Promoting diversity and increasing equity for all through open access to university's digital fabrication facilities

Covadonga Lorenzo, Epifanio Lorenzo
CEU University, Spain

Abstract

Promoting diversity and increasing equity are goals shared by many European universities, but achieving these aims in the classroom is often hard to do. The present paper illustrates innovative educational approaches carried out at Fab Lab Madrid CEU, the digital fabrication laboratory based at CEU University, to provide knowledge more accessible for all through new learning opportunities and open access to digital fabrication facilities. To do so, it makes use of three case studies that describe the practical outcomes of workshops in which students engage with remote access to digital fabrication technologies through a platform designed for the European Union NEWTON project. The platform is an innovative tool that provides educational content and new solutions for technology-enhanced learning to increase learner quality of experience for all.

1. Introduction

Drop-out rates of studies in Spain are one of the highest in the European Union: in 2017, 20% of Spanish youth between 18 and 24 years were registered in the statistics of Early School Leaving (AEP). Social class is the factor with the highest incidence in the risk of dropping out of school, and is attributable by 50%. This percentage is explained by issues such as economic difficulties, but mainly by "the differences in the cultural capital of the students" and "the absence of family and institutional support networks". [1] Unfortunately, educational exclusion is one of the main problems of social exclusion. Moreover, if we consider, not only disadvantages but learning difficulties and disabilities as potential limitations for college success, the number of students in risk of education exclusion increases. Students with disabilities are an at-risk population, sometimes absent from the diversity groups. [2] It seems that developing new approaches for equitable education for the growing diversity of students at the university level has become an imperative.

2. Objectives

Education seems to be the main way to avoid exclusion and, from Fab Lab Madrid CEU, the digital fabrication laboratory based at CEU University, promoting diversity and increasing equity for university students has become a mayor goal, through the implementation of initiatives that allow instruction and open access to digital fabrication facilities for young people of vulnerable social environments in disadvantage and students with disabilities and learning difficulties.

Our main objective is to enhance social inclusion and social cohesion in the education system at university level by promoting the use of new technologies. It should be achieved through specific objectives, as finding new educational approaches and materials for inclusive activities in the university's courses; enhancing the capacities of all university students for designing and fabricating, acquiring important skills required in the job market and finally, improving professors' competences and practices for inclusive education.

3. Methodology

The paper describes three case studies that show the practical outcomes of workshops in which students engage with remote access to digital fabrication technologies thanks to the Cloud Hub application created for the NEWTON project, which is a large European Union project focused on the integration of new solutions for technology-enhanced learning, that enables learning content use and supports the generation of new material and content exchange among students to increase learner quality of experience for all.

The case studies' participants include students that come to the university classroom with different backgrounds and cultural contexts, some of them at risk of poverty and social exclusion and some others with disabilities. Workshops are focused on introducing students to the use of digital fabrication technologies and offers remote access to Fab Lab machines, which includes laser cutters, 3D printers,

milling machines, 3D scanners, traditional hand tools (saws, drills, hammers, chisel, etc) and an electronics lab with design tools and test equipment. Fab Labs have been proven as attractive models of education, particularly as places to provide training in a wide range of areas from design thinking to product development, [3] to teach courses at the university facilities to motivate high-school students on their future careers [4] or to use next generation technologies on active learning activities. [5]

Our paper will show that Fab Labs not only help in acquiring technical skills but also in encouraging social interaction promoting diversity. To that end, workshops are designed to follow a project based learning approach, where students work collaboratively on the design and fabrication of a prototype. They start with a short introductory talk on digital fabrication, showing possible applications of Fab Lab technologies in different disciplines and fields. Later on, students are trained on the use of the Cloud Hub application [6] that allows to easily using Fab Lab machines remotely, so that students send their designs to be fabricated even if they are not physically in the Fab Lab. Finally, students are required to develop a group assignment to show the skills learned on the class and encourage interaction and problem solving collaboratively.

The first workshop was focused on the implementation of the design of a low-cost newborn incubator to be sent to the Public Hospital in Makeni (Sierra Leone). 15 students in disadvantage were trained on the use of design software to improve the existing prototype attending the prerequisites stated by the hospital. After that, students were required to work collaboratively during a week preparing and sending their files through the Cloud Hub app. Files were sent to a Raspberry Pi, connected to the CNC machine. Using the app, students select the Fab Lab machine to be used and the material to be milled. The platform is designed to assign all the parameters needed to mill the pieces. Finally, students meet together at the Fab Lab to assemble all pieces and discuss results with Fab Lab instructors.

The second workshop involved 15 students with disabilities coming from Fundación Oxiria that were studying a Diploma on Floristry at ISEP CEU. The challenge was the design and fabrication of 3D flowers using a 3D Printer and open software. To that end, students started designing the pieces before using 3D printers to make a bouquet of flowers. The aim was to show the applications of technology in their field, so that they can introduce 3D printing technologies on their everyday work as florists.

The third workshop involved 40 students that include 30 Peruvian architectural students in risk of social exclusion. They were trained on how to use Fab Lab technologies on-site and remotely through the Cloud Hub app to analyze which one help better to improve their academic results and promote their social interaction. They had to build a summer pavilion using remotely a vinyl cutter machine to make small-scale architectural models and after that, a laser cutter machine on-site to build a real size pavilion using recycled materials.

4. Results

Results reveal that digital fabrication laboratories not only help in acquiring technical skills but also in allowing social interaction and communication among students, promoting diversity and equity in the classroom. Findings also indicate that learners are more motivated when engaging in more personalization, collaboration and new pedagogical approaches that run between on-site and remote learning with the help of instructors who are confident in creating a richer educational environment available for all. Analysis has shown high degrees of student's motivation and satisfaction with social experiences from our academic programs on campus of a variety of diversity groups. We also found out high degrees of belongings and low degrees of social exclusion felt by students with disabilities, as well as good degrees of success with the use of Fab Lab technologies. Work is ongoing and although these experiences do not provide validation of the programs, they prove that it achieves its goals providing better educational practices for all. NEWTON project has received funding from the European Union's Horizon 2020 Research and Innovation program under Grant Agreement no. 688503.

10. References

[1] A. Tarabini, J. Jacovkis, and A. Montes, *Los factores de la exclusión educativa en España: Mecanismos, perfiles y espacios de intervención*, UAB & UNICEF, Spain, 2017.

[2] E. Kim and K. C. Aquino. *Disability as Diversity in Higher Education: Policies and Practices to Enhance Student Success*, Routledge, New York, 2017.

[3] C. Lorenzo, Improving Learning Process through Digital Fabrication. *EDULEARN Proceedings*, IATED, 2017.

[4] C. Lorenzo, Digital Fabrication as a Tool for Teaching High-School Students STEM at the University. *Interaction Design Conference Proceedings*, Stanford, 2017.

[5] E. Lorenzo & C. Lorenzo. On Active Learning and Sharing through Digital Fabrication, *ICERI 17 Proceedings*, IATED, 2017.

[6] G. Cornetta, A. Touhafi, F.J. Mateos, and G.-M. Muntean, A Cloud-based Architecture for Remote Access to Digital Fabrication for Education, *CLOUDTECH Proceedings*, Brussels, 2018.