that ER is appropriate for teaching subjects of STEM education. Though many researches took into account various learning theories that support collaboration, problem-solving, discovery, and construction of knowledge, there were some researches that lacked any pedagogical framework. In spite of the positive cognitive and affective outcomes of ER in learning, there are aspects that require further investigation.

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INTRODUCTION

In recent years, the research community has shown great interest in Educational Robotics (ER) as a technology which substantially promotes the educational process (Eguchi, 2014; Fanchamps, Slangen, Hennissen, & Specht, 2019; Ospennikova, Ershov, & Iljin, 2015) and offers significant benefits in learning and teaching (Benitti, 2012; Jones & Castellano, 2018; Julià & Antolí, 2015). ER gives students the opportunity to explore, create and implement knowledge into dealing with authentic problems (Bers, Flannery, Kazakoff, & Sullivan, 2014; Ching et al., 2019). Moreover, it increases interest in and motivation for learning, advances learning results (Chin, Hong, & Chen, 2014; Ching et al., 2019), improves critical thinking and creativity (Atmatzidou & Demetriadis, 2016; Noh & Lee, 2019) and contributes to the acquisition of cooperation skills and team spirit (Hwang & Wu, 2014; Menekse, Higashi, Schunn, & Baehr, 2017). Robotics can, among others, be effectively used as a cognitive tool in a number of fields such as Mathematics (Durak & Saritepeci, 2018; Martínez Ortiz, 2015), Language (Mubin, Stevens, Shahid, Al Mahmud, & Dong, 2013), Natural Sciences (Eguchi, 2014) and Geography (Serholt, 2018), or as a means of teaching in technological education with the aim of obtaining essential knowledge in Robotics, Programming and Technology (Kandlhofer & Steinbauer, 2015; Mubin et al., 2013). Many researchers regard ER as the most appropriate instrument to support STEM education (Kennedy & Odell, 2014; Kopcha et al., 2017; Master, Cheryan, Moscatelli, & Meltzoff, 2017). Through Robotics-oriented activities, students participate in the construction of robots (e.g., a LEGO kit) and apply their knowledge and skills in the domains of Science, Technology, Engineering and Mathematics into the solution of everyday problems (Ching et al., 2019; Eguchi, 2014; Scaradozzi, Sorbi, Pedale, Valzano, & Vergine, 2015).

Increased interest in ER led to several literature reviews in order to examine the research trends and reach conclusions regarding the implementation of robotic interventions in education. Earlier literature reviews that have ER as their research subject (Anwar, Bascou, Menekse, & Kardgar, 2019; Benitti, 2012; Karim, Lemaignan, & Mondada, 2015; Mubin et al., 2013; Toh, Causo, Tzuo, Chen, & Yeo, 2016; Xia & Zhong, 2018) explain the benefits and insufficiencies of this technology in teaching and learning, and highlight the research trends, resulting in valuable knowledge and conclusions. Nonetheless, these reviews manifest certain characteristics or limitations concerning the research, which dictate further study and investigation of ER in education. All of the reviews (see next section) examine ER in K-12 education and draw conclusions regarding all three levels of education: Early Childhood Education, Primary Education and Secondary Education. However, the majority of the studied articles concern researches from Secondary Education thus resulting in unsafe conclusions about the use of Robotics in ages from 6 to 12 years. The lack of studies in previous years on the topic of ER for young ages was a decisive factor in that respect (Chen et al., 2017; Ching et al., 2019; Di Lieto et al., 2017; Sullivan & Bers, 2018). This lack is also confirmed by the fact that 10 of 21 articles in the present review were published in the years 2012-2017, while 11 were published in the last two years, namely 2018-2019. In addition, some of the reviews focus on a particular area of knowledge such as Mathematics and Physics (Karim et al., 2015) or STEM education (Anwar et al., 2019) thus creating the need for a research concerning the implementation of robots in a broader learning context. Moreover, a significant number of the reviewed articles were not empirical researches, while others originated from conferences, which potentially raises issues regarding the quality of the reviews. Finally, even in the most recent reviews (Anwar et al., 2019; Xia & Zhong, 2018), no 2018 articles on the subject of ER for ages from 6 to 12 years are included, and the number of relevant studied articles which were published in 2017 was also minimal.