

A NEW HORIZON FOR ONLINE TEACHING AND LEARNING

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Abstract

The Polytechnic Institute of Oporto (IPP), which has a solid history of online education and innovation through the use of technology, has been particularly interested and focused on Massive Open Online Courses (MOOC) developments. The aim of this paper is to present the whole process from initial discussions to completion of the “Mathematics Without Limits” MOOC Project that exists in IPP and also to contribute for a change in the way as teaching and learning Mathematics is seen and practiced nowadays. In 2013, IPP developed its own platform, which gave us the opportunity to explore new educational techniques as a pedagogical resource as well as to enhance students’ motivation, through a set of interactive materials at their disposal, totally adapted to their needs. Students lack of motivation is mainly justified by their weak Math preparation, poor consolidated basis on the subject and different backgrounds of the students. To tackle this issue and based on our Math online courses teaching experience, we decided to create short duration MOOC, expecting to aid retention of students and also to reverse the path of students giving up on Math by giving them a friendly way of managing their own learning commitment. We also think that this MOOC will be a good approach to level out some math skills among freshmen.

Keywords: MOOC, Online Learning, Open Education, Connectivism.

1 INTRODUCTION

Higher education institutions (HEI), particularly those in which Mathematics is a necessary pre requisite for their courses, have been faced year after year with the problem of students having different levels of mathematics knowledge. HEI have made several attempts to overcome this issue, for instance, some of them are offering intensive courses before the first year in higher education (usually named as *Mathematics Zero* or *Pre-Calculus* courses). Massive Open Online Courses (MOOC) can be a good opportunity for students at schools (as well as instructors and HEI) who are interested in expanding their knowledge taking advantage of the available opportunities to learn Maths online.

As we have already stated, in 2013, IPP developed its own MOOC platform. This project development gave us the comprehensive opportunity to merge into “one”, Mathematics lecturers from four for the seven schools in the IPP, exploring all the technical available resources in the platform (some new and other constraining ones), trying to adapt them into technical and pedagogical predefined goals and to the particular needs of each “customer” (student, public in general, etc). In this sense, we defined course’s pre-requisites as well as some mechanisms to avoid students “desertion” (see section 4).

The first (small) MOOC will be one of (hopefully) many others under the edge of “Mathematics Without Limits” (name adopted for IPP Maths MOOC) and it is expected:

- Help pre-university students to prepare for the National Mathematics Exam – all the contents were carefully built with this goal in mind ;
- Allow the public in general to refresh or gain some training in the contents developed, for each item;
- Reverse the “general” misleading conception in learning Mathematics – it is difficult, (so I) don’t understand it, (so I) don’t like it and...(so on).
- Give a friendly way of managing each one’s learning commitment;
- Avoid premature abandon providing a friendly way of managing each individual learning commitment.

This particular course was chosen also by a combination of other factors:

- Previous team experience with e-learning systems;
- Attract new “future” students for IPP;
- Increase national and international visibility of the IPP;
- Importance of developing a new teaching model and learn by doing methodology.

The idea of placing course materials online is not new. Since the early 2000s, HEI have provided access to course materials, lecture notes, assessment materials, and lecture recordings online. One such precursor was Massachusetts Institute of Technology OpenCourseWare (MIT OCW) project created in 2002 where course materials for approximately 2150 courses are available, among these course materials are complete sets of video lectures available for about 50 courses [1].

One more example of a massive collection of course materials is Open Yale Courses, started in 2007 at Yale University. Each course includes a full set of class lectures produced in high-quality video accompanied by such other course materials as syllabi, suggested readings, exams and problem sets. The lectures are available as downloadable videos, and audio-only version is also offered [2]. Many other HEI were launching similar initiatives about the same time as well.

2 A BRIEF HISTORY OF MOOC

In September of 2008, George Siemens (Athabasca University), Stephen Downes (National Research Council) and Dave Cormier (University of Prince Edward Island) created an open course called Connectivism and Connective Knowledge, also known as CCK08 [3]. It was the first course to incorporate open learning with distributed content, making it the first true MOOC. It attracted 2200 participants worldwide. Fig. 1(retrieved from [5]) shows the structure of the CCK08 course network [4].

Participants in the course were encouraged to develop their own online presence in order to add some value to this distributed resource network. The course authors then used a content aggregation tool in order to bring all the contents/contributions in one place.

