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Gender and STEAM as part of the MOOC STEAM4ALL

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Abstract—**This paper presents findings on participants of a massive open online course named "Educational Robotics for all" developed under Open edX platform. The document describes the organization and structure of the MOOC and some of its preliminary results. As an example, Module 2 about Gender and STEAM is presented and discussed.**

Keywords— Diversity, Educational Robotics, Gender, Inclusion, STEAM

I. INTRODUCTION

Nowadays, the culture and society are mainly digital. In this context, massive open online courses (MOOCs) allow people from different background and countries access to education on different areas [1, 2, 3].

Robotics and computational thinking are valuable tools for developing the pedagogy of science, technology, engineering, and mathematics (STEM), and for promoting the inclusion and integration of students. We currently have a multitude of robotic teaching tools at our disposal. These tools arise with the aim of promoting innovation and motivation of students during the learning process. Robots are more and more common in today's society. Therefore, it is important to integrate robots at all levels of our daily lives. For this reason, we have designed a MOOC focused on the presentation of a combination of teaching methodologies, educational robotics tools and a student learning management methodology. All of this is focused on strengthening the presence of women in engineering. Different previous experiences have been used for the development of the contents of this MOOC, such as those indicated in [4-19].

This course is developed in collaboration with the IEEE Education Society, the DIECCTQAI (Electrical and Computer Engineering Department) of the UNED, the IEEE, the Spanish Chapter of the IEEE Education Society, the IEEE Student Branch of the UNED and Plaza Robotica.

The teaching team integrates national and international experts in the field of Open Education and educational activities for the promotion of women and young people in engineering and STEM. It includes experts from UNED, University of Northumbria (United Kingdom), University of La Laguna, University of Porto, University of Salamanca, Federal University (Brazil), Polytechnic University of Madrid, University of Vigo, and University Miguel Hernández. The common link between them, besides being experts in the subject matter of the course, is membership of the IEEE Education Society, the educational section of the largest engineering association in the world.

The MOOC structure and design are described in [20]. In the following sections, we will present the main goals and the structure of the MOOC and, we will describe a Module 2, as example of the educational contents and instructional design.

II. A MOOC ON "EDUCATIONAL ROBOTICS FOR ALL"

A. Main goals
The main goals of this MOOC course are the following:
- The value and relevance of including women and other underrepresented groups in engineering education and STEAM careers;
- Active teaching methods and project-based learning focused on robotics and related STEAM activities;
- Robotics tools, including the user interface environments of Scratch, Crumble, and Arduino;
- Concepts that facilitate the deployment of robotics tools in an educational environment; and
- Methods for student learning management.

Also, as part of this course, the students Will learn how to:
- Create simple robotics applications using a variety of instruments.
- Integrate robotics and related STEAM activities into classroom or online instruction; and
- Manage this same instruction to present concepts effectively, offer constructive feedback, monitor student progress, and motivate students from underrepresented populations.

B. Modules
The topics of this MOOC are organized in several modules, which are:
- Module 0: Presentation of the course: introduction to the course. Throughout this part will be presented in course content. Estimated dedication less than 1 hour.
- Module 1: Special interventions on women in engineering. Videos of experts giving their point of view about women in engineering. Estimated dedication of 2 hours.
- Module 2: Gender and STEAM: During this topic there is an introduction to gender, diversity, and inclusion in STEAM. Furthermore, the design co-educational practices for STEAM is included. Additionally, the inclusive design and project-based learning in STEAM projects is detailed. Finally, the application of gender and value-sensitive design in STEAM projects is shown. Estimated dedication of 4 hours.
- Module 3: Electronic instrumentation in learning environments: As part of this topic, different types of electronic instrumentation commonly used in the electronics industry are discussed to be integrated into the classroom and a series of elements are provided that users can use to make applications in the context of STEAM and educational robotics. Once this topic is finished it is possible to make simple applications with any of the instrumentation dealt with throughout this topic. Estimated dedication of 4 hours.
- Module 4: Educational Robotics Tools: Within the content of this topic the Scratch, Crumble and Arduino tools are introduced. This is a first contact of these tools. Part of the topic describes the user interface environments and provides a series of elements that users can use to make applications in the context of STEAM and educational robotics. Once this topic is finished, it is possible to make simple applications with any of the three educational robotics tools. Estimated dedication of 4 hours.

