Graphic classes in the worldwide classroom: a comparison of two MOOC experiences

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Abstract: Graphics are present in the day-to-day professional practice of architects and engineers, not only to receive and transmit information, but also to design and create. Students who are accepted on university courses have varied curriculum vitae, and some may initially lack skills. Consequently, engineering schools have developed a Massive Open Online Course (MOOC) entitled "The Language of Engineering" (ELI), which reviews basic geometry concepts and develops spatial intelligence, among others. The Barcelona School of Architecture has produced "From reality to design. From design to augmented reality" (RA), which covers topics including traditional architectural representation and the latest techniques. The goal of this study was to explain and analyse the main characteristics and learning strategies of these two MOOC (strengths, weaknesses and opportunities for improvement). The results show that although strategies vary depending on the subjects, the contents and exercises should be practical and adapted to students (interests, level, time availability and aesthetics), always considering motivation as a key point (gamification). These topics have been found to have a considerable influence on the success of a MOOC. Therefore, the conclusions should be considered in subsequent versions of these courses and other MOOCs.

Keywords: architectural representation; drawing; ICTs; gamification; digital image

1. Introduction

Technology is present in our lives and has a direct influence on the way we interact, think and work. Graphic expression has incorporated new technologies and computer programs, and these have influenced how we see, understand, design, explain and build. In many cases, freehand drawing has been relegated to the more conceptual stage of the design process (Carazo and Martínez, 2013).

As university teachers, it is difficult to determine which graphic skills and tools our students (future professionals) will need when they finish their degree, in a professional world that is so changeable, and without being caught up by short-lived trends (Nocito *et al.*, 2016; Fernández *et al.*, 2016; Madrazo, 2016; Alonso *et al.*, 2016; Redondo *et al.*, 2016).

Education has also succumbed to the new technologies and, within e-learning, Massive Open Online Courses (MOOC) are particularly relevant, and are revolutionizing higher education (Muñoz-Merino *et al.*, 2014). Some of the most prestigious universities in the world have already opted for this new way of teaching classes: Stanford (Coursera) (Coursera, 2012), MIT/Harvard (edX) (edX, 2012) and Udacity (Udacity, 2011). MOOCs have arisen as the result of arduous experimentation in educational technology and online learning, with a pedagogical approach. They are massive, open, online and free, but also inclusive, flexible in terms of timetables and content, and can be taken anywhere in the world if there is an internet connection. In addition, they tend to include self-assessment, group work, games and video simulation (Vázquez and López, 2013).

There are two main kinds of MOOC: xMOOc and cMOOC. The first use a behavioural approach similar to that of traditional courses, but online, while the second are based on the theory of connectivism, which uses social networks to interact and generate content in the form of an open education resource (OER) (UNESCO, 2002). This is an advantage, because teachers can reuse the material from other MOOCs or improve it (Palomo-Duarte, 2017).

In some courses, students are involved in the management and development of the MOOC, which enables self-management and sustainability (García *et al.*, 2016).

It has been shown that Hangouts (a free videoconference app from Google) is a valuable tool for creating an educational community around a MOOC. It helps to get participants involved and to generate content that is of interest to them, which facilitates the reuse of material in future editions. Notably, Hangouts is viewed more when participants from different MOOCs are invited (Palomo-Duarte, 2017).

Despite the short time that MOOCs have existed and their constant evolution, some initial conclusions can be drawn (Daniel, 2012). The points to improve include addressing the high dropout rate: although thousands of students register for MOOCs, less than 10% complete them (Daniel, 2012; Galán, 2014). This figure is much lower than that of a traditional face-to-face course, although the comparison is not straightforward. Motivation is different for a person who registers for a free online course and a person who makes a personal and financial commitment to a traditional course. Although some MOOCs have higher completion rates, their success could be due to their practical focus, their illustrative and informative nature, the clarity of presentation and additional complementary and written material (Ubieto-Artur *et al.*, 2017). Other challenges are financial sustainability, the gradual loss of skills of university teaching staff, cheating and plagiarism (Sinclair *et al.*, 2015). In addition, some MOOC lack learning principles (for example, problem-based learning, activation, demonstration, application and integration) (Margaryan *et al.* 2015).

