Engineering MOOCs for Future Engineers: Integrating MOOCs into Formal Learning Environments

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Abstract: The implementation of MOOCs in formal learning environments is allowing students to access and interact with learning resources within an evolved educational paradigm where they are able to benefit from an unprecedented personalization of the learning experience. However, this shift raises significant questions regarding the compatibility of content and methodology with the formal requirements of higher education, the cognitive readiness of students to engage in virtual learning environments and the evaluation of the acquisition of knowledge and skills. On the basis of empirical studies carried out within formal learning environments, we demonstrate a generic learning approach that engineers MOOCs for the requirements of our course, ensuring that our students engage with learning content in congruent ways.

Introduction

The launch of multiple MOOC platforms including Coursera, EdX and Udacity marked a pivotal changing point in online education. Although the origins of MOOCs can be traced back much further, in 2012 these platforms collectively generated an unprecedented hype around online education (Hyman, 2012). The initial euphoria surrounding the launch of these platforms has subsided and the MOOC environment is entering a phase of maturity where multiple platforms, methodologies and pedagogical scenarios are flourishing.

As with all ICT for education developments and as these online courses make a formal entrance into higher education curricular, it is important to examine the different possibilities, reflecting upon the inherent virtues and shortcomings of the various developments and to propose effective curricular scenarios for the successful integration of MOOCs into traditional formal learning environments (Cruz Limon, 2002). Indeed, it is essential to consider the interest for both the teacher and the student, the different possibilities that such a venture can offer and on a fundamental level, the justification for the implementation of the scenario.

At both the Ecole Centrale de Nantes (French graduate school of generalist engineering) and Télécom Bretagne (graduate school of engineering in information sciences), we explored the integration of MOOCs with the objective of attempting to respond to the heterogeneous requirements of our students who are increasingly searching to personalize their higher education experience (Clegg and David, 2006). In addition, by accompanying our students in their exploration of online environments, we aimed at supporting them in their development of critical thinking skills as they engage in a constructivist learning process (Huang, 2002).

In order to encourage these processes, (Bruff et al, 2013) encourage the development of blended learning scenarios when integrating MOOCs into traditional formal learning environments, using præsential sessions in the form of thematic seminars to effectively discuss and analyse material discovered in the online environment. Following the exploration of different curricular scenarios and a conclusive initial experiment in 2012 (Carolan and Magnin, 2013), the institutions are conjointly adopting a similar blended learning approach to the integration of MOOCs by creating a common course that is "wrapped" around an existing online learning environment, ITyPA – *Internet Tout y est Pour Apprendre*.

Whilst the nature of the selected massive open online course that is built upon connectivist learning precepts implies a less formally structured approach, the objectives are very much the same. We will be examining the engineering and the integration of this MOOC into the specific environment of French engineering schools, developing transferable skills that are common to many curricular.

The MOOC Ecosystem

Within the ecosystem of MOOCs, we can identify two categories of MOOC: the xMOOC or extension MOOC, based on a transmissive pedagogical approach that attempts to reproduce elements of classical university courses within a virtual environment and the cMOOC or connectivist MOOC based on a less prescriptive approach with the organizer as facilitator and the students building their learning paths based on interaction with both the content and other users. These notions were first practiced by Siemens, Downes and Cormier (McAuley et al., 2010).

In addition to these major categories, the learning experience can be sub-categorized according to several other factors including whether they are institutional or individual initiatives, whether they are synchronous or asynchronous, whether they are deterministic or self-deterministic, whether they involve

individual or group work, with all of these factors contributing to their degree of openness. These characteristics are present in the taxonomy developed by (Clark, 2012) who attempted to provide a more comprehensive and inclusive categorization of MOOCs. In all, Clark defined eight categories of MOOC that are not necessarily mutually exclusive. This taxonomy can be further exploited by defining the scenarios and modalities that higher education establishments implement for the exploitation of MOOCs in formal learning environments.

In the first scenario, one finds educational establishments that have undertaken strategic infrastructural investments to produce learning platforms that provide extracts or complete courses offered within their establishment and/or the establishment of key educational partners that we shall refer to hereafter as **Macro MOOCs**. These platforms primarily based in start-ups emanating from Ivy League colleges in the United States of America offer access to a wide catalogue of xMOOCs. As well as providing an important means for the dissemination of knowledge, these platforms are important communication tools for outreach and are increasingly important sources of revenue (Welsh and Dragusin, 2013).

The second scenario concerns smaller establishments that previously offered a handful of online courses to their students and have taken steps to open their courses to a wider public or have specifically created a small number of online courses often referred to as **Micro MOOCs**. These courses are generally created and managed on the impulse of professors interested in the impact of ICT in education in relation with pedagogical engineers and rarely benefit from sustained financial investment.

