A Massive Open Online Course (MOOC) for Implementing Pedagogical Tools in Undergraduate Respiratory Physiology

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A Massive Open Online Course (MOOC) for Implementing Pedagogical Tools in Undergraduate Respiratory Physiology

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Abstract

Massive Open Online Courses (MOOC) have received increasing attention in recent years for their potential to engage on-campus students in active learning while conveying knowledge to a broad international public. In this article, we describe the creation of a MOOC as a mandatory integrated supplement to a respiratory physiology and pathophysiology university course taught to undergraduate medical students. We discuss how this MOOC integrates several didactical tools such as flipped classroom activities, peer-review evaluations, active learning principles or multidisciplinary fundamental-clinical approaches. The impact and satisfaction analysis on 8,400 participants, including seven percent of medical students, suggests that a specific scientific subject from an undergraduate medical curriculum could stimulate the motivation of both on-campus and international students. This MOOC experience renews the view on medical education and deserves further development.
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Key Words: MOOC, international education, medical education, undergraduate medical curriculum

Introduction

Advances in communication technology have triggered the development of online teaching since Professor Sidney Pressey created the first electronic learning device, the 'Automatic Teacher', in 1924. Since then, we have been observing a shift in the development of online education where the influence of change in education has replaced change in technology with a growing focus on soft skills and education (Adams and Morgan 2007). It is in this perspective that Siemens and Downes from the University of Manitoba created the first massive open online course (MOOC) in 2008. This MOOC had a decentralized non-linear structure based on networking and focused on exploration and conversation rather than on instructor-provided content (Mackness 2013). It was however, a few years later that MOOCs met their huge popularity with a course by Sebastian Thrun and Peter Norvig from the University of Stanford titled "Artificial Intelligence" that was taught in 2012. This new MOOC followed a more traditional teaching approach being hyper-centralized, content-based and linear. Today, MOOCs are typically focused around a set of short, modularized video-lectures, followed by different types of assignments, e.g. multiple choice questions, quizzes, etc.

Given the advantages of MOOCs and their use in education, it is surprising that medical schools have been slow to adopt them. Ninety-eight MOOCs related to health and medicine were offered in 2013 (Liyanagunawardena 2014). Although it is widely accepted that online learning is effective, the potential role of MOOCs in medical education remains under researched (Pickering 2017). Even the description of a medical MOOC design remains scarce (Murphy 2013, Reinders 2016, Swinnerton 2017).

That is why we decided in 2014 to create a MOOC format as a supplement to a medical course titled "Respiratory Physiology and Physiopathology", which is taught to undergraduate students in the second year of medical school at the Université Catholique de Louvain (UCL, Belgium). The main objectives for this ambitious project, in addition to opening an international course, targeted the teachers of two groups of learners, students on campus and international students. For the international teacher and his/her university, the aim was to provide an innovative tool that would help to stimulate and reinforce student motivation. For the on-campus teacher and his/her students, the aim was to foster active learning by using the MOOC as a tool in a flipped-classroom. The MOOC was envisioned as an opportunity for international students to master human respiratory physiology (excerpt from the text of the video teaser: **https://www.edx.org/course/respiration-human-body-louvainx-louv8x-1**) while attending a university level course.

The aim of this article is to describe the steps that lead to the creation of a new MOOC in medical undergraduate education by focusing the reader's attention on the pedagogical tools underlying its construction.

Method

Respiratory Physiology and Physiopathology is a course taught to undergraduate students of the second year of medical school at a large French-speaking University in Belgium. This course is offered every year to an average of 300 students and represents three credits out of a total of 60 credits needed to complete the medical school program.

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The MOOC

The MOOC "Louv8x: Respiration in the Human Body" was created as an integrated complement to a Respiratory Physiology and Physiopathology course, rather than as a replacement for the course. It follows the structure of a traditional course in which the theoretical content is transmitted through videos followed by multiple-choice quizzes or other types of assignments. Clinical cases are used as a starting point to introduce the basic and fundamental pathophysiological concepts presented by the textbooks of West (West 2007) and Nunn (Lumb 2016) and by the clinical instructor's experience. Louv8x contains five major sections:

1) the basics of breathing (atmosphere, anatomy, physics)
2) oxygen and carbon dioxide
3) daily breathing (sport, altitude, pregnancy, diving)
4) breathing and diseases (asthma, emphysema, pulmonary edema, pollutants, and smoking)
5) supplements for medical students on pulmonary compliance, surfactant and fibrosis.

