Assessment and recognition in technical massive open on-line courses with and without on-line laboratories

Sergio Martin, Manuel Castro, Elio Sancristobal, Gabriel Diaz, Felix Garcia-Loro, Clara Perez, Blanca Quintana, Rosario Gil, Pedro Plaza, Africa Lopez, German Carro

Electrical and Computer Engineering Department

Universidad Nacional de Educación a Distancia

Madrid, Spain

smartin@ieec.uned.es

Antonio Robles, Llanos Tobarra

Dep. Sistemas de Comunicación y Control

Universidad Nacional de Educación a Distancia

Madrid, Spain

arobles@scc.uned.es

Miguel Rodriguez-Artacho

Dep. Lenguajes y Sistemas Informáticos

Universidad Nacional de Educación a Distancia

Madrid, Spain

miguel@lsi.uned.es

Jose A. Ruiperez-Valiente

Teaching Systems Lab

Masschusetts Institute of Technology

USA

jruipere@mit.edu

***Abstract*—This paper describes the organization and results of several MOOCs delivered about technical topics (i.e., digital electronics, VHDL design on FPGAs, open education and OERs repositories and the use of STEAM technologies to encourage diversity and inclusion), where on-line laboratories have been used in some of them. An analysis of the enrollment, students participating on tasks or quizzes, drop-out rate and certifications requests have been done.**

Keywords—on-line laboratories, massive open on-line courses, MOOCs, assessment, drop-out rate, recognition, certificates.

1. INTRODUCTION

In4Labs is a Spanish project devoted to accelerating the transition of traditional industry towards Industry 4.0. It has as one of its tasks the creation of a Massive Open Online Courses (MOOC) about Industry 4.0 technologies including virtual and remote laboratories.

One of the main problems that we face in the design of MOOCs in technical disciplines is that students need to carry out practical activities. However, these activities are usually difficult to provide in MOOCs, where the main resources are videos or readings. It is here where virtual and remote laboratories play an important role. These educational tools allow students to remotely carry out these practical experiences [1] by using on-line simulators or real hardware but controlled remotely.

Studies on on-line labs have shown that students can benefit from their flexibility and thus strengthen their innovative capacity and logical thinking [2]. Platforms such as UNED Abierta already integrate this type of laboratory in their courses, and it is here where we will put the focus of study in this work [3].

This paper studies several technical MOOCs, ones containing on-line laboratories and others not, delivered in an OpenEdX platform (UNED Abierta) to study the drop-out rate and certifications requests in each one of them.

In particular, the research question to analyze in this paper is the following:

RQ: Do MOOCs including remote laboratories

The results of this paper may be of interest for those looking for design new MOOCs about technical disciplines, especially those thinking about including on-line laboratories as a resource in the course.

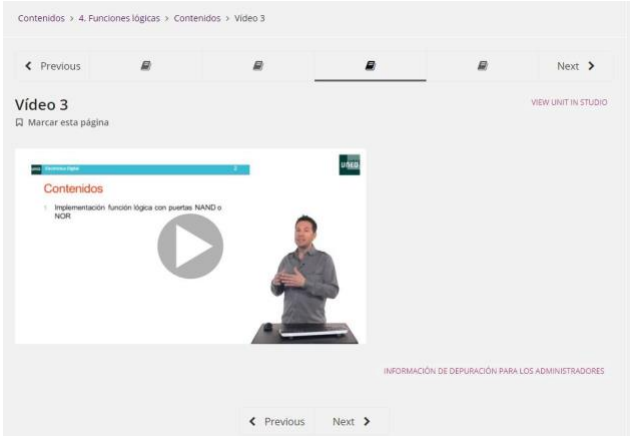

Fig. 1. Digital electronics MOOC section with a video-lecture.

The structure of this paper is as follows: Section 2, methods, describes the methodology followed in this study. Section 3, results, provides the data obtained from the studied courses. Finally, section 4 provides the analysis of the results and some conclusions.

2. METHODS

The methodology used to carry out this study is the following:

1) MOOCs definition. Among the decisions to take in the definition of this kind of technical MOOCs can be found the following ones: syllabus definition; type of assessment; type of interaction between students; and use of different type of credentials.. In particular, the following MOOCs were defined:

a) Introduction to Digital Electronics (Figure 1). This is a course about digital electronics with 5 modules covering different topics of digital systems, such as bool algebra, function simplification, logic gates, combinational circuits, flip flops, and sequential circuits (e.g., counters). This course includes 10-20 minutes video-lectures (Figure 1) and numerous interactive virtual labs (Figure 2) to allow students to practice what they learnt in the video-lectures [4].

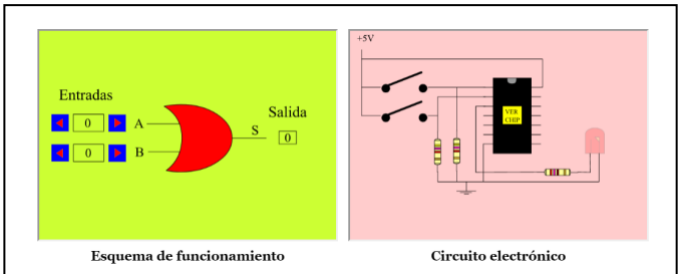

Fig. 2. Digital electronics MOOC section with an example of virtual laboratory.