The third scenario concerns establishments that allow students to follow pre-identified MOOCs in order to obtain a certain number of the required credits for their course upon completion and are referred to as **For-Credit MOOCs**. These courses are generally made available to allow students to punctually personalize their learning experience and to gain access to expertise outside of their chosen establishment.

The fourth scenario refers to establishments that allow students to follow pre-identified MOOCs whilst imposing a certain number of additional environmental constraints in order to bridge the gap between the formalized physical and virtual learning environments. These environmental constraints generally include additional præsential sessions and/or complementary activities. We shall refer to these scenarios as **Integrated MOOCs.**

Qualifying Learning Experiences

Following the veritable surge of MOOCs into the education landscape in 2012, researchers and educators are now adopting a more critical and analytical approach to examining the integration of these elements into learning sequences. It is important to question whether these courses can adequately meet the demands of higher education where students are expected to go beyond drill and practice into a more critical phase of study.

The majority of institutions that provide MOOCs claim that the learning experience of online students is very similar to that of their institution-based counterparts. To encourage this sentiment, they provide certification for users who successfully complete courses. These certificates, whilst representing an achievement for online users, currently have questionable academic value (Bachelet and Cisel, 2013).

On a conceptual level, there are equally many divergences between these virtual and physical learning environments. It is difficult to translate the discreet learning encountered in physical environments into online environments. Traditionally, in a seemingly passive lecture hall, teachers are constantly interacting with learners, adapting the delivery of content in function of their reactions. In addition to these implicit interactions, the social education that these formal learning environments impart is seemingly lost.

In order to counteract these deficits and to enable course organizers to manage the "massive" participating public and its varied productions, many platforms have introduced mechanisms of peer support and peer assessment, encouraging participants to exchange experience and knowledge. This has a positive effect on the student experience as they find themselves alternately in the roles of both learner and tutor yet serves to further discredit the academic value of the student's achievements (Bachelet and Cisel, 2013).

This is particularly well illustrated if we consider For-Credit MOOCs more closely. When an extra-institutional MOOC is integrated into a traditional university course, it is difficult for teachers to effectively follow student progress and to evaluate the impact of these courses on student learning. This is particularly hindered by the fact that many of these courses are operated on a pass or fail basis and therefore do not necessarily confer a grade. In addition, the majority of the student productions are stocked on servers to which the institutional staff does not have access.

It is for these reasons that the community is becoming skeptical towards the implementation of MOOCs in traditional university courses. According to a survey carried out by *The Chronicle of Higher Education*, seventy-two percent of MOOC professors believe that students who complete extra-institutional MOOCs should not obtain credit from their institutions (Kolowich, 2013).

In order to put these aforementioned issues into perspective and to better apprehend them, we can collate the defining characteristics of MOOCs with the established MOOC in higher education models as shown

in the table below. Consequently, this will enable us to tailor the online learning experience to the specificities of the physical learning environment and the expected learning outcomes.

Table 1: General characteristics of the four models of MOOCs in higher education.

Characteristics	Macro MOOC	Micro MOOC	For-Credit MOOC	Integrated MOOC
Institutional or Personal Initiative	Institutional	Personal Initiative	Institutional	Institutional
(A)synchronous	Synchronous	Synchronous	Asynchronous	Synchronous
Deterministic or Self-deterministic	Self-Deterministic	Self-Deterministic	Deterministic	Self-Deterministic
Individual or group	Individual	Individual	Individual	Group
Relative openness	Highly formatted. Limited occasions for interaction.	Increased proximity between organizers and participants.	Open in terms of choice. Limited in terms of interaction.	Increased potential for interaction and personalization.

If we examine the MacroMOOC, the institutional affiliation of the course supervisors and the synchronous nature of the course creates a highly structured environment for formal learning. The implication of the participant in the course can be considered as self-deterministic as there is no formal obligation for the participant to complete the course. Participation in the course is generally on an individual basis with occasional limited and relatively anonymous interaction between participants in the MOOC's forum and through eventual peer assessment. The sheer mass of participants limits all interaction between the course supervisors and the participants.

In relation to the MacroMOOC, the amplitude of the MicroMOOC affords greater interaction between course organizers and participants leading to a greater implication of the participant in the management of the learning experience and instant qualitative feedback for the course organizers. However, MicroMOOCs receive limited public and academic recognition meaning that the learning experience is perceived to be considerably less formalized.

For-Credit MOOCs afford a greater personalization of the learning experience for the students and allows them to benefit from external competence. However, the impact of this process is hindered by the asynchronous nature of these courses and the limited possibilities for student interaction. Student participation is equally constrained by extrinsic motivational factors that limit the self-determinism of this learning model.