- Module 5: Deploying educational content with Scratch, Crumble and Arduino: Know educational content using Scratch, Crumble and Arduino. Throughout this topic we show examples of educational application with each of the educational robotics tools Scratch, Crumble and Arduino. Examples of educational content display related to STEAM and educational robotics in the classroom are described. At the end of this topic it is possible to create educational content related to STEAM and educational robotics to be displayed in the classroom. Estimated dedication of 4 hours.

- Module 6: Student Learning Management: As part of this topic a student learning management methodology is presented. With the content of this topic is detailed how to manage the learning process of students, how to manage the educational content deployed in the classroom and how to improve the educational content already deployed using the information acquired from the educational results obtained. At the end of this topic it will be possible to manage the learning process of the students and to manage the educational contents and their life cycle from one course to the next. Estimated dedication of 4 hours.

- Module 7: Lessons learned and conclusions: This topic addresses the lessons learned from this course and summarizes the conclusions. Estimated dedication of 2 hours.

The course includes a set of multimedia videos in each of the modules. In addition, these are accompanied by exercises, surveys and explanations that allow students to learn the contents autonomously.

The target audience of the course are people without previous experience in robotics who want to get into educational robotics and use what they have learned at home, in their institution or as part of their research.

The duration of the course is 2 months, and it has been developed from 15th October 2020 to 16th December 2020 (Fig. 1).
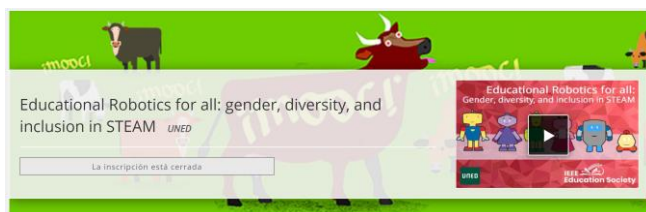

Fig. 1.   MOOC published in UNED Abierta platform (https://iedra.uned.es/courses/course-v1:UNED+STEM_EngiFound_001+2019/about)

III. EXAMPLE OF THE CONTENTS: MODULE 2

All modules had a similar instructional organization including the main points: a Pre-Test, different documents in PDF, different videos, a set of activities, a forum and a quiz.

As example of this instructional design, we present the Module 2 about Gender and STEAM.

Fig. 2.   Structure and organization of the Module 2

The first activity was regarding to a pre-test on the previous knowledge of students about the topic. Then an introduction about the main fundamental concepts of the topic was introduced through videos and educational documents in PDF, such as about gender, stereotype and co-educational concepts. Following, an introduction to how to design a co-educational practice for STEAM was described (Fig. 3). In this section, some innovative projects have been presented as example of good practices (Fig. 4). Then, some guidelines about how to apply gender and value-sensitive design in STEAM projects was given. Also, some strategies about intersectionality of promoting gender thorouh education was presented, based on previous innovative projects developed in the University of La Laguna and University of Salamanca, in Spain. In particular, a collaborative design of good practices in equality in the teaching-learning process at the University of La Laguna, with a particular focus on the approach applied in the Degree of Computer Science [21]. Also, a project focused on mainstreaming the gender perspective in software engineering teaching [22]. Finally, we have assessed the knowledge of the module using a quizz and promoting the interchange of experiences and knowledge usign a forum.
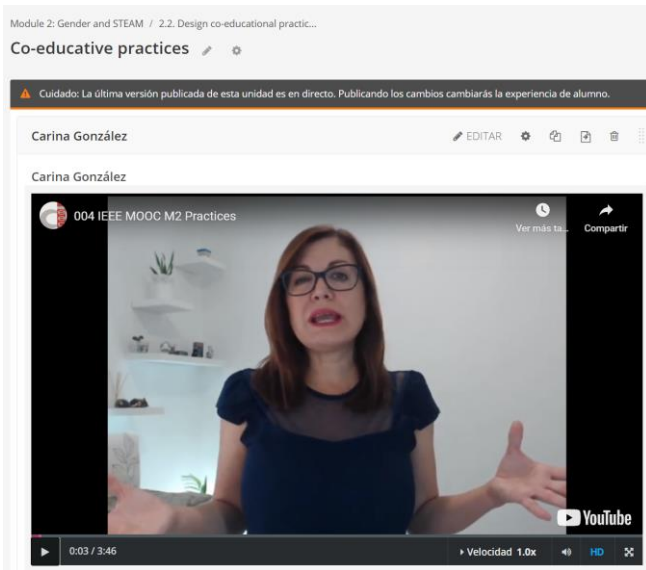
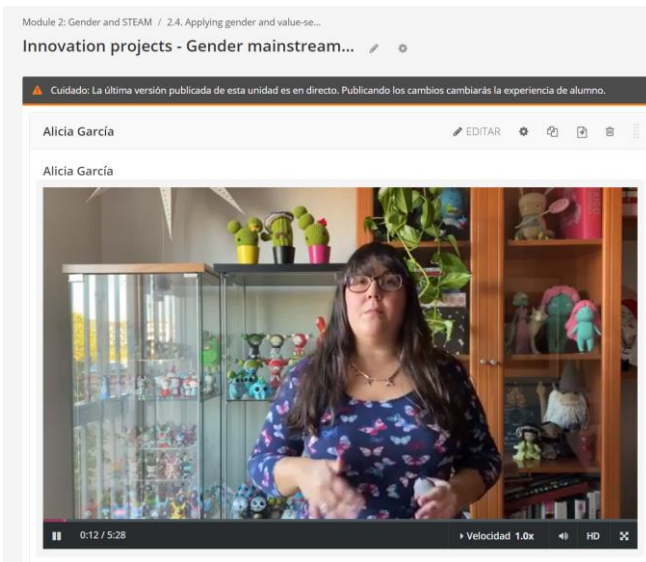Fig. 3. Example of the contents regarding to co-educational practices

