Chapter 6
Instructional Design to Foster Computational Thinking Using Educational Robotics

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ABSTRACT

The way of approaching the difficulties in technological areas is opening potentialities for teaching and learning, considering the competences as actions that put into practice skills to solve problems. A clear example is the computational thinking that proposes a way of thinking and facing different challenges. Through the design-based research methodology and the ADDIE model, an instructional design is proposed to carry out activities using educational robotics, analyzing its impact on skills related to computational thinking. An educational intervention is carried out with students from 13 to 15 years old from the three grades of secondary education in Mexico. It was established that the student's reaction to a challenge is: a) Due to lack of confidence in his or her own abilities, it is difficult for him or her to face the problem. b) Knowledge of computer thinking allows him or her to think of a strategy to try to solve it. The results suggest that those who have notions about computer thinking have more facility to think and face the different challenges.

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INTRODUCTION

In recent decades, different issues have been raised and discussed regarding the competencies that students should develop at different levels of the education system, seeking to prepare students in increasingly earlier stages with skills that will allow them to face 21st century jobs (Keevy & Chakroune, 2015). On the other hand, ways have also been sought to involve teachers in the development of digital competencies so that they can update their educational practice (INTEF, 2017).

Placing the competencies in students considered to be of the 21st century, different scenarios were found such as the Partnership for 21st Century Learning (P21) which determine a framework for 21st century learning where it defines and illustrates the skills and knowledge students need to succeed in work and life, distributed in three categories (Battelle for Kids, 2019), or the Assessment and Teaching of 21st Century Skills project (ATC21S) which defined ten 21st century skills into four broad categories (ATC21S, 2012), in this way it is possible to find different proposals that make clear the lack of a general framework of competences.

Another competence that has become more relevant in recent years are those related to the STEM disciplines, an acronym for Science, Technology, Engineering and Mathematics, which represents a way of looking at education, and a way of learning together with other disciplines, one of the main goals in any STEM program is to know and use the different learnings individually or together for problem solving. According to Glancy & Moore (2013) the strategies employed individually in each of these disciplines are: logical and deductive reasoning in mathematics, design thinking in engineering, research in science, and computational thinking in areas of technology.

Before wanting to integrate all the disciplinary areas in the solution to a specific problem, it is necessary to start with only one, to identify and know in depth the strategies that it uses and the skills that are derived, to know when to use one or another, depending on the need or situation that you want to solve. However, computational thinking has become an essential competence because of its approach to solving problems in a variety of disciplines (Barr & Stephenson, 2011), and one of the increasingly common tools for fostering this type of competency is educational robotics (Valcárcel & Caballero, 2019; Sisman & Kucuk, 2019; Esteve-Mon, Adell-Segura, Llopis, Valdeolivas & Pacheco, 2019).

According to the needs of teachers and students, an instructional design is proposed for the creation of activities that encourage the development of computer thinking through the use of educational robotics. Design-based research, the phases of the ADDIE model and the elements that make up a didactic sequence have been used as a basis. The project was carried out in a Secondary School in the State of Mexico.

BACKGROUND

Computer Thinking

Wing (2006) introduced the term *computer thinking* as a fundamental skill that can be used by anyone and that is not only exclusive to those involved in computers, proposes to add computer thinking to the analytical capacity of each child in their daily activities such as reading, writing and arithmetic. Furthermore, it mentions that computational thinking involves problem solving, system design and understanding human behavior, based on the fundamental concepts of computer science.