Students who are accepted on university degrees of Architecture and Engineering have varied curriculum vitae and some may initially lack certain basic and specific skills. Consequently, the Barcelona School of Civil Engineering (ETSECCPB) and the Terrassa School of Industrial, Aerospace and Audiovisual Engineering (ESEIAAT) of the Polytechnic University of Catalonia UPC BarcelonaTech, in collaboration with teachers from several upper secondary schools, have developed a MOOC called "*The language of engineering*" (ELI). ELI offers basic knowledge of degree subjects to ease entry to university (UPC, n.d.; Estela-Carbonell et al., 2016). Technical drawing, one of the modules of this MOOC, helps students to revise basic concepts of descriptive geometry and to develop spatial intelligence. The Barcelona School of Architecture (ETSAB) has created "*From reality to design. From design to augmented reality*" (RA), which covers not only introductory degree subjects, but also more advanced, cross-cutting topics to attract a wider public. Contents include freehand drawing (Figure 1), CAD, retouching and photomontage of architectural images, 3D modelling, 3D printing, rendering and visual simulation through virtual and augmented reality.

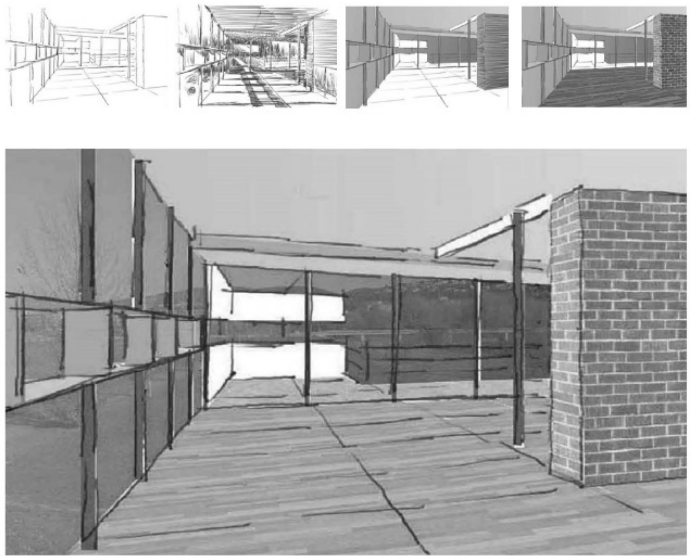

Figure 1. Freehand drawing using a graphic tablet (RA). Author: E. Redondo.

Although we do not know how MOOCs may change in the future, it seems they are likely to form part of higher education, either as a support or as regular classes. The aim of this paper is to compare these two leading graphic MOOCs, to determine how graphics subjects are taught through them, analyse their strategies, confirm or reject their strengths and weaknesses, and draw conclusions that could influence future versions of these or other MOOCs.

2. *Characteristics of the MOOCs under study*

Below, we set out some of the characteristics of the MOOCs under study, including subject area, structure, exercises, assessment, start date, duration, number of students registered, platform and state (Table 1).

Table 1. Characteristics of the MOOCs under study.

MOOC	**From reality to design. From design to augmented reality**	**The language of engineering (technical drawing module)**
Target	Facilitate access to bachelor’s degree courses in design and architecture	Facilitate access to engineering courses
Pathways	Introduction or basic Intermediate modelling Advanced visual simulation Flexible pathway	No pathways
Subjects	Basic projection systems Freehand architectural drawing Computer-assisted architectural drawing The digital image in architecture (I): principles The digital image in architecture (II): image processing Modelling Visual simulation Environmental context New ICTs for architecture and design	Geometric constructions: basic concepts Geometric constructions: regular polygons Geometric constructions: tangency Multiview projection: figures with flat faces Multiview projection: figures with curved faces
Structure of the subjects	Explanatory video One or two exercise tutorials Additional information on the model to represent	Initial test Theory videos Additional material: video exercises Final test ⇒ Gamification
Exercises	Practical exercises: hand and computer drawn	Multiple choice questions
Calibration of exercises	Low, medium and high	Low, medium and high
Assessment	Self-assessment and assessment by three students	Multiple choice questions. Automatic correction.
Start date	Start of the semester: March	Start of the semester: September
Maximum length	8 weeks	9 months
Surveys	Initial survey to determine existing skills and final satisfaction survey	Final satisfaction survey
Registered students	75	325
Platform	MOOC UPC (MOODLE)	MOOC UPC (MOODLE)
State	Temporarily closed	Open

3. *Discussion*

3.1. Subject areas

In RA, students are introduced to subjects that they will encounter during the bachelor's degree and postgraduate courses in architecture and design. This MOOC covers traditional architectural representation (freehand drawing) and more contemporary subjects (taking and managing a point cloud, CAD-CAM, 3D printing, video, virtual reality, and augmented reality) (Figures 2 and 3). In contrast, ELI is focused on revising and complementing the basic theoretical knowledge required for the first years of engineering courses, although the drawing module is also valid for architecture and upper secondary school students. In the ELI, students will revise basic concepts of plane geometry and develop spatial intelligence through the recognition of multiview projections of a figure. This second MOOC provides a good theoretical and spatial basis, which should be complemented by a practical component (freehand and computer drawing), acquired independently or during the first years of the degree.

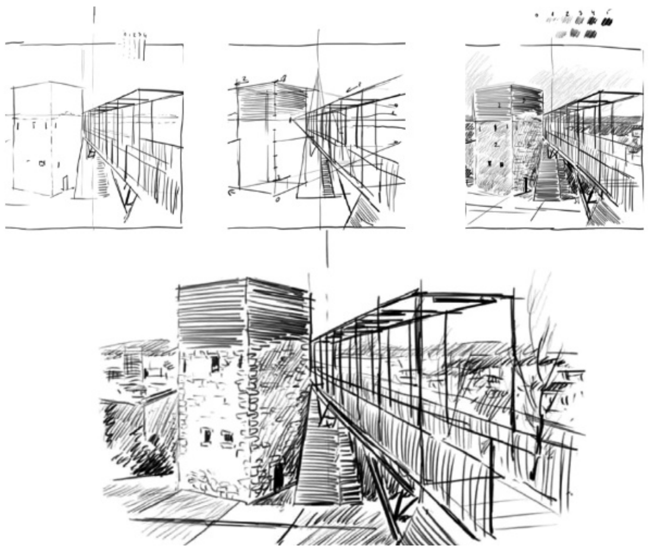

Figure 2. Freehand drawing using a graphic tablet (RA). Author: E. Redondo.

3.2. Motivation, a key point

Self-learning is not easy as it requires organisation and discipline. The two MOOCs employ different strategies to achieve it. RA uses an attractive selection of highly practical contents, in which students can see an almost immediate relationship between the practical exercises and the profession. The contents and practical exercises are highly visual, with videos, step-by-step instructions, and some classes given by university lecturers. In addition, the course can be adapted to the student's interests (pathway) and level (initial survey).

Figure 3. Taking and managing a point cloud generated from laser scanners for the construction of buildings (RA). Author: E. Redondo

The ELI includes techniques, elements and game dynamics (gamification) to stimulate motivation, productivity and learning. ELI is the name of a fictitious person who accompanies the student throughout the course (ELI cries when the student gets bad marks, stands on a podium when the marks are excellent, etc.) (Figure 4). In addition, when participants reach a score above 80% for a subject, they are offered additional information or a game as a reward or positive reinforcement.

Figure 4. Solution to a video exercise on the subject of multiview projections (curved faces) (ELI).

Initially, the CANVAS platform was considered for ELI, but finally the MOODLE platform was selected. Subsequently, all materials were moved to Open edX, as this platform presented them in a more attractive way. The first edition of ELI was hosted by UCATx. Currently, it is taught in MOOC-UPC. RA was constructed using the MOODLE platform and was taught in MOOC-UPC and in Atenea. Unfortunately, this MOOC is currently inactive, although some of the explanatory videos can be found on UPCommons, the open knowledge portal of the UPC (UPC. SBPA, n.d.).

As ELI is mainly a theoretical course, it helps that the contents and solutions of exercises are explained by university lecturers in video format. The videos were created with care on a set (Figure 4), by specialists. The collaboration of secondary school teachers in this project helped to calibrate the difficulty of the course, and the points that need reinforcement.

3.3. Different assessment methods

The assessment of RA practical exercises consists of a first stage in which students self-assess their work. The author adds to the image file or screenshot a label with the weighted grade of A, B, C or D, as shown in Figure 5. A is the highest mark and D is a fail. Then, three other randomly selected students assess the work, to generate an assessment or public recognition of having passed the exercises.