Video capsules

Video capsules constitute the framework of the course content, as is typical for all MOOCs. The aim of these videos is to convey a large amount of information in an efficient way despite the relatively short length of the video. We therefore used two main sources of inspiration. The first source was Khan Academy, which is an educational organization created in 2006 by Salman Khan. This organization provides free lectures through short YouTube videos illustrating theories of various topics in a tablet drawing style. Supplementary exercises and tools for educators are provided. The second source was *'C'est pas Sorcier'*, a very popular French educational television program that produced 559 episodes between 1994 and 2014 on diverse topics such as history, biodiversity, physics or health. *'C'est pas Sorcier'* provides theoretical explanations of scientific phenomena through field visits, miniature models, and lab experiments. By referring to these two educational designs, we aimed to capture and hold the student's attention by conveying the information in different ways. Students are alternately presented with simple graphs and diagrams created with a drawing application. Interviews with experts are shown, and metaphorical representations such as an electric train to represent oxygen transportation, nylon stockings to represent lung compliance, and a bathtub to represent ventilation, are used throughout.

Discussion forums and quizzes

In addition to providing knowledge with videos, we proposed features for promoting student comprehension. Quizzes and questions follow each video and guide students in their learning and understanding. Inviting students to share their learning experience in the forums triggers cognitive and emotional engagement. It is worth noting that the educational team is not excluded from these interactions as they follow up on the forums and propose 'hangouts' sessions consisting of live 'question and answer' sessions.

Daily work

Each video capsule is followed by creative, concrete, and personal assignments the aim of which is to promote active learning. For instance, students can be invited to:

(1) *Apply* knowledge they have acquired. For example, to 'simulate hyperventilation', the student is asked to lightly hyperventilate and write down the symptoms experienced and estimate the alveolar ventilation.

(2) *Analyze* clinical data. For example, to 'estimate the expiratory flow in asthma patients', the student must calculate his theoretical peak flow using tables and compare it with imaginary pathological values.

(3) *Synthesize* clinical information. For example, the student is asked to 'choose a respiratory pollutant, and summarize its mechanism of action'.

Evaluation

When constructing the evaluation tools, our choices were guided by the desire to have tools that would not be only evaluative but also be formative. More precisely, for the evaluative part, students are invited to answer short assignments after almost every session. They are presented with multiple-choice quizzes and image-based exercises in which the student is asked to point to a certain part of the graph/image or enable annotation problems e.g. problems to which the answers are limited to a word on number.

Finally, a mid-term and a final exam were proposed consisting of open questions assessed by peers. More precisely, participants had to answer a few open-ended questions. A few days later participants received an evaluation grid for assessing two other participants as well as their own work. In sum, each paper is evaluated three times and the end score represents the mean of the three evaluations (Chen 2012, Speyer 2011). The peer evaluation technique is an opportunity to engage student involvement and responsibility. Students are encouraged to reflect on their work and contribute to the group. They are encouraged to develop their judgment skills and to provide relevant feedback (Bostock 2000, Karakitsiou 2012). In addition to their usefulness, the development of these skills is a requirement for our undergraduate students. Peer assessment is a very handy tool to help students acquire these competences.

Flipping the Classroom

One of the aims of creating this MOOC was to use it as an innovative tool to complement the on-campus course in a blended learning strategy known as a "flipped classroom". Part of the instruction for a flipped classroom is delivered online outside the class while the educator guides students to apply the theoretical concepts and engage creatively in the subject during the classroom sessions. This type of

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teaching is encouraged by education experts and contrasts with the traditional lecture where students passively receive information from the instructor (Prince 2014). In addition to being a positive experience for students, active learning methods also imply a change in the role of the instructor, who becomes rather a 'guide on the side than a 'sage on the stage' (Stinson and Milter 1996).

Target audience

The MOOC "Louv8x: Respiration in the Human Body" was created as a supplement to a university course. Hence a sufficient level of complexity needed to be maintained so the MOOC could be used as a complementary tool to the classical *ex-cathedra* course. Louv8X must stay nonetheless accessible to everyone so no prerequisites are required from the on-line participants who wish to enroll. Despite the many advantages that a MOOC offers to online and international students, our priority remains our on-campus students and our MOOC needs to benefit them first.