As the fourth and final model refers to a specific online course, the Integrated MOOC, provides less freedom for students in terms of choice and they may therefore be considered to rely upon extrinsic motivations. However, this is largely compensated by the fact that the Integrated MOOC allows for the greatest personalization of the learning experience as students are encouraged to explore course content in both the virtual environment and the physical environment of their learning institution.

Bearing these elements in mind, we considered it important to question the first three aforementioned scenarios and therefore adopted the integration of the fourth scenario, where the learning experience of the student is engineered in order to capitalize upon the time spent online. This choice was not without its own risks as by engineering student participation in these courses, we could interfere with the self-deterministic values of both online formal and informal learning. In order to effectively undertake this process, we developed the strategy that will be described herein.

elTyPA – Engineering The Learning Experience

ITyPA (*Internet Tout y est Pour Apprendre*) (Gilliot et al., 2013) is the first Francophone connectivist MOOC. The global objective of this course is to allow users to collaboratively explore and implement Personal Learning Environments. Launched in October 2012, the first edition attracted in excess of 1,300 users. Each week, participants would collaboratively explore one of the pre-defined themes, sharing knowledge, resources and experience with other users. This would culminate in a weekly hour-long synchronous online intervention that was then made available asynchronously, where the co-conceptors of the course would discuss the subject with invited experts. Participants were able to interact with the presenters and the identified experts by commenting on the live feed, Twitter feeds and internet relay chat channels.

ITyPA 2, launched in October 2013 built upon the legacy of the first edition through the creation of a dedicated user platform where users were be able to regroup their resources and through the introduction of gamification precepts through badging. The 2013 edition also saw the introduction of regional, national and international partnerships that served as relay sites allowing participants to meet and interact physically and/or virtually, based on geographical proximity or in relation to common objectives. The Ecole Centrale de Nantes and Télécom Bretagne were partners of ITyPA 2, providing relay sites for ITyPA participants and, on a more formal level, providing accreditation for participants seeking certification through badging.

These establishments who are training future engineers to meet the challenges of modern industrial environments also proposed eITyPA, an engineered elective version of ITyPA to their fourth year and fifth year students. The elective nature of this course was considered to encourage the students to adopt an intrinsically motivated approach. The course was therefore freely undertaken by around ten percent of students with the course officially representing the equivalent of around 35 hours of classroom time with students generally devoting 3-4 hours per week to this course over a 10-week period followed by a period of individual and group reflection (Carolan and Magnin, 2013).

Engineering Course Structure

Following an initial experiment in 2012, involving around 50 students, we were able to analyze the attitudes of learners towards this online course (Carolan & Magnin, 2013). Whilst the majority of students were very positive about their experience, certain students highlighted the difficulties they had in understanding how to position themselves in relation to a connectivist approach to learning, others expressed the difficulties they encountered due to the lack of structure that is inherent to connectivist environments, echoing the findings of (Mackness et al., 2010). In order to address these issues we have modified our on-site handling of the course. This is a complicated process because of the aforementioned risk of interfering with the self-deterministic qualities of online learning. We therefore integrated a certain number of constraints to the course whilst allowing learners a high degree of flexibility in their application.

The first modification that we made to the cursus was the introduction of a third præsential session within the course syllabus. In 2012, students were to attend two formal interactive sessions. The first session occurred at the mid-term and encouraged students to reflect together on their experience and to ask questions relating to concepts that they didn't fully master or understand. The second session, which occurred one month after the end of the course, engaged the students in an analytical process whereby they were encouraged to question both the pertinence of the learning experience and their positioning within the learning environment.

The aforementioned third session was planned in the days leading up to the course and exposed the students to the variety of online learning environments and associated learning styles in order for them to position themselves within the online learning context with greater ease. It was considered that this would present a social benefit for the students who would be able to identify fellow participants in the physical space, therefore increasing the potential for exchange. This is an essential factor in online learning, underlined by Mackness et al. (2010) who stress the importance of moving from connectedness to veritable interaction.

This supplementary session was specifically designed to address the issues relating to appropriation of the online learning environment. In association with experts in the different fields explored during the course, we presented the students with the ecosystem of online learning, attempted to position MOOC ITyPA within this context and explored the notions of connectivism. This session was organized in the resource center of the establishment that is used by a great deal of these students, allowing them to become conscious of a cornerstone in their personal learning environment. The question of physical space in online learning was raised by a previous study where students would often meet up in order to follow the weekly synchronous sessions together.

Early indications tend to show that this additional session had a significant effect on student understanding of the notions of connectivism and the necessity for them to set personal objectives that drive their participation. Students were able to raise fundamental questions about scientific terms that in our preconceptions we had wrongly considered to be assimilated such as mindmapping and strategic intelligence.