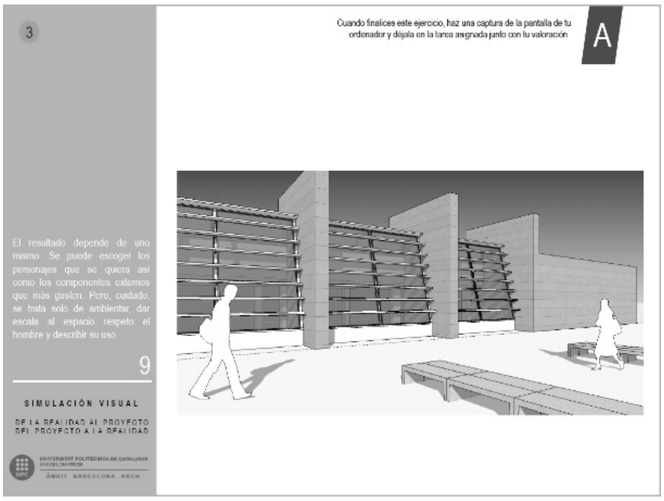

Figure 5. Self-assessment (A). Visual simulation subject. Author: E. Redondo.

A different assessment system is used in ELI: marks for the multiple choice tests are produced automatically and immediately, and students can repeat the tests as many times as necessary. The questions vary randomly, drawn from a bank of multiple choice questions, using WIRIS quizzes (Estela-Carbonell and Villalonga, 2009).

3.4. Participation and its determining factors

When the results of participation in RA were analysed, it was found that the dropout rates went up exponentially from the second week onwards. One of the main reasons could be the high volume of work set. Each week, a subject is taught, and the student must submit a related practical exercise. The practical exercises tended to require considerable effort. Most of the participants were Spanish students of the bachelor's degree in architecture, who may find it hard to combine the university course with the intensive, eight-week MOOC. Those responsible for the MOOC consider that there are an excessive number of guidelines and tips available on the internet in video format for many of the drawing applications that are used on the course. As the MOOC is so short and intensive, dissemination to secondary school teachers cannot be implemented fast enough, because the syllabuses for the second year of upper secondary school have a heavy workload and are not flexible, particularly for upper secondary students who take the university entrance exams at the end of the ordinary academic year.

Although we do not have data on the number of students who completed the ELI, students of this MOOC can study at their own pace (with no weekly assignments to submit). The course runs for nine months, and students can choose which subjects they want to practice. This gives students freedom in their learning, and makes it easier to combine with the first years of the degree, which tend to be selective and complex, or with other courses, or work life.

The subject area may also influence dissemination, as the ELI addresses more general topics that form part of most syllabuses of technical degrees, while the RA deals with more specific subjects of interest to a minority.

3.5. Miscellaneous

These two free MOOC have not been designed to replace traditional classes, but to complement them. Students are given a grade or mark to get an idea of their level on the MOOC material, but this does not have a direct impact on their academic mark. Therefore, if students cheat on their marks they are cheating themselves. It is questionable whether MOOCs contribute to a gradual decline in the skills of university lecturers. Although university lecturers' tasks have become more diverse in recent years (research, teaching and online teaching), all these tasks are complementary.

4. Conclusions

Massive Open Online Courses (MOOC) were studied, which teach graphics subjects and are aimed at students who have finished upper secondary school, to help them to access university, or at students who have completed the first year of engineering or architecture degrees. These courses are inclusive, massive, open, free, and complement traditional classes. Although the two MOOCs under study differ widely, we noted relevant aspects, strategies and points to improve when a MOOC with these characteristics is developed:

- MOOC materials are appreciated if they are visual, practical and progressive. The participant's interest, level and available time should be considered, so that the courses can be taken successfully. In addition, the direct application or relation of the MOOC to professional practice should be clear.
- The participation of secondary school teachers helps to calibrate and adapt the course correctly.
- The selection of platform could influence how the materials and data derived from following the course are displayed. These data could be of use in future versions. The platform will also influence the dissemination of the MOOC, and will consequently affect participation.
- Gamification and positive reinforcement are strategies to stimulate motivation.
- It is essential to ensure that videos and other multimedia resources are of high quality. Surveys administered to RA students reveal that this aspect is very important, considering the competition from tutorials available on the internet.
- The creation of an educational community could help students to follow the MOOC, resolve problems, and generate materials of interest, which could be reused in future versions or other MOOCs. The opportunity to share resources between MOOCs could help to increase the number of users and spectators.

These conclusions are expected to influence future versions of this and other MOOCs.

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