Analysis

After enrolling in Louv8x, participants were invited to answer an online survey about their occupation, the reason why they enrolled in the course, and their degree of familiarity with the MOOC's topic. At the end of the MOOC, participants were invited to answer a second survey related to their appreciation of the different aspects of Louv8x and their perceived competence before and after having taken the course. Students had to indicate on a ten-point Likert scale whether they disagreed or agreed with the statements. Degree of satisfaction was then reported on a four-point Likert scale that evaluated the following aspects of the course: workload, calendar, grading, quality of the videos and the quizzes, interactions, messages, hangouts, team presence, guidance and the technological environment.

A paired student t- test was used for comparing results before and after having followed the MOOC. A Mann-Whitney U test was conducted to compare the means of on-campus students and international students.

Results

The MOOC 'Louv8x: Respiration in the Human Body' was built during a six-month period preceding its first edition in 2015. Adapting the course into a MOOC required the mobilization of an educational team of approximately ten people (see acknowledgment section) that was involved throughout the whole creation process. The team was also involved in the course follow-up and the launch of each new edition. Third-year medical students managed the discussions on the MOOC forum and its translation into English.

Enrollment in Louv8X was as follows: 2,700 participants in 2015 and 5,700 in 2016 (51% in French and 49% in English), of whom 2,040 (24%) were considered as active and regular students. Medical students on campus represented approximately seven percent of the cohort.

The MOOC starts with an introductory video that offers an overview of the course content: https://www.edx.org/course/respiration-human-body-louvainx-louv8x-1
The course content is spread over eight weeks for a total of twenty videos of +/-10 minutes each. Figure 1 shows an example of a screenshot from a video made in the playful manner of the French "C'est pas sorcier" style. Figure 2 shows an example of Khan-style tablet drawing for explaining immunological aspects of asthma. We maintained a multidisciplinary approach with the videos with references to various disciplines such as histology, pharmacology or immunology. The link with these disciplines is particularly obvious in fifteen academic expert interviews inserted into the videos.

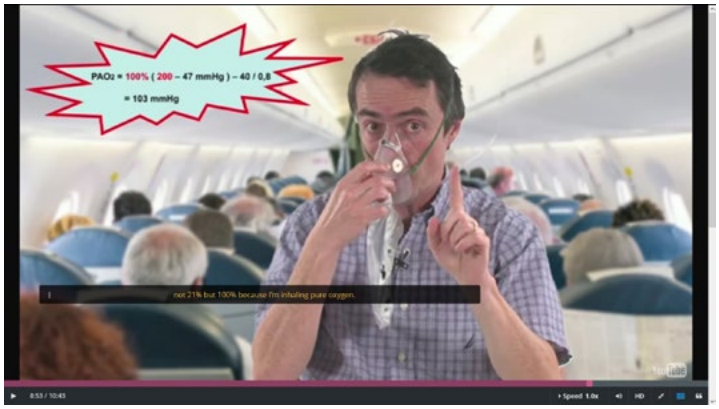

Figure 1. Example of screenshot from a video explaining changes in oxygen pressures in case of pressurization incident.

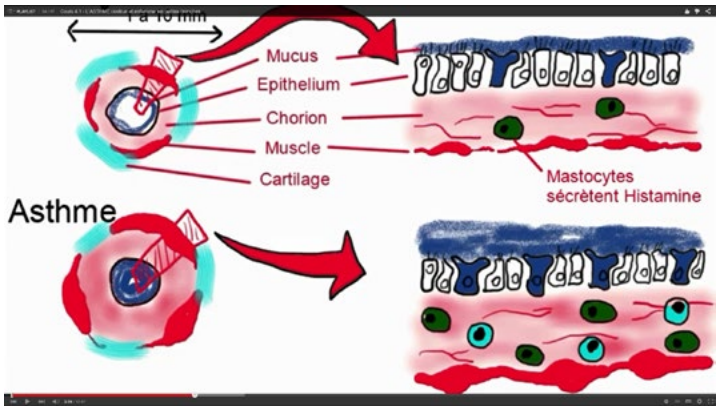

Figure 2. Example of Khan-style tablet drawing for explaining immunological aspects of asthma

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Each video session is followed by an evaluation of the student knowledge with short tests like multiple choice quizzes and image-based exercises (Figure 3). More complex learning tasks, demanding active learning, are then proposed in order to apply, to analyze, and to synthesize the knowledge. Answers to those tasks are posted on the discussion forum and eventually commented upon by the participants. This continuous evaluation constitutes the "daily work" category. The educational team also proposes two 'hangouts' sessions, the first one after 2 weeks and the second at the end of the course. The hangouts consist of live question and answer sessions broadcasted on YouTube: See the link: https://www.youtube.com/watch?v=NRvNCvHmLc0

