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AN EDUCATIONAL PROJECT IN ARCHEOASTRONOMY: THE POK-COURSERA MOOC COURSE

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ABSTRACT

MOOCs, or Massive Online Open Courses, are a relatively new e-learning based tool on web platforms integrating short video lessons, tests and didactic materials. In June 2016 the MOOC platform of the Politecnico of Milan launched a course entitled "Archaeoastronomy: the science of stars and stones" devoted to the general public and exported, since autumn 2016, on the platform Coursera. We briefly overview here the context in which the course has been developed, and the way in which the storyboards of the course - which is entirely filmed in the form of 'green screen plug-in' of the teacher in the different scenarios object of study – have been developed. After one year, the course has more than 9000 subscribers worldwide, a number which allows us to perform a first evaluation of the most common student's difficulties and critical views.

KEYWORDS: MOOCS, Education, Archaeoastronomy

1. INTRODUCTION

In the last decade, the educational field has witnessed the birth and evolution of the so-called MOOCs, Massive Open Online Courses. Historically, the term MOOC was introduced by Dave Cormier (University of Prince Edward Island in Canada) in 2008 for the course called "Connectivism and Connective Knowledge". This course was attended by more than two thousands students and made ample use of several social media applications e.g. blogs, forums and Facebook (Kaplan et al., 2014). The idea spread widely up to the point that 2012 was proclaimed ``The Year of the MOOC'' by the New York-Times (Pappano, 2012).

What is a MOOC? Adopting the definition of the Oxford English Dictionary, which added the word just one year after the term was coined, a MOOC is "*A course of study made available over the Internet without charge to a very large number of people*", but such interpretation does not describe the aim, the strength and the power of MOOC. According to the European commission (2014): "*a MOOC* is *an online course open to anyone without restrictions (free of charge and without a limit to attendance), usually structured around a set of learning goals in an area of study, which often runs over a specific period of time (with a beginning and end date) on an online platform which allows interactive possibilities (between peers or between students and instructors) that facilitate the creation of a learning community. As it is the case for any online course, it provides some course materials and (self) assessment tools for independent studying*". With this definition we can determine the idea behind the MOOC, which becomes clearer reading the words of Salman Khan: "*Our mission is to provide a free, world-class education for anyone, anywhere*"[1].

Salman Khan, founder of the *Khan Academy* in 2006, is one of the pioneers of the MOOC with Sebastian Thrun and Andrew Ng. The latter are two professors of Standford University who, in 2011, opened access to their online courses reaching more the one hundred thousand of students. They co-founded respectively *Udacity* and *Coursera* which – together with edX, developed through a collaboration between Harvard and the Massachusetts Institute of Technology – are the main MOOC platforms. Even though the MOOC phenomena was born in the USA, soon after it spread in Europe with ventures like *iversity* (Madrid, Florence, Hamburg), *FutureLearn* (UK), *Fun* (France), and, as we shall see, *POK* (Milan).

The numbers of the MOOC phenomenon are impressive: in less than ten years the number of Universities around the world involved in MOOC projects increased up to more than 700, and at the end of 2017 we count about 7000 courses delivered[2].

It is worth noticing that a MOOC is different from a traditional on-line course: they share some common aspects, but they have different goals and structure (Perna et al., 2014). Moreover, a MOOC, which does not require prerequisite knowledge, is able to attract more users than a traditional on-line course (Pursel et al., 2016), providing, for instance, interactive elements (Kaplan et al., 2016), visual stimulation, and story-telling characteristics of videos (Choi et al., 2007).

All in all, a MOOC is a course which is massive, because the number of users who can enrol is intended to be very large since access is without limitation, and has a clear defined syllabus, offering contents delivered with different formats, such as videos and text. Moreover, the course offers a possibility of interactions with instructors and among students by forum, social media and so on. Finally, there are assessment activities (e.g. quizzes) which allow the learner to take a certificate of completion. Thus, a MOOC has a rather complex structure which provides different on-line activities and learning outcomes. MOOCs thus provide an alternative to traditional higher education, but institutions and authorities have been offering MOOCs also with different aims. For instance, as tool for marketing, to build a brand, to serve a social good, to experiment with new technology, to develop pedagogical innovation, or to improve cost/revenue ratio (Andrà et al., 2015; Sancassani et al., 2017; Liyanagunawardena et al., 2017).