A major element of the MOOC was therefore the Daily Newsletter, which gathered the aggregated contents, events and discussion, and distributed it to course participants each day.

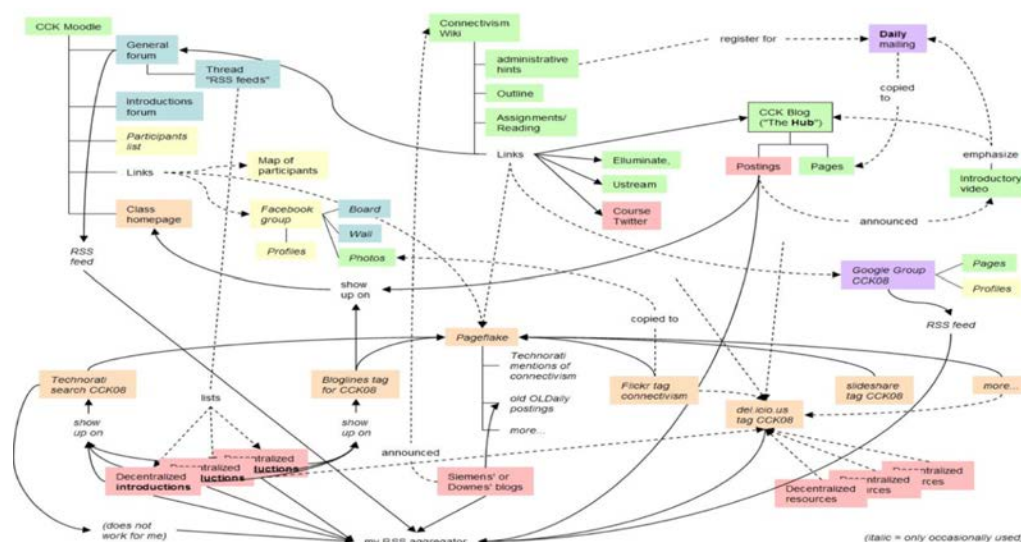


Fig. 1 Structure of the CCK08 course network by Downes and Siemens

Initially MOOC were created for very specific pedagogical concepts, but quickly it took a huge dimension without necessarily following the initial design. For this reason, in 2012, Siemens [4] came up with the terms “cMOOC” and “xMOOC” to distinguish between connectivist massive open online courses (cMOOCs) and Coursera and edX massive open online courses (xMOOCs). This second type of MOOC is essentially developed by world-leading campus-based universities (such as Stanford University or Massachusetts Institute of Technology) as a progress of an institutional strategy concerning on-campus teaching and digital technology [6].

Another significant factor that differentiates an xMOOC from a cMOOC is who are behind them. Instead of a group of individuals building the course as in a cMOOC, an xMOOC usually has one or more HEI behind it, and, in some cases, a for-profit company [7].

According to Downes [8] a cMOOC is designed as a network, while an xMOOC is based on a central course site and content that will be followed by all students. The xMOOC, is like a traditional HEI course. It typically requires the development of custom content and, therefore, is usually very expensive to build. xMOOCs are sometimes mentioned as not pedagogically driven, and the consequence is that they assume pedagogies mainly based on behaviourist psychology [9].

Within a cMOOC, learners are encouraged (though not required) to contribute actively, using these digital platforms. The participant's contributions in form of blog posts, tweets etc. are aggregated by course organizers and shared with all participants via daily email or newsletter. cMOOCs are also not typically sponsored or funded by higher education institutions but are organized by individuals with a passion for a specific content area. Organizers commit their time to create a framework for learning where participants from all over the world can connect, share, contribute, collaborate to learn and expand their professional and personal network. cMOOCs are also open and flexible, receptive to needs of its participants which can provide a tailored learning experience [10].

MOOC had blowup into the academic perception in summer 2011, when a free artificial-intelligence course offered by Stanford University in California attracted 160 000 students from around the world, 23 000 of whom finished it.