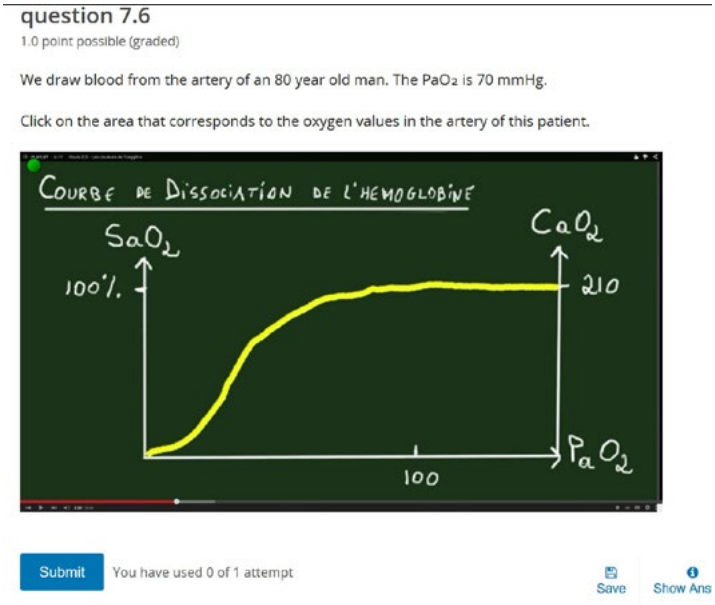

Figure 3. Example of an image-based exercise on the use of the Haemoglobin dissociation curve

A mid-term and a final exam are organized according to a peer-evaluation process. To obtain a certificate, both continuous assessment and final certification are taken into consideration for calculating the final grade. The certificate may be optional for international students. We made the peer evaluation task compulsory for the on-campus students. Extra points (five points out of a total of 20 in the first edition and two out of a total of 20 in the second) were added to the final 'traditional' university exam to those on-campus students who successfully followed the two peer evaluations certifications. We observed that 98% of them obtained the maximum grade.

We consider the time for following one video and its evaluation to be approximately one hour. To allow some extra time for the students, we reduced the number of classroom sessions from 35 hours to 31. The classroom sessions are designed to discuss the theoretical material students viewed at home through interactive 'flipped-classroom' activities such as multiple-choice exercises with Wi-Fi or SMS interaction, respiratory experiences conducted in the classroom, and above all, by taking the time to explain the more difficult aspects of the course.

Due to the scientific orientation of the Louv8x MOOC, it is expected that the international students have (or are willing to acquire) basic knowledge of biology and human anatomy in order to understand the scientific terminology. In total, 90% of 506 international participants answering a 'pre-MOOC' survey had a type of professional or non-professional understanding of the topic. A substantial number of active participants in the discussion forum were professional respiratory physiotherapists. Seventy percent of the participants (N=350) had a profession and only two percent of participants were looking to acquire a certificate.

One hundred sixty-eight students (on-campus students N= 59, international students N= 109) answered the post-survey to evaluate the added value of Louv8x in terms of competence and satisfaction. Table 1 shows the perceived competence evaluated as follows:

1) Evaluating: I am able to evaluate the quantity and quality of oxygenation of a patient.
2) Distinguishing: I am able to distinguish between normal and pathological states.

The self-competence perception before and after the MOOC was significant and similar for both groups of students. Table 1 shows that the mean satisfaction for each group and each parameter were above average. International students were slightly more satisfied than the on-campus students. These differences were statistically significant ($p < .05$) for workload, grading, educational design, video, interactions, and team presence.

	Online participants	(N=109)	On-campus Students	(N =59)
COMPETENCE	0 to 10		0 to 10	
	4.91 ± 3.18		5.24 ± 3.26	
	8.20 ± 1.40	p < 0.05	8.60 ± 1.58	p < 0.05
	5.48 ± 3.08		5.74 ± 3.00	
	8.42 ± 1.16	p < 0.05	8.64 ± 1.60	p < 0.05
SATISFACTION	0 to 4		0 to 4	
	3.67 ± .58		3.19 ± .85	
	3.69 ± .51		3.51 ± .65	
	3.65 ± .59		3.28 ± .82	
	3.64 ± .54		3.40 ± .69	
	3.94 ± .23		3.75 ± .51	
	3.93 ± .25		3.88 ± .38	
	3.64 ± .57		3.36 ± .72	
	3.14 ± .83		2.73 ± .93	
	3.66 ± .54		3.49 ± .57	
	3.32 ± .73		2.95 ± .89	
	2.03 ± .22		2.07 ± .32	
	2.79 ± .43		2.75 ± .48	

