Chapter 13
i9MASKS Project:
A Learning-by-Doing Summer Experience With Engineering Students

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ABSTRACT

Engineering education is a challenging topic that has been deeply explored in order to provide better educational experiences to engineering students, and the learning by doing approach has been appraised. Amidst a global pandemic, an engineering summer program denominated i9Masks emerged and aimed to create transparent facial masks for preventing the virus spreading. This project had the participation of 21 students from different engineering areas, as well as professors and monitors whose guidance and commitment were of great importance for its success. Aiming to understand the importance of this engineering hands-on project for students' training, two inquiries were applied, being one for students and the other for professors and monitors/researchers. Students described this initiative as an amazing and innovative experience that they would like to repeat and considered useful for their careers. Regarding the impact perceived by the teaching staff, the results proved that they enjoyed participating in the i9MASKS project and sharing knowledge with students in a practical way.

INTRODUCTION

Engineering and science are complex and demanding topics to teach since the theoretical concepts have to be taught and well assimilated by students, but the practice is the key in engineering education (Carlson and Sullivan 1999; Saravanan et al. 2021). For this reason, engineering teachers must have the ability to go beyond theory teaching and try whenever possible to propose practical activities so that students can visualize and apply what they learn in the classroom (Hackathorn, Solomon, Erin D. Blankmeyer, and Tennial, Rachel E. Garczynski 2011). In this sense, different methodologies have been implemented in order to improve and better prepare engineers for professional challenges that will eventually emerge in the future, such as active learning pedagogical frameworks (Freeman et al. 2014; López-Fernández et al. 2019). Students are engaged in the learning process and develop teamwork skills and the ability to operate in technology-enabled environments. These practices have been applied and investigated in different engineering areas, such as electrical engineering (Saravanan et al. 2021), aerospace engineering (López-Fernández et al. 2019), materials engineering (Renuka 2021), and software engineering (Ma et al. 2014), among others, and for engineering education in general (Arulanand, Babu, and Rajesh 2020; Freeman et al. 2014; Ricaurte and Viloria 2020).

Overall, it has been shown that active learning has a positive impact on students motivation and learning (López-Fernández et al. 2019), supporting the use of active learning in regular classrooms, and therefore, the continued use of traditional lecturing have been raised questions (Freeman et al. 2014). Unfortunately, with the pandemic crisis of COVID-19, educational institutions were forced to close and recreate/improvise their teaching methods promptly with the rapid transition to online learning which extremely affected students' learning in higher education (Bestiantono, Agustina, and Cheng 2020; Chaturvedi, Vishwakarma, and Singh 2021; Khan et al. 2020). Despite the endeavor and work of professors to teach and capture the attention and interest of students, some investigations have shown that the quarantine caused disturbances on students such as stress, frustration, and in many cases, depression. Due to the impossibility of carrying out in-person practical activities, the learning process was hindered more and affected the assimilation of the concepts taught. Thus, to resume in-person activities in higher education institutions, the Foundation for Science and Technology – FCT created an initiative denominated "Summer with Science". The special support provided by FCT allowed researchers and professors to develop innovative projects related to the COVID-19 pandemic. This initiative was very enriching for the students but also for the teaching team, researchers, and monitors, as they had a different summer with their hands-on science and developing tools to help fight the pandemic. i9Masks was one of the projects developed at the University of the authors of this paper. As the name indicates, this project intended to develop innovative masks for preventing the virus' spreading. Given that traditional masks hide our facial expressions, emotions, and hinder communication, the i9Masks project aimed to develop transparent facial masks by using a silicone elastomer, frequently used in several biomedical applications (Carvalho et al. 2020; Carvalho, Gonçalves, et al. 2021; Carvalho, Rodrigues, et al. 2021; Catarino et al. 2019; Faustino et al. 2016; Rodrigues et al. 2020; Sadek et al. 2021), while ensuring the protection effectiveness against the virus.

i9Masks project joined students of electrical, mechanical, physical, biomedical, and industrial engineering from two universities and Polytechnic institute, and they worked as a team with researchers and professors, acquiring multidisciplinary and ground-breaking knowledge in various scientific areas in a "learn by doing" way. They had the opportunity to learn about rapid prototyping, computer-aided design, 3D printing, microfabrication and microfluidics techniques, numerical simulations, microelectronics

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