In 2012, new endeavours such as edX[11], Coursera [12] and Udacity [13] introduced more than 200 online costless college courses made accessible to any person with an Internet connection[14]. These courses exploit web technologies to offer free online education to as many persons as possible. In May 2012, Harvard and MIT inaugurated the non-profit edX and, since then, the University of Texas and the University of California Berkeley have joined them. The for-profit MOOC platform, Coursera, was launched with a merging partnership of 33 colleges and it exposes contributions from Princeton, Stanford, Penn, Duke, Ohio State, the University of Virginia and other colleges. Another for-profit MOOC platform, Udacity, was co-created by Stanford professor Sebastian Thrun, David Stavens, and Mike Sokolsky [14].

It is easy to understand why MOOC are making such a storm in higher education world. They are free, so they can help decrease the runaway costs of higher education for students; some of the world's best universities are teaching them; they are available online, so students from anywhere can access to them and learn anytime; and they commonly offer courses in high demand areas such as computer programming, engineering, and mathematics [15]. Although now, the overall common feeling is that, in some years, there will not be a reverse point for HEI, being MOOC the future of learning globalization, many argue that this is just a passing by "tornado" (not even a real storm), and that, like e-learning courses, it has his "boom" days counted. Credibility, Assessment and Certification are the most frequented open issues, some of them discussed in the next section, but many other questions arise, like David Willey posted in [16], many MOOC are not open; some not massive and some not even "courses" or the risk of turning MOOC into some kind of "second choice education" as Tony Bates referred (quotation in [10], pp.93).

3 ADVANTAGES AND DISADVANTAGES OF MOOC

Although the concept of MOOC looks completely attractive, there are certain challenges that need to be addressed. We will see some points of view of the opponents and proponents of MOOC.

3.1 Advantages

- **Free:** Most MOOC are free or practically free, a definite plus for the student. One of the most important factors for a lot of aspiring students is whether or not they can afford the high education fees required for enter on a course. With MOOC, all they need is a computer with an Internet connection.
- **Quality:** Would MOOC achieve such popularity if Universities like Stanford, Harvard, MIT, etc., hadn't been the ones at the forefront of this-innovative change in education? The reason why so many students sign up for these courses is because they know that they will be taught by respected and renowned professors. On the other hand, because MOOC are short, professors are forced to examine every bit of material as well as their teaching methods.

- **Bring students together from all over the world:** A lot of students around the world dream about getting the opportunity to enroll in a popular university. However, due to stiff competition and limited number of admissions, only a select few are able to gain admission to these universities. MOOC offer an opportunity for these students to make their dreams come true, as they get the chance to enroll for courses offered by these universities. Among these students we can certainly find several from “the other side” of the globe, being this the only way to overcome distance restrictions and complement, their “national” individual learning process. We cannot forget to refer, as “probable” MOOC “clients”, the emergent economies from southern countries where the access to HE is still residual, but we have an entire (young) population avid of knowledge, and for MOOC, you only need an internet connection to learn.
- **New business opportunities:** Some MOOC companies launched in 2012: edX, Coursera and Udacity, are offering good business opportunities on science and technology fields.

3.2 Disadvantages

- **Make discussion a challenge.** It is very difficult to facilitate significant conversation in a classroom with 150 000 students. There are electronic alternatives: message boards, forums, chat rooms, etc., but the face-to-face communication is lost, emotions often misunderstood. This is a particular challenge for humanities courses. Heller writes, “When three great scholars teach a poem in three ways, it isn't inefficiency. It is the premise on which all humanistic inquiry is based” [17].
- **Grading papers is an impossible mission:** Grading thousands of essays or research papers is intimidating. Heller reports that edX is developing software to grade papers, software that gives students immediate feedback, allowing them to make revisions [17].
- **Make it easier for students to drop out:** Signing up is so easy, but studying to complete the course is a completely different thing. According to statistics, only 10% of students who start a MOOC are able to complete it. In this way, the MOOC, turns out to be not so massive as it seems...
- **Financial details and intellectual property:** Who owns an online course when the professor who creates it moves to another university? Who gets paid for teaching and/or creating online courses? These are issues that will need to work out in the upcoming years.
- **Faculties will be eliminated:** Some people see MOOC as destroyers of traditional higher education. Who needs professors when a school can hire an adjunct to manage a MOOC class? Fewer professors will mean fewer Ph.D.s granted, smaller graduate programs, fewer fields and subfields taught, the eventual death of entire “bodies of knowledge” [17].
- **Price of free teaching:** In general, teaching MOOC requires a lot out of professors. In this particular case there were four Mathematics professors that designed, drew, created a Pool of Questions (multiple choice, true/false, matching and embedded answers), animated and recorded a complete Probability and Combinatorics Course. Designing and delivering a MOOC is time-consuming: each professor spent over 150 hours on this MOOC just to put it in an “embryonic stage”, long before it even started.

4 DECONSTRUCTING “MATHEMATICS WITHOUT LIMITS”

“Mathematics without Limits” (or in its original version – in Portuguese – Matemática 100 Limites) is the first MOOC launched by IPP, for incoming HE students to prepare them for post-high-school courses using mathematics. “Mathematics without Limits” consists of three different Courses: Probability and Combinatorics, Introduction to Differential Calculus and Trigonometry and Complex Numbers. The Probability and Combinatorics Course (PCC) consists of nineteen different modules/lessons spanning four weeks, with a weekly average dedication of three to five hours. Topics covered include:

The Random Experiment and the Sample Space, Events and Operations on Events, Probability and Properties of Probability, Exclusive Events, Conditional Probability, The Intersection (and) Rule for Independent Events, Independent Events, Law of Total Probability and Bayes Theorem, Fundamental Counting Principle, Factorial of a Natural Number, Permutations, Combinations, Pascal's Triangle, Newton's Binomial Formula, Probability Distribution, Binomial Distribution and Normal Distribution. Most of the topics in the Probability and Combinatorics Course have already been taught in high

school.

The course also presents an entry test, not mandatory, named as “Math Diagnostic Test (MDT)”, which includes a diagnostic scoring report to help students to identify strengths and weaknesses in some topic areas, and provides students with a clear and objective perception of their initial level. Our aim was to not only focus on high school students, but also to make the course attractive to anyone interested in Probability and Combinatorics or Mathematics in general. The main page of the PCC is presented in Fig. 2.



Fig.2 Screenshot of the main page of PCC.

All modules have similar structure (see Fig. 3): have an ordered set of videos lectures where the respective concepts are presented along with several illustrative examples; after each video, students can take a small quiz, with 5 random questions, and apply the concepts addressed in videos-lectures.

Regarding Video-lectures, we analysed several potential formats⁽¹⁾, and, noticing that video style might have effects on learning performance and students' enrolment, we chose the very popular Voice Over Presentation style, whose main component is usually a PowerPoint presentation, supplemented with a voice over explaining the slides. These video-lectures, whose duration varies between 5 and 12 minutes, were created with Camtasia Studio software for a dynamical editing, over pre-animated PowerPoint presentations combining visual information with audio narration. It turned out to be a time consuming process since it took us quite long time to create our presentations, record the audio and synchronize it with slides.

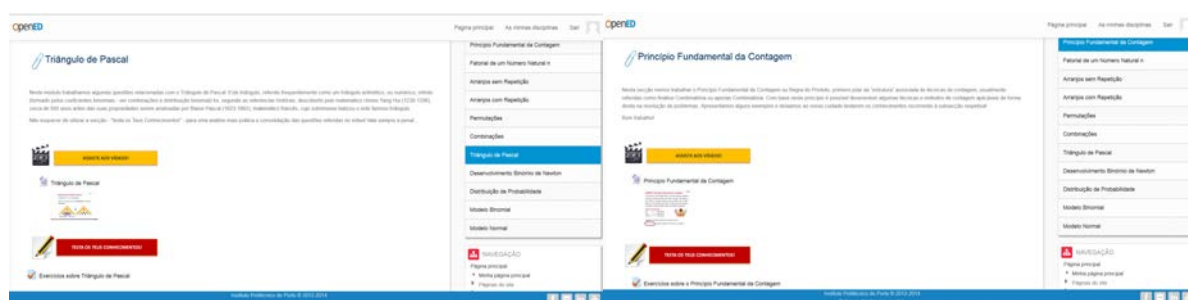


Fig. 3 Screenshot of the structure of “Pascal Triangle” and “Fundamental Counting Principle” modules.