Table 1: Descriptive and mean comparisons on a scale going from 0 to 10 for competence, and 0 to 4 for satisfaction (going from 'Not at all' to 'Very much')

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Discussion

This paper described the creation of a MOOC as a supplemental tool for undergraduate medical students in which several instructional designs were employed while conveying medical knowledge to a broader public. In particular, we implemented didactical video capsules with a clinical context integrating fundamental and clinical information, peer- and self-evaluations, active learning principles, interactive discussions in forum, flipped classroom activities, and personal assignments. An improved perceived competence and satisfaction was confirmed both for on-campus students and international students, the latter declaring to be slightly more satisfied.

Cook *et al*. have previously pointed out that employing proven and context-appropriate principles of learning was more important in terms of learning efficiency than the modality, in this case online versus a traditional course presentation (Cook 2014). Our study confirms the feasibility of integrating several didactical tools into an undergraduate medical curriculum, those tools embracing student engagement and motivation. In this sense, we participated in the re-imagination of medical education, relying not so much on the technologies but on a pedagogical perspective about medical teaching and student learning (Doherty 2015, Prober 2013).

Criticisms and warnings have been published about the pedagogical value, the learning outcomes, and student time efficiency when using a MOOC (Daniel 2012, Hortsch 2015, Kirschner 2013). We therefore kept in mind throughout the creation and editing process that our priority in terms of course content and pedagogical goals remained our on-campus students. However, several factors might explain the slightly lower general satisfaction for the MOOC by on-campus students in comparison with international students. The general context for an undergraduate medical student involves a higher rate of constraints in terms of requirements for a successful examination. The integration of two didactical supports (*ex-cathedra* and online), the insertion of the MOOC amongst the general workload of second-year medical school courses, and the mandatory regular MOOC study throughout the semester instead of just before the exam session, may have been perceived as unnecessarily burdensome by some of the on-campus students.

Amongst the several challenges, dealing with two different student populations was critical. The international online students were far more numerous than the on-campus students, ninety-three percent versus seven percent. The population of on-campus students had a mandatory need to pass a university exam for a high-level university course. Dealing with two populations of different interests has been previously shown to potentially disrupt traditional teaching practices (Ng'ambi 2015). The rare on-campus student participation in the discussion forum or hangout sessions, the lack of interaction between on-campus and international students, the lower rate of peer-evaluation participation for the international students, all confirmed different behaviors between both populations.

The certificate value of the MOOC among on-campus students has been a subject of discussion: 5 points out of a total of 20 points for the first edition and 2 points out of a total of 20 for the second edition. There are currently no complete credits for university students following a MOOC and there is no guarantee of authenticity through the physical presence of supervisors during the examination (Doherty 2015). Factoring in the MOOC for part of the final certification mark seemed to us a compromise in valuing the weight of the MOOC in the final grade for on-campus students.

Finally, a major drawback we have noted in the creation of the MOOC is the financial and time investment that it requires. Previous articles have shown that benefits of online learning come at a price (Cook 2014). Considering those issues, while we do recommend trying the 'MOOC experience', it is important to consider at first the goals that one wants to reach in order to evaluate whether the cost-benefit ratio is satisfactory.

The main limitation to the MOOC concerns the low number of on-campus students participating in the surveys, limiting the weight of their contribution in the discussion. Our primary objective was to describe a new MOOC creation while considering its various pedagogical tools.

Conclusion

Creating Louv8X was a very satisfying experience and helped us to renew our view on education. The first editions proved that a very specific scientific subject in an undergraduate medical curriculum, such as respiratory physiology and pathophysiology, could stimulate the motivation and the satisfaction of both on-campus and international students. Using this tool in a context of a flipped classroom allowed us to increase our interactions with the on-campus students. Using a peer-assessment tool helped us to provide students with skills they need to acquire at the end of their study program. Using video capsules allowed us to integrate a multidisciplinary approach to a clinical context. Using personal assignments and interactive discussions allowed us to encourage active learning. We however want to stress that, although enriching on many levels, the efficiency of education and the pedagogy of medical learning were not improved by the MOOC itself, but rather by the way several pedagogical tools were included and tested throughout this MOOC. Given the costs in terms of time and money to develop a MOOC, we believe that the numerