Chapter 24
Building a Design-Centered STEAM Course

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ABSTRACT

This chapter presents the blended-learning, project-based high school STEAM (science, technology, engineering, art, and mathematics) course that has been developed and delivered at the American Community Schools (ACS) Athens. The STEAM course fosters data literacy; critical, creative, and computational thinking; and problem-solving. The topics range from the internet of things, artificial intelligence, and data-based investigations to an introduction to aerospace, electrical, and architectural engineering, in the context of the Fourth Industrial Revolution. Computer-aided design software and the design thinking methodology are the major creative tools students use to experience immersive STEAM learning. The content of the course is described in terms of learning goals, instruction, and assessments, accompanied by instructional material. The transition of the STEAM course to an online setting is also discussed, and the author's reflections are shared.

INTRODUCTION

In blended learning programs face-to-face instruction is combined with computer-mediated instruction (Graham, 2006). Within this theoretical framework lies the learner-centred i²Flex model that ''integrates student independent, inquiry-based learning that is guided and monitored by faculty with face-to-face, technology-supported learning'', being flexible in terms of time, pace, place, and/or mode (Avgerinou & Gialamas, 2016).

This chapter presents the development and delivery of the American Community Schools (ACS) Athens i²Flex STEAM (Science, Technology, Engineering, Arts, and Mathematics) high school course (Karampelas, 2019a; 2019b) in terms of curriculum, instruction, assessments, and reflections. The STEAM course aims in providing high school students with knowledge and skills regarding its constituent disciplines that are important under the context of the Fourth Industrial Revolution (Schwab, 2016) of

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cyber-physical products. Relevant emerging fields are, indicatively, the Internet of Things, 3D printing, Artificial Intelligence, autonomous vehicles, reusable rockets, and nanotechnology.

The importance of STEM (Science, Technology, Engineering, and Mathematics) has been repeatedly emphasized and relevant strategies for STEM education have been announced (e.g. STEM for All, 2016; National Science & Technology Council, 2018). Recently, a movement from STEM to STEAM has been considered as a way of further engaging students with creative thinking under STEM investigations (Allina 2017; Psycharis, 2018; Perignat & Katz-Buonincontro, 2019; Psycharis et al., 2020). While integration of the Arts and creativity into STEM can take various forms, the author's implementation into the presented high school course mostly refers to the broad use of Computer-Aided Design and the Design Thinking methodology (Szczepanska, 2019; Chung, 2020; Kolko, 2020).

The Chapter's objective is to present the i²Flex (blended) high school STEAM course that has been developed and delivered at the American Community Schools (ACS) Athens.

INSTRUCTIONAL DESIGN CONSIDERATIONS

Contributing into equipping high school students with knowledge and skills of the Fourth Industrial Revolution was the main drive of the author while building the STEAM course. Therefore, timely content was included in this course's syllabus like, indicatively, Artificial Intelligence and Aerospace Engineering, with the common reference of the Fourth Industrial Revolution allowing for connecting the dots between the different disciplines introduced to students. With the need to guide students beyond building awareness and interacting with novel content toward the higher order thinking required for brainstorming and creating solutions, creativity emerged as the most important element of the STEAM course. Consequently, the assessments were designed to provide students with opportunities to be creative through imagining solutions, sketching and, most importantly, through using Computer-Aided Design (CAD) software to build virtual worlds. In need of a structure to both guide the instructional design and facilitate the students' learning in the classroom, the author employed the Design Thinking methodology. Through empathizing, defining, ideating, prototyping, and fine-tuning, the author made decisions about what content to introduce students to and how to improve its delivery and assessment. Similarly, having students observing their achievements through the lens of the aforementioned creative phases during large-scale projects was an intentional attempt to foster a sense of meaningful progression and overall purpose of consecutive assessments.

Furthermore, the instructional design allowed for students' voice and choice when possible, especially regarding suitable design software, as well as for opportunities for students to communicate their work between each other. Finally, and in accordance with introducing timely content and skills for the future, the STEAM course was designed to be a blended-learning one, shifting the centre of gravity from a teacher-centred approach to a student-centred, teacher-facilitated delivery. The familiarity of the author with the i²Flex methodology (Sidiropoulou et al., 2021) was instrumental in creating blended-learning experiences for the students.