Changing perspective, one can wonder why learners should enrol and attend a MOOC: they may enrol because they are curious about MOOCs themselves, or interested in trying on-line learning in a specific topic or, for a small percentage, because the MOOC leads to a college credit (Liyanagunawardena et al., 2017). A milestone study (Christensen et al., 2013) argues that `curiosity' and `advancing in a current job' are two main reasons for enrolling in a MOOC. However, there are other aspects to be taken into account, for instance, students can take advantage in exchanging with other students and with professionals, doing that independently of time and place (Kaplan et al., 2016).

A typical aspect of the MOOC phenomenon is that, despite the number of participants remarkably increases reaching more than one million of enrolled students (Chuang et al., 2016), many participants register in a MOOC but never return after registration; the percentage of MOOC completion is typical-

[1]Khan Academy https://www.khanacademy.org/about

[2] Class Central http://www.class-central.com

ly around 10% or less (Liyanagunawardena et al., 2017). For instance, in 2016 the completion rate of the courses delivered by Harvard and MIT was about 6%, Figure 1 reports the details of the last four years of MOOCs (Chuang et al., 2016). It can be seen that the completion rate, i.e. the percentage of "certified" students over the enrolled students, slightly decreases.

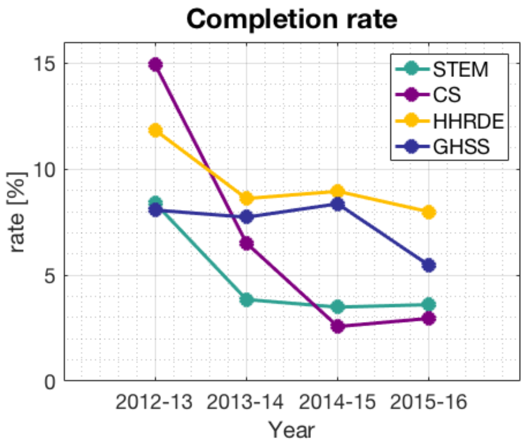

Figure 1. Completion rate of HarvardX and MITx courses. STEM=Science, Technology, Engineering, Mathematics; CS=Computer Science; HHRDE=Humanities, History, Religion, Design, Education; GHSS=Government, Health, Social Sciences.Image by authors based on data from Class Central: www.classcentral.com

2. POLIMI OPEN KNOWLEDGE AND THE ARCHAEOASTRONOMY MOOC PROJECT

Politecnico di Milano (a member of Idea League and one of the leading technical universities in Europe) has been one of the first universities in the EU to develop its own MOOC platform, called Polimi Open Knowledge - POK (www.pok.polimi.it). Technically, POK is a online platform designed by the Politecnico center for Innovative Didactics (METID) on the basis of Open edX. The portal POK was launched in June 2014 and suddenly reached more than six thousand users, coming from 131 different countries (Corti et al., 2016).

The peculiarity of POK is the aim which underlies the hosted courses. Indeed, the strategy of Politecnico di Milano is to use MOOCs mostly to support the traditional education facilitating and bridging the transitions at the key stages of the educational path (Agasisti et al., in press). The main aim of POK is therefore to "bridge the gaps" between the steps of students' academic path, and to accomplish the so-called third mission of the university providing MOOCs for a wide audience.

From the technical point of view, a MOOC on POK/Coursera is usually structured into "weeks", namely the macro units which identify the main topics of the course (estimate learning time is about one hour per week unit). Each week is composed of "lessons" which are divided into "items" or "elements". There are different elements in the course. For instance, video lectures, reading sessions and quizzes. Moreover, a "discussion" space is available as a forum where enrolled people may interact each other and with the instructors. Assessment is based on multiple-choice tests. Learners who answer successfully the assessment mark their score and eventually take the grade if the score is greater than of a certain percentage (usually 60%) of the assessment.

Within this scenario, it was decided to export in MOOC form the in-presence course of Archaeoastronomy which one of us (GM) has been teaching to the students of Civil Architecture since 2011, based on the companion textbook (Magli, 2015).

The first task was to adapt the course to a level understandable to the general public. The in-presence Archaeoastronomy course starts with a deep insight into naked eye astronomy, which is typically poorly known to the students mostly due to the fact that is traditionally overlooked in the High School programs. It was decided to keep naked eye astronomy in the MOOC at the simplest possible level: key concepts (like altitude, azimuth and declinations of celestial bodies) are discussed in video-lectures, but atmospheric effects are deferred to reading part in week 6; similarly, the apparent motions of the sun and of the stars, together with precession and obliquity, are discussed in a video-lecture, but the Moon and Venus are deferred to week 6.

The second problem was that it was fundamental to make the student familiar with several different archaeological sites around the world. To solve this problem, we opted for the chroma-key to film the teacher. The images were then merged in photographs of the sites in a dynamic way using the Adobe© softwares Premiere and After Effects. For internal consistency (for instance, to assure that the proportions between the human figure and the monuments were correct), the majority of the photographs used in the course were those taken directly on site by the teacher.

A third problem was of course the simulation of astronomical events. The use of a virtual planetarium was mandatory here, and we opted for Stellarium (2009) mainly because it is an open-source software, and therefore it is downloadable at no charge by all the students to make their own experiments. Stellarium actually is a very good software from the astronomical point of view, but it revealed itself to be not optimal for our aims. In fact, it was necessary to grab its animations directly on screen using OBS (Open Broadcast Software) and it is at present impossible to save astronomical situations in a simple way for later, or production, use.

Finally, we wanted to re-create solar hierophanies to give to the students a hint of what can actually be seen in places like, for instance, Giza and Chichen Itza'. To this aim, the software Google Earth proved fundamental: animated 3D simulations of Google Earth were indeed grabbed on screen and processed through the software Premiere, such as the hierophany of the Horizon of Khufu shown in Figure 2. The final result is structured into 6 weeks:

1) Astronomy with the naked eye: how the ancients saw the sky (5 videos-lectures)

2) Astronomy, power and architecture (4 video-lectures)

3) Ancient Egypt (5 video-lectures)

4) The Pre-Columbian world (4 video-lectures)

5) The classical world (3 video-lectures)

6) Astronomy insight (1 video-lecture, 18 readings)

Each of the above weeks has a quiz section composed of 5 questions. Figure 3 shows the structure of a week within the Coursera platform. Most of the quizzes are at a very general level and are aimed only to check that a few fundamental concepts have been learnt. For example, one question aims to check that the student understands that declination is independent on the observer, another stresses the role of horizon altitude in archaeoastronomy. Since the last week is a deep insight into naked eye astronomy and technical archaeoastronomy, such a section is reserved to subscribers.

Figure 2. A frame of the video "The Horizon of Khufu" showing the hierophany at Giza at the summer solstice. Image by authors.

Last but not least, an underlying problem of the whole course was that we wanted to give very strong advices on the fact that Archaeoastronomy is a rigorous scientific discipline, in spite of the elementariness of the approach taken. The choice made was to insert warnings at each step were a very well-known pseudo-scientific topic could be matched into by a gullible audience (this occurs, for instance, when Astrology is touched upon, or in the discussion of the structure of the Maya Calendar).

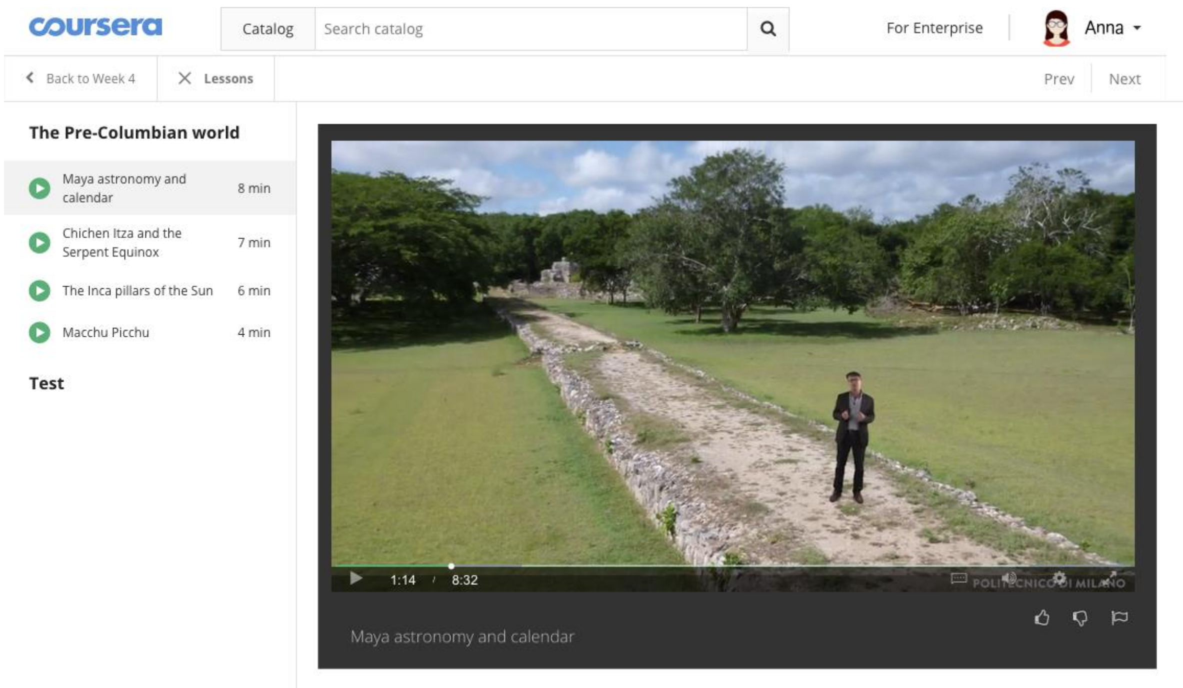

Figure 3. The structure of Archaeoastronomy MOOC on Coursera, the Week 4 details. Image by authors.

3. THE RESULTS AFTER ONE YEAR

In this section we report some data of the Archaeoastronomy MOOC hosted by Coursera since January 2017. Then we focus on the educational aspect and the appreciation of the course.

The MOOC has been visited by more than 25 thousand registered Coursera users, among them about 9500 enrolled on the course (data extracted on January 25th 2018). The enrolled users are classified as *active* if they viewed at least a reading or discussion, or they at least began watching a video and/or an assessment; the course has about 6000 (63%) active learners while the completion rate is about 9%, a datum in accordance with the average MOOC completion rate worldwide. Among the completers, 189 learners required the certificate (a fee is applied by Coursera for it).

The majority of the learners comes from North America (39%) while 33% of learners come from Europe, followed by Asia (15%) and South America (7.2%). We highlight that the percentages related to North America and Europe are above the Coursera average. Above the average is also the percentage from specific countries rich in cultural heritage such as Turkey (120 active learners), and Egypt (99). The population of the course is very balanced between male (49%) and female (51%), which is quite unusual with respect to the other Coursera MOOCs which register an average of 60% male. The age distribution of the learners (Figure 4) has a peak at the range 25-34; the majority (70%) of learners are *not* students, but people holding a bachelor or masters level degree.

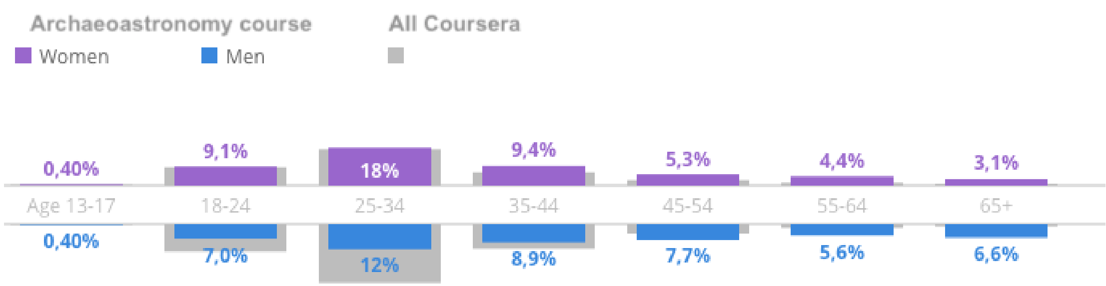

Figure 4. The age distribution of the Archaeoastronomy MOOC learners. Image by Coursera analytics.

Moving on to the appreciation of the course, Coursera allows learners to rate (from 1 to 5 stars) the course and to evaluate each item of the lessons with a *like* or *dislike;* reporting a *problem*, namely a technical issue with the item and a comment about the content, is also possible. All the feedbacks are anonymous. Analysing the global rating of the course, the vast majority of students rate the course with an encouraging 4 to 5 stars. The total number of *like* is 1444 whilst the *dislikes* are just 43. The most appreciated item is the introduction video titled *Archaeoastronomy: the science of stars and stones*, followed by the *Supplementary Course text* and the video *Celestial coordinates and the apparent motion of the sun*, on the other hand, the most disliked item is the test *Astronomy with the naked eye: how the ancients saw the sky* followed by the test *Astronomy insight*.

Some interesting negative comments are worth recording. For instance, the following comment (2 star rating) helps us to identify some common difficulties of the students: *Too much information crammed together. Videos too short and astronomy concepts not well explained.* It is actually part of the MOOC philosophy to keep the videos length much shorter than a standard classroom lesson, and we followed this approach consistently. Lessons with technical astronomy concepts can however be too dense in comparison to more descriptive lessons on specific monuments. Indeed, many posts on Forum sound like this: "very confusing with too many new terms the first week", some of them contain possible indicator of "give up" (citing a learner), other contain more proactive approach: "Week 1 was challenging, and I loved it. I didn't pass the quiz on my first attempt but that inspired me to go back and be very specific about the terminology used". Overall, the community is very active and the learners support each other proposing extra material. We plan to expand the didactic material available for the naked-eye astronomy part in order to overcome these difficulties. In this respect it is interesting to see that some of the difficulties experienced by the students depend on their latitude. For example, people living at non-tropical latitudes do not experience in their daily life zenith passages and pole-exchanged culmination of the sun and clearly reflect this in their difficulties. More generally, some students point out difficulties dealing with most of the quizzes on Astronomy with the naked eye. These difficulties are also testified by posts such as "I wonder what is `the true east'". Again, this is the most technical part and apparently, we can put more effort in making it understandable to the general public; from some comments and emails received, however, we can perceive that some misconceptions are hard to dismantle. One example is on the concept of inter-visibility: we put much effort in stressing that only inter-visible monuments can be claimed to be intentionally topographically aligned; in spite of this, questions and dreams about "ley lines" are commonly seen. Another example is the idea that the sun "rises in the East" with tremendous difficulties in accepting that the true rising point at the eastern horizon actually changes each day.

Unfortunately, since the data are anonymous, it is impossible to deduce whether the comments are made by students who attended the whole course and even passed, or not. We could resort to the comments of the forum threads to study the learners' attitudes which effect their performance and even the causes of possible drop-out, but such techniques require the qualitative analysis of large-complex-data (about 100 threads with replies and hundreds of views for each one). In any case, the construction of a syllabus of astronomical concepts and of a small database of common misconceptions to be added to the course appears worth making.

4. CONCLUSIONS AND PERSPECTIVES

To conclude then, we can say that the POK-Coursera Archaeoastronomy MOOC has been and is a good laboratory to test key stages in teaching Archaeoastronomy to a worldwide public. It certainly has to be improved and implemented with further didactic tools. Nevertheless, we can argue that, although this MOOC is in line with the other MOOCs of Coursera in terms of completion rate, it differs from them under many respects. First of all, the course appears to have the strength to attract a major number of female students with respect to the Coursera average, contributing to reduce the gender knowledge gap in cultural astronomy. Another aspect to be highlighted is the very attendance rate on the course which allows us to compare the student's attitudes and behaviours. It is, in particular, very clear that the MOOC learners are more engaged than attending students in formulating questions and in discussing topics together.

Finally, it is our hope that the course can be of help in disseminating a rigorous approach to Archaeoastronomy and in providing information to challenge the alarming number of pseudo-scientific doctrines.

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