Chapter 21
Home Design Using Robotic Devices:
3D Bioclimatic Home Design Utilizing Arduino

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ABSTRACT

Programming and robotics are critical thought-provoking concepts that shape STEM courses within secondary schools today. Their use in creating engaging, skill-building projects in technology education is constantly increasing worldwide. In this work, a novel learning scenario aiming at the design of 3D bioclimatic spaces is proposed. It combines Arduino microcontroller with 3D printing devices. The scenario is appropriate for the last grades of P-12 students and can be easily implemented in every secondary high or vocational school. It is fully compliant with most national ICT curricula adopted. The main objective is that students will enhance their critical thinking capacity, increase the level of digital literacy, and develop design skills by exploring and constructing appropriate 3d space models.

INTRODUCTION

City building blocks today embed technologies inside their very own physical structure. ICTs are fluctuating ubiquitously in all vital living spaces, interacting with the other social, physical, and psychological dimensions. This is particularly important for homes, where people spend most of their lives and even more, in the contemporary hygienic restraint conditions. The transformation of elements of modern internal living balancing with the preservation of traditional ethics create a critical tradeoff for the sus-

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tainability of healthy and quality life paths. The idea could also apply to school buildings, where public education is deployed for large pupil congregations.

The rapid digitization of every part of our lives is, today, unprecedented. Schools are the incubators of our future society. They at once sense, through their sensitive probes, the waves of forthcoming changes and embed them into their knowledge infrastructure, developing the necessary skill sets for their students. Robotic devices and architectural design nicely converge to the core of a STEM school curriculum (National Research Council, 2011), which provides students with a captivating piece of learning science and shows a promising career path.

Undoubtedly, robotics and programming are one of the most challenging courses in technology curricula within our schools today. Applying this kind of technology to the manifold of our students' living spaces creates a fascinating endeavor. Using inquiry-based instruction techniques, a novel learning scenario proper for last grades P-12 students is proposed, aiming at the design of 3D bioclimatic inner spaces and utilizing suitable robotic devices (e.g. Arduino). This innovative project can be easily implemented in every secondary high or vocational school, as it requires minimal resources and is compliant to the national ICT curricula issued by the Ministry of Education. It naturally implements a STEM course since it combines educational technology and learning with robotics and programming skills.

BACKGROUND

Why is programming such an attractive course in school curricula? Why do children have to develop coding skills? Why do teachers embed computer-based activities into their daily practice? Because programming is a much valuable skill as it promotes creativity, teamwork, logical reasoning, mathematical intuition and problem-solving skills (Brennan, 2009; Berry, 2013). In general, it helps students develop their own thinking paths, not following instructions, thus it paves the way for computational thinking (Papadakis, 2019).

This situation comes along with difficulties. A major one occurs during in the construction of an algorithm or program (Papadakis et al., 2016; Tollervey, 2015). According to the classical teaching approach, students in the beginning are taught a general-purpose language (Pascal, Basic, C, Java, etc.). This choice is problematic, as those languages include multiple commands which in combination with formal structural and grammatical details form a large amount of information that must be mastered by the students. This forces them often, to be more concerned with the language technical details and not focused on fundamental concepts and programming techniques. Papadakis et al. (2017) suggest the combined use of appropriate activities and solving selected problems in a computer lab using real programming language environments (programming languages like C, C++, Java, Python which are widely used in programming contemporary software and hardware systems).

A combined approach to learning programming recommends appropriate teaching environments that on the one hand help students solve problems and on the other effectively address the aforementioned misconceptions and difficulties (Papadakis & Orfanakis, 2014; Papadakis & Kalogiannakis, 2019). This approach emphasizes on the pedagogical design for teaching novice programmers, as the emphasis will shift from teaching a strict language syntax to the development of critical and analytical thinking through problem solving (Papadakis et al., 2016).

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