Chapter 10
Designing Tools and Activities for Educational Robotics in Online Learning

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ABSTRACT

The COVID-19 pandemic and the subsequent school closures created several challenges for teachers and students. From one day to the next, teachers had to rethink their educational activities and move to remote learning. Especially with regard to educational robotics activities, which makes large use of physical artefacts, this abrupt shift towards online learning represented a major change in how activities had to be designed and implemented. In this chapter, some experiences of online educational robotics activities carried out in compulsory schooling and teacher training are presented. The experiences are then discussed using a model for the development of educational robotics activities in order to reflect on how to design such activities that can be carried out online. The examples presented in this chapter showed there is great potential for educational robotics in online learning.

INTRODUCTION

The Covid-19 pandemic has affected many areas of our lives on an unprecedented scale, the educational system included. Almost overnight, educational institutions had to move from the traditional classroom in person setting to emergency remote learning (Hodges, Moore, Lockee, Trust, & Bond, 2020). Teachers

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as well as students faced the challenge of adapting to this new reality in order to enable a continuation of courses in online learning formats. On the one hand, both teachers and students had to cope with technical challenges caused by the immediate and increased use of sometimes unfamiliar technological media such as new video conferencing tools, online discussion platforms or lecture recording software. On the other hand, and even more importantly, teachers had to think how these tools could effectively be used for teaching and learning activities, and redefine their practices. This was especially in regards to educational robotics activities, with the abrupt shift towards online learning representing a major change in how activities had to be designed and implemented.

Educational robotics (ER) builds heavily on the idea of having tangible objects that learners can use and manipulate following the learning theories of constructionism and social constructivism (Papert, 1991; Resnick et al., 1998). Another important aspect of educational robotics classroom activities is the social interactions within work groups, allowing peers to learn with and from each other, following an educational approach to projects where collaboration between group members is required to achieve the final result (Ardito, Mosley, & Scollins, 2014). Replicating these elements in online learning, where students and teachers are working from home poses significant challenges. Nevertheless, different efforts have been made before and during the pandemic to enable the implementation of educational robotics activities in online learning scenarios. To design meaningful ER online activities, it can be helpful to build on existing models and conceptualizations such as the Educational Robotics Learning System (ERLS) model (Giang, 2020). It was devised to support developers and educators in the design of ER tools and activities is based on the idea of instructional alignment (Cohen, 1987; Biggs, 2003).

The objective of this chapter is to provide an overview of different approaches to ER online activities explored in recent years. The advantages and challenges of these approaches are discussed on the basis of six examples, with a particular emphasis on instructional alignment as described by the ERLS model. Specifically, we illustrated how tools and activities have been designed to facilitate meaningful online learning experiences. The next section provides a brief introduction to the concept of instructional alignment and the ERLS model. Thereafter, we present three examples describing ER online activities designed for compulsory school students. Finally, another three examples illustrate how online learning can be leveraged to train teachers in the field of ER.

BACKGROUND

Instructional alignment is a well-established principle that has guided curriculum planning for a significant amount of time. It considers the interplay of three components: intended outcomes, instructional and assessment processes (Cohen, 1987). Previous work has shown that consciously aligning these components can result in significant improvements of student achievement (Mitchell, 1999; Wonder-McDowell et al., 2011). By linking the ideas of instructional alignment with the learning theory of constructivism, Biggs (1996) introduced the concept of *constructive alignment*. He particularly emphasized the importance of considering teaching and learning as a system, in which ideally "all aspects of teaching and assessment are tuned to support high-level learning" (Biggs, 2003, p.1).

Based on the ideas of constructive alignment, the Educational Robotics Learning System (ERLS) model was devised as a conceptualization of instructional alignment in the context of ER activities in classroom education (Giang, 2020). The model consists of four main components (Figure 1): intended learning outcomes, instructional activities, assessment activities and ER artifacts (i.e., robots, interaction/