Enjoying FPGAs: Foundations, simulation and practice. This course teaches everything you need to enjoy designing digital systems with FPGA devices. Students learn from the architecture of these devices to the use of commercial tools and real practice with remote laboratories. The course is based on short and entertaining videos, with a practice-oriented design thanks to the use of real devices through remote laboratories, provided by LabsLand (Figure 3). Therefore, it is not necessary to have an FPGA to be able to take the course and enjoy designing with real FPGAs.

b) Educational Robotics for all: gender, diversity, and inclusion in STEAM. This course focuses on the presentation of a combination of teaching methodologies, educational robotics tools, and a student learning management methodology. All of these topics are discussed in a way that focuses on strengthening the presence of women in engineering. This course includes 10-20 minutes video-lectures.

Foundations to Open Education and OERs repositories. This 5-week course is designed to provide a comprehensive understanding of the ways in which open education and open educational resources are changing the rules of education. The purpose of the course is to help faculty and professionals dedicated to education to understand the advantages of open education and how they can apply it to their everyday teaching. This course includes 8-15 minutes video-lectures and numerous reading materials. All the developed materials [5] (e.g., video-lectures, powerpoints, reading documents) were provided for download as open educational resources (Figure 4).

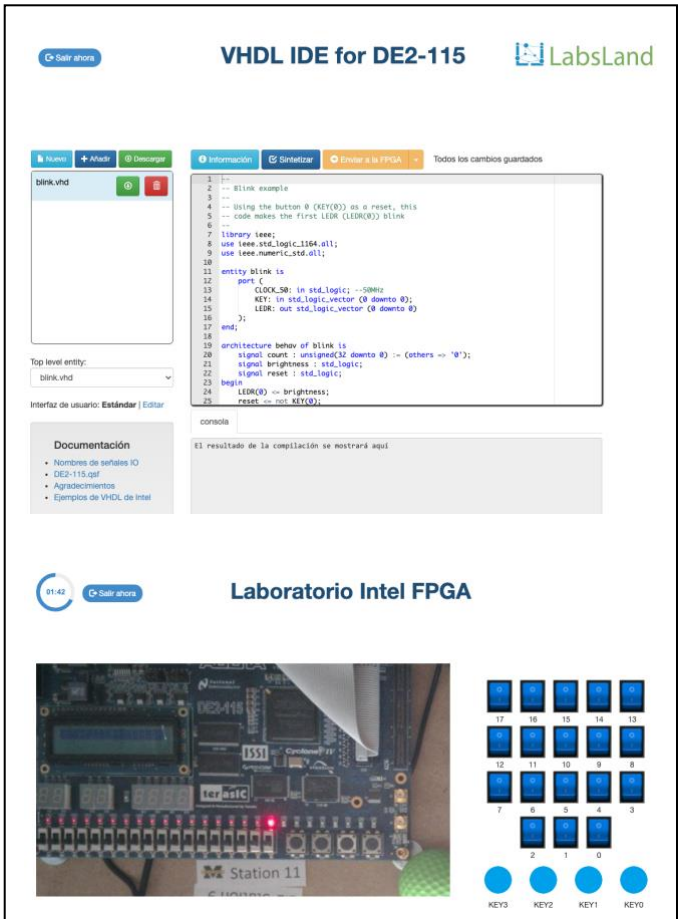

Fig. 3. Remote laboratory accessible in the Enjoying FPGAs MOOCs. IDE screen where the student writes the VHDL code (up). View of the webcam and the virtual control pointing to the remote FPGA laboratory (down).

2) MOOC assessment and interaction definition. The assesment and interaction on each one of the MOOCs were carried out as follows:

a) Introduction to Digital Electronics. The assessment was based on one quizz per module. Additionally, there was a pre-test at the beginning of the course and a post-test at the end, to allow the evaluation of the learning improvement. Finally, a satisfaction survey was provided at the end of the course. Students in this course were divided into two groups: experimental group, with access to video-lectures and virtual laboratories; and control group, with access to video-lectures and static images, instead of virtual laboratories. The interaction between students and the teaching staff was done through the course forums.

Enjoying FPGAs: Foundations, simulation and practice. The assessment in this course is organized through a final quizz test in each one of the four modules. Additionally, there are two peer to peer review tasks (modules 3 and 4), where students have to grade the VHDL designs of other students. The interaction between students and the teaching staff was done through the course forums.

b) Educational Robotics for all: gender, diversity, and inclusion in STEAM. The assessment in this course was done through a pre-test at the beginning of each module and a post-test at the end, to allow the evaluation of the learning improvement in each module. The interaction between students and the teaching

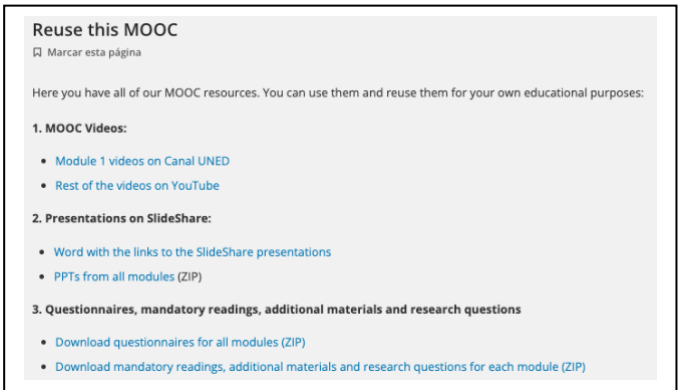

Fig. 4. Screenshot of the Foundations to Open Education and OERs repositories MOOC where all the developed materials are provided to the students as OERs.

staff was done through the course forums but also a social network activity was proposed. Students were encouraged to Tweet with the #STEAM4ALL hashtag about their advances in the course and some collaborative activities (Figure 5).

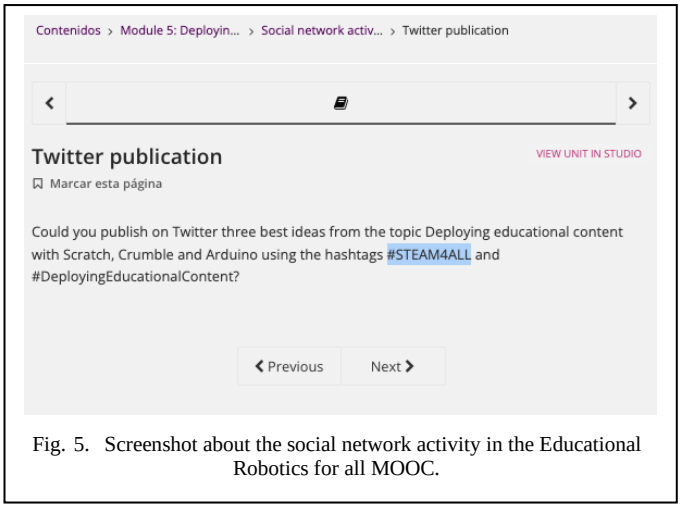

Fig. 5. Screenshot about the social network activity in the Educational Robotics for all MOOC.

Foundations to Open Education and OERs repositories. The assessment in this course was done through a pre-test at the beginning of each module and a post-test at the end, to allow the evaluation of the learning improvement in each module. The interaction between students and the teaching staff was done through the course forums.

3) Learning analytics of key performance indicators. The following indicators were analyzed in each course in the last edition of each one of them:

- number of students enrolled in the course
- number of students that carried out any test or task
- number of students approving the course
- number of recognition certificates requested

3. RESULTS

The result of this study is shown in Table I, specifying number of enrolled students, number of students submitting some tasks or participating in any quiz test, drop-out rate and number of recognition certificates requested in total.

TABLE I. ANALYSIS OF DROP-OUT AND RECOGNITION CERTIFICATES REQUESTED.

MOOCs	***Enrolled students***	***Students doing some task or quiz***	***Students passing the course***	***Recognition certificates requested***
Introduction to Digital Electronics	339	60 (17.7%)	21 (6.2%)	12 (3.5%)
Enjoying FPGAs: Foundations, simulation and practice	191	44 (23.1%)	14 (7.3%)	14 (7.2%)
Educational Robotics for all: gender, diversity, and inclusion in STEAM	172	15 (8.7%)	9 (5.2%)	1 (0.6%)
Foundations to Open Education and OERs repositories	106	19 (17.9%)	15 (14.1%)	6 (5.6%)

4. DISCUSSION AND CONCLUSIONS

The results obtained in the study indicate that the number of recognition certificates requested in each one of the courses is, in the best of the cases, below the 8% of the total enrolled students at the beginning of the course.

Another conclusion that can be derived from the results is that the use of remote laboratories inside the MOOC do not provide additional motivation to pass the course, since the MOOCs about digital electronics and FPGA design do not provide better results in this item. In three of the four courses only around 6% of the enrolled students pass the course.

Regarding the number of students doing some task or quiz, in three of the four courses only around the 20% of students carried out some task or quiz. This means that around 80% of the enrolled students did not carry out any task. They were just interested, in the best of the cases, in having a look to the video-lectures, but they could not devote time to any quiz or task.

The experiences described in this work will help authors of this study, researchers of the In4Labs project, to specify the performance indicators of the MOOC that has to be designed in the project in relation to those described in the present study.

This study presents some limitations, such as the low number of students analyzed. As future work, this study can extend the analysis to more editions of these courses to obtain more accurate and sound results.

Another interesting future work will be analyzing the satisfaction questionnaires delivered to the students at the end of each MOOC. This analysis will help us to understand if there are any differences in satisfaction, for example between MOOCs with and without remote laboratories.

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