


Chapter 3

Theories and Practices Behind Educational Robotics for All

Amy Eguchi

 <https://orcid.org/0000-0003-1240-9228>

University of California, San Diego, USA

ABSTRACT

The chapter aims at helping educators and classroom teachers who are new to using educational robotics as a learning tool in their classrooms. It discusses the approaches using robotics as a learning tool - a tool perfectly suited for enabling constructionist learning in the classroom and how educational robotics can provide 'all' students motivation to learn STEM and computing science concepts. Educational robotics as a learning tool requires teachers as well as students to shift from traditional pedagogical approaches to learner-centered active learning approaches. The chapter discusses how the shift can be made in successful ways and provides guidance to pre- and in-service teachers on how to implement educational robotics as a learning tool to reach and attract 'all' students to promote their learning.

INTRODUCTION

When the novel coronavirus, officially named SARS-CoV-2, which causes Coronavirus Disease 2019, known as COVID-19, hit the U.S. and the world in early 2020, people did not realize how it would potentially change the world forever. Some might fear the changes. Others may embrace them as they bring new opportunities for growth into the future. The changes that a crisis brings into our society could be turned into new opportunities to make the future better (Everly Jr., 2020). COVID-19 pandemic has highlighted or justified the roles of robots and artificial intelligence (AI) in our society. There have been more needs for using robots in the medical field, such as Blue Ocean Robotics' UVD Robots used for disinfecting against viruses (McCall, 2020). Amid COVID-19, Rwanda has announced the use of robots that perform a number of tasks to manage and track the risk of coronavirus infection. Their robots can screen up to 150 people every minute for symptoms of the virus, including temperature and dry coughs (Salaudeen, 2020). It is also reported that a growing number of robots 'work' inside restaurants and out on the street delivering food (Lee, 2020; Metz & Griffith, 2020). Before the pandemic, many people

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feared that robots and AI would result in people to losing their jobs (Howard & Borenstain, 2020). It seems that those worries have become less of a concern now that AI-enhanced technologies are helping us by mitigating the spread of Coronavirus. An increased number of robots are out in society to do the jobs that we cannot do because of stay-at-home orders.

Two decades ago, Hendler shared his observation:

A funny thing is happening in the field of robotics. A revolution is occurring without being noticed by many in the robotics research community. The robotics journals and conferences have largely missed the fact that robots are starting to leave the laboratory and make it out into the world. (Hendler, 2000, p.2)

Robots have been around in our society for almost two decades. The acceleration of AI development and the 2019 pandemic have contributed to the growing number of robots visible in our lives. Whether humans are ready or not, the various roles that robots and AI-enhanced technologies take on in our society will continue to grow.

Two decades ago, when robots started to leave laboratories, they also began to journey into schools as well. Since then, robots have played an increasingly important role in making learning *fun* (Eguchi, 2012) following a pedagogical approach that believes playful learning shapes the future of the world (Edwards, 2008). Robots excite and spark curiosities in children and adults with playful minds. Robots stimulate excitement and enthusiasm when children learn through building and programming them (Bers, 2008; Bers et al., 2014; G. Chen et al., 2017; Eguchi, 2012; Leonard et al., 2016). The use of robotics in education has grown in popularity among educators since early 2000 (Berns et al., 2005; Carbonaro et al., 2004; Eguchi, 2012; Mataric, 2004; Miller et al., 2008; Ospennikova et al., 2015; Papanikolaous & Frangou, 2009). Robotics in education falls largely into three categories – robotics as a learning objective, a learning aid, and a learning tool.

Robotics as a learning objective focuses on learning the knowledge and skills necessary for professions in computer science, robotics, AI, and engineering (Miller et al., 2008). Robotics as a learning aid focuses on the use of social robots in educational settings such as robotic language tutors and teacher assistants (Chang et al., 2010; G. Chen & hang, 2008; J. Chen et al., 2009; de Jong et al., 2018; Li et al., 2009). For example, Roybi, Inc. developed an affordably priced robot that can teach multiple languages (<https://roybirobot.com/>). Social robots have been also used as an intervention for students with autism spectrum disorder (e.g. Changchun Liu et al., 2008; Feil-Seifer & Mataric, 2008b, 2008a; Kim et al., 2013; Krane, 2010; Miller et al., 2008; Roth, 2009; Scassellati et al., 2018; Simut et al., 2016).

Robotics as a learning tool, which is the focus of this chapter, makes use of robots to spark children's imagination (Li et al., 2009) and engages them in further exploration and learning (Miller et al., 2008). As a learning tool, it has changed the way students learn. The United States government highlights the need for fostering the skills in addition to the content knowledge necessary to solve complex problems in society (U.S. Department of Education, 2015).

In a world that's becoming increasingly complex, where success is driven not only by what you know, but by what you can do with what you know, it's more important than ever for our youth to be equipped with the knowledge and skills to solve tough problems, gather and evaluate evidence, and make sense of information. (para. 2)

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