Chapter 8
Using 3D Printing as a Strategy for Including Different Student Learning Styles in the Classroom

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ABSTRACT

This chapter aims to explore the contribution of 3D printing technologies as a collaborative resource in higher education teaching. It was conducted in the course "Physics of Materials," in which the contribution of practical experience in the learning process was analyzed and the degree of interest, motivation, and understanding by students on academic content was assessed. Practical demonstrations with resources prepared by 3D printing can be a very motivational learning facilitator. To this end, the learning styles of students were determined through the Honey-Alonso learning styles questionnaire (CHAEA). A second questionnaire was used to obtain information about the motivational importance of 3D printing technology in teaching activities in the classroom. The authors concluded that 3D printing can positively help teachers to improve students' engagement and proactive behavior, as well as teaching environment, by including different methodological styles in the learning process, particularly in courses with a significant theoretical content.

INTRODUCTION

The concept of 'styles' related with 'learning' was first put forward by cognitive psychologists. *Tan Dingliang (1995, cited in Jinjin Lu, 2014, p.36)* defines learning styles as: 'the way that a learner often adopts in the learning process, which includes the learning strategies that have been stabilized within a

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learner, the preference of some teaching stimuli and learning tendency.' *Reid (1995, p.12)* summarizes previous definitions of learning styles *(Dunn & Dunn,1978; Keefe, 1979; Brown, 2002, p.10)* as: 'internally based characteristics of individuals for the intake or understanding of new information'. Essentially, learning styles involve how a person perceives, processes, uses, and manipulates information to facilitate learning. This chapter attempts to establish how 3D printing can play a role in the classroom to achieve a more efficient learning, particularly in engineering education.

Student learning styles are increasingly studied around the world *(e.g. Sánchez-Martín et al, 2017; Parrish, 2016; Hames & Baker, 2014; Cagiltay, 2008; Edward, 2001; Hench, 1993)*. This is mainly due to the importance that each student has as a social, independent, human being, with individual aspirations and needs. Students can be proactive and engaged or, alternatively, passive and alienated *(Ryan & Deci, 2000)*. Thus, keeping motivation when approaching academic contents requires innovative and motivational teaching methods *(Acca & Aicwa, 2010)*. Consequently, the better one knows the characteristics of students who share the same environment, the easier it is to maintain good social relationships and develop the necessary skills for success *(Edward, 2001)*.

Modern higher education institutions require flexible teaching and learning practices, focused on new technologies, and providing greater efficiency in acquiring knowledge *(European Commission, 2014)*. Technology can change the classroom experience *(Laurillard, 2013; Acca & Aicwa, 2010)*. The teaching methods used in the classroom should provide a favorable environment for the development of self-work skills. Knowing how to learn tends to be a key skill for innovation and experience in modern communities and workplaces, which tend to be more demanding *(European Commission, 2014; Pacific Policy Research Center, 2010)*. Therefore, it is important that teaching, and, in particular, the teaching approach (as well as methods and techniques employed), addresses the development of those particular skills.

Towards this goal, teachers could consider the different students' learning styles. To address real-world needs/problems, teaching should focus on diverse approaches, strategies, materials, and resources to ensure effective communication for most students and their individual styles *(Pacific Policy Research Center, 2010; Honey & Mumford, 2000; European Commission, 2014)*.

This chapter begins by describing the theoretical models about teaching and learning. Subsequently, it characterizes learning styles and then focuses on experiential learning using 3D printing technology.

The key results of the chapter follow from a comparison of the learning styles among higher education students (in order to understand how 3D printing technology can play a role on their learning process and support their learning style). From that, a discussion is provided on the importance students assign to this technology in the classroom, followed by a discussion on whether that experience can motivate students' interest in an academic content. Finally, some conclusions are drawn regarding the global perspective of the potential role of 3D printing in engineering education.

THEORETICAL MODELS OF LEARNING: PROGRESSION AND MODERNISATION

Selecting the most appropriate teaching method for student's knowledge acquisition is a vital process *(European Commission, 2014)*. Over many years and students' generations, several teaching models have been developed *(Parrish, 2016)*. There are two main teaching methods: direct (teacher-centered) and indirect (student-centered). In direct teaching methods, teacher gives the information or step-by-step instructions directly to the students (e.g. information, facts, rules, action sequences). This is the most