Fig. 4. Example of the contents regarding to innovative projects

IV. PRELIMINARY RESULTS

This course ended on December 16, 2020. A total of 237 students were registered in this MOOC. The students took the MOOC from different countries of the 6 continents. The countries with the highest number of students were Spain, Venezuela, United States, Brazil, Colombia, and Indonesia. In relation to gender, almost 50% of the students were men and 50% of the students were women.

At the beginning of the MOOC, a survey was carried out to find out, among other things, the motivations of the students. This survey was answered by 46 students. Some of the motivations of the students at the beginning of the course were the following:

- To know the participation of women in the world of robotics.

- Apply it to my class.

- Have a more diverse vision of education

- Have tools to make my computer science classes for inclusive

- To be able to create an inclusive environment with this type of education

- To learn about the gender, diversity, and inclusion point of view of the robotics learning process, and to be able to assess this kind of issues when teaching robotics in the future

- To learn how to integrate gender inclusion into my courses at the university, especially to make informatics attractive to more women

- To improve my knowledge about Inclusive Educational Robotics

At the end of the MOOC, a survey was conducted to find out the degree of student satisfaction and the extent to which students had met their goals. This survey was answered by 16 students. Figure 5 shows the students' response to the question: With consideration of your goals for enrolling, did this course meet your expectations?
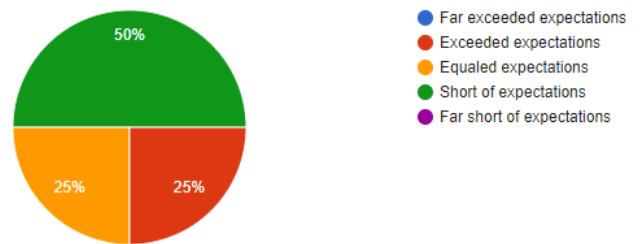

Fig. 5. Degree of objectives accomplishment.

In addition, students were asked about the degree of knowledge acquired throughout the MOOC. Figure 6 shows the students' response to the question: How much did you learn in this course?
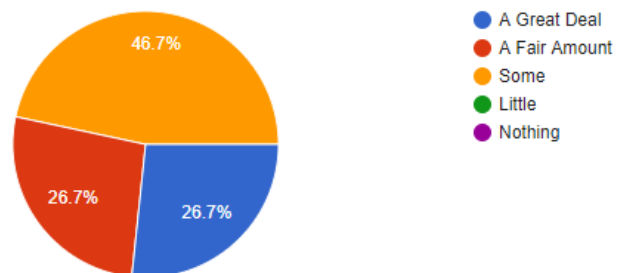

Fig. 6. Degree of acquired knowledge.

V. CONCLUSIONS

Open education, and in particular, MOOCs, open possibilities to expand the education to everywhere and to everyone. As we can observe in this digital era, robotics and STEAM are key knowledge that should be incorporated into education and into curriculums. Teachers and other citizens need to know more about the possible uses and applications to their realities and contexts of these technologies. We have presented the design of a MOOC course that aims to show some of these main applications and uses.

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