Concerning the quizzes, students are allowed to have multiple attempts at each one of them. This can help to transform the quiz taking process into an educational activity instead of a simple assessment. As the quiz is randomized, the student will get a new version in each attempt, which will be useful for practice purposes. Feedback is provided for each question, allowing the students to see one (of the possible) proposed solution, step by step, as showed in Fig.4. The Pool of Questions, from which the

⁽¹⁾ The most common video-lecture styles, are: The talking-head lecture (which is the type used by most of the universities like, for example, Oxford, Stanford, MIT courseware, among others, and it usually uses a webcam recording of a teacher, during which he talks about the subject); Lecture Capture (the record of a live lesson or lecture at school or university) and the aforementioned Voice Over Presentation.

All the videos and each question from the bank were firstly reviewed by the four professors directly enrolled in the MOOC development and, afterwards, by a few Math IPP professors that volunteered to revise all the contents.



In order to have a dynamical course other activities, such as the use of forums, will be available. Any forum in which you can post messages also allows you to attach files to the message. Therefore, we will ask students to create a list of exercises for the next edition of the course: a student may propose an exercise with its solution and upload it on the platform. If the other students feel that the proposed exercise is interesting then they can vote in this exercise. At the end of the course we will have a list with the most voted exercises. The name and country of the students, who proposed each exercise that is in the list, will be identified.

Forum allows all MOOC participants to communicate with each other, and we can use it also as News or Announcement forum where instructor may post an announcement to students. We intend to launch, as well, an open question forum - "Doubt Ed" – where participants may question professors and other participants about all kind of doubts they have in course context. There is no limit to the number of forums which can be in a course so it is important that the forum will be well organised.

In this first MOOC we have chosen our own platform (Moodle), because it's an open source, highly expandable and customizable. We thought it was the most appropriated because we wanted a full-featured Learning Management System. One of the great strength of Moodle is its combination of full functionality with extensive customization options. Moodle offers all the basic course elements plus fairly advanced elements. As Moodle is open source, users have the ability to customize nearly everything within their implementation. With this platform we have autonomy and independence; however we are aware that if we had opted by a platform like for instance, Coursera, Edx or Miriada X the impact would be better because these provide basic services for the implementation and delivery

of MOOC, offer advertising and “massive” reach, are more appropriate for massive “external” consumption but on the other hand has high cost.

It was also very important that the MOOC was led by a team who was enthusiastic for the initiative because it is hard to create a course from the ground up without many resources available. Our team consists of four Mathematics Professors, who created the PowerPoints, the videos and a set of exercises with more than 280 questions. Furthermore the fact of having some background experience, granted by MatActiva Project ([19], [20], [21], [22], [23]) helped us to structure this first MOOC.

Based in our experience and research we decided to develop short duration courses, 4-6 weeks length. With this decision we estimated to aid retention of participants by giving them a convenient timeframe for their learning commitment.

It takes an immense amount of work to produce an adequate MOOC and a staggering amount of work to produce a really good one.

One of the reasons why professors responsible for this project were drawn to MOOC was altruism, a desire to increase access to higher education and Mathematics courses worldwide.

6 CONCLUSION

MOOC represent a potential educational technology with a very fast development. They are a quickly growing global phenomenon changing the way how knowledge and education are being spread widely and followed in the world.

For instructors, particularly for those who are at the early stage of their careers without much experience, MOOC can give them a chance to become students again and learn the art of teaching from tutorial videos and examples provided by experts. For students, MOOC can offer an opportunity to improve their knowledge about their favourite subject or about difficult subjects, as well as go further than the curriculum of their academic programs.

Another important feature is that a MOOC does not necessarily stop once the course closes. All MOOC “contents” can be (re)utilized, with the eventual necessary adaptations, to a “flipped classroom” enrolment, where professors send students home with assignments to listen or watch a video lecture, solve one particular problem, and return to the classroom for more valuable discussion time or other interactive learning.

Based on our experience, we can say that not everything is an advantage in MOOC. They require in advance a huge preparation and a big effort from professors and the complete enrolment of an editing team. They need investment in advertising or to be put in the hands of a MOOC provider. The business model it's not clear, neither are the “real” benefits.

It is not yet defined how the institution is going to recognize the work of the professors involved (recognition as teaching time, as teaching hours' reductions or financial retribution).

To continue this study, we are now planning to collect data at the end of the course that is going to enable us to answer some research questions, test hypotheses, and evaluate outcomes.

MOOC are causing a revolution in HEI today. We would like to finish this paper by leaving one question. What will the impact of this “revolution” on teaching in HEI be, especially on Mathematics teaching?

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