During this session, the students were made aware of the importance of tracking their progress throughout the course in order to develop an analytical approach to the course from the onset. The second major modification that we proposed contributes towards this activity. In agreement with the course supervisors, the syllabus was formalized by dividing the nine topics covered across the course into three clearly identifiable three-week long learning sequences. The first sequence encouraged participants to explore the very nature of personal learning environments, the second sequence encouraged participants to engage in meaningful interaction with their peers and the third and final sequence allowed participants to capitalize on their learning experience and to consider the evolution of their personal learning environment.

Students were then set the task of critically reporting back on online activity related to at least one of the topics of their choice from each learning sequence. This was designed to go some way to addressing the issues raised concerning the suitability of online courses for developing the transferable skills that a traditional university education provides. It also provides material evidence of the student's implication in the virtual course and the resulting progress they have made.

This is essential when we consider the dynamics of online communities. As a general rule, in online communities, around five percent of members are memorably active, around ten percent of members are moderately active and the remaining eighty-five percent of members follow the activities of the more active members. This natural balance ensures that the ratio between content producers and content explorers remains viable (Waard et al, 2011). It would therefore be logical for the majority of our students to follow the activities of the other members of the group without proposing content. This does not mean, however, that they are not

engaged in active learning processes. It is therefore necessary to provide them with a channel for the formalization of this learning experience.

The final major modification was the introduction of gamification precepts, notably goal-focused activities, to the learning experience (Glover, 2013). At the beginning of the course, students were presented with a series of challenges that they could choose to undertake. The list of challenges included, post a comment on a blog-post of a fellow participant, share three useful weblinks that you have discovered, engage in a meaningful exchange with a participant outside of your educational establishment. These challenges were designed to motivate the students to set achievable goals and provide supplementary sources of interaction that would encourage them, in turn, to set each other challenges. It was intended that this final modification enable students to surpass the comfort zone represented by the community of institutional peers, a vital precept in connectivism, the importance of which the students often realize a late stage (Carolan and Magnin, 2013).

Evaluation Design

The impact of these modifications on motivation, participation and the acquisition of skills and knowledge is measured through the independent completion of a questionnaire. Organized into five different sections, the questionnaire includes both open and closed questions that cover their participation across the course. The first section entitled "Preparing for the Course" encourages students to reflect upon their motivations for choosing the course, their awareness of online learning environments before the course and the impact of the first præsential session on their understanding of the course. The second section entitled "Your Learning Environment" asks participants to reflect on the spatial and temporal conditions of their learning and the potential impact that external factors may have had on their motivation and participation. The third section entitled "Assessment of Your Experience" asks students to consider their acquired knowledge and skills, the obstacles to their acquisition and how they eventually overcame these obstacles. The fourth section entitled "Where next?" requires participants to consider how the knowledge and the skills that they have obtained during the course will evolve in the months immediately following the course. Finally, the fifth section entitled "Over to You" allows students to freely comment upon their experience and suggest possible evolutions for future participants.

The results of this questionnaire* will enable us to qualitatively assess the impact of this course and the modifications provided on the learning experience of our students. Further analysis of the results of our empirical study into motivation, participation and the acquisition of skills and knowledge from a student perspective through their correlation with our previously established results (Carolan and Magnin, 2013) and with the statistics resulting from learning analytics will enable us to qualitatively assess the impact of these modifications. Comparing these results with the teacher-based assessment of student participation and acquisition of skills and knowledge that results from the analysis of student productions will allow us to take this process even further.

Conclusion

The engineering of the ITyPA MOOC experience is allowing us to reach a sustainable balance between the inherent virtues of both online and traditional learning environments. The MOOC environment is allowing our students to engage in self-deterministic learning, developing their autonomy and broadening their horizons within an international context whilst the physical learning environment is allowing them to channel this knowledge with hindsight and in concordance with the requirements of the local context.

Within this context and having explored the different options for the integration of MOOC into traditional formal learning environments, one major question still remains. Is it preferable to create a MOOC for the "massive" public and then subsequently engineer it for the specificities of a learning community (MacroMOOC or Integrated MOOC) or to take existing courses and simply mediate them (MicroMOOC or For-Credit MOOC)? Indeed, it appears that the engineering of MOOCs is more suitable to higher educational environments.

Firstly, the engineering of MOOCs allows for the integration of the essential critical thinking skills that differentiate university education from primary and secondary cycles. Secondly, it ensures a coherent compromise between the need for the student to personalize their learning experience and the need for establishments and society as a whole to impose consistent benchmarks. Thirdly, this scenario allows for the distribution of the MOOC to a wider public, allowing the institution to capitalize on an increasingly important communicational tool.

***Results will be available following the course that ended in December 2013 and will be discussed during the eMOOCs 2014 conference.**

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