Chapter 10
Introducing Computational Thinking Unplugged in Early Childhood Education Within the Context of Physical and Natural Science Courses:
A Pilot Study in Greece

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ABSTRACT

In the contemporary digital era, introducing computational thinking concepts is considered an imperative need at all stages of schooling, since they are inextricably linked to skills applicable and beneficial in everyday life. This chapter presents a novel educational framework that aims to foster the growth of computational thinking at early childhood stages, within the context of physical and natural science courses, pursuing the unplugged philosophy and following the principles of game-based, project-based and collaborative learning. This chapter also presents a relevant pilot study, conducted with second grade students of a Greek primary school, with the objective of assessing the feasibility of the proposed educational framework, as well as examining its effectiveness. The results stemming from the pilot are promising and reveal that the proposed approach serves our goal to enhance computational thinking at the first stages of schooling through engaging and fun educational activities that appeal to young students.

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INTRODUCTION

Nowadays, computational thinking is considered a significant competency for all the productive members of a contemporary society. In fact, by the end of the century, it is expected to evolve to a fundamental skill, just as reading, writing and arithmetic are at present (Wing, 2006). The Next Generation Science Standards include mathematics and computational thinking in the list of the proposed practices for K-12 science classrooms (National Research Council, 2012), although its kick-off incorporation in educational process is suggested in grades 3-5. Nevertheless, recent literature proposes its introduction even at the first stages of schooling (Angeli et al., 2016; Kanaki & Kalogiannakis, 2018; Kazakoff, Sullivan, & Bers, 2013; Papadakis, Kalogiannakis, & Zaranis, 2016; Sullivan & Bers, 2016; Sung, Ahn, & Black, 2017).

Since computational thinking has been acknowledged as an important learning objective for all students in K-12, various educational techniques have been presented in order to illustrate how its concepts could be introduced in several grade levels and discipline areas (Barr, Harrison & Conery, 2011; Hsu, Chang & Hung, 2018; Kanaki & Kalogiannakis, 2018; Mannila et al,. 2014; Sung, Ahn, & Black, 2017; Voogt, Fisser, Good, Mishra, & Yadav, 2015). These techniques could be grouped into three basic categories: (a) the ones that are computer-based, (b) those that do not use digital technology i.e. the unplugged ones and (c) the techniques that employ tangible computing (Wohl, Porter, & Clinch, 2015).

Our purpose is to present an unplugged educational framework for cultivating fundamental computational thinking concepts at early childhood stages. The proposed framework is grounded in project-based, game-based and collaborative learning. It exploits the benefits of retrieval practice, since the subject of the relevant educational activity should have already been taught earlier in the school year. It employs peer feedback and is developmentally appropriate for children ages 6-8. It is designed to be applied within the context of the study of the environment, which encompasses the study of physical and natural sciences and is one of the basic courses of the primary school curriculum in Greece (Kalogiannakis & Kakadiaris, 2017; Kalogiannakis, Ampartzaki, Papadakis & Skaraki, 2018; Kalogiannakis & Papadakis, 2019).. Its most noteworthy characteristic is that it focuses on exercising children's basic computational thinking skills, even though no specific reference is made to these skills (http://physgramming.edc.uoc.gr/unplugged/main.html).

The proposed educational approach is designed to be simple and engaging. The simplicity is achieved through activities that are appropriate for the age of the target group and can be easily understood after a short explanation. Its engaging character is based on the attractive and playful character of the educational activities. Moreover, collaborative creativity is cultivated as children are motivated to work in groups in order to reach a common goal (Anastasiades, 2017). Students become active in an educational environment that builds unity between the members of a group and focuses on the exchange of ideas and the negotiation of perceptions (Glăveanu, 2011).

The pilot was conducted attuned to the ethical guidelines of educational research in a primary school in Greece, in May 2018. The target group was 17 second grade students (9 girls and 8 boys). Besides us, who were responsible for the implementation of the whole attempt, the class teacher also participated in the pilot. To establish the credibility of the research, a computer scientist with long experience in teaching also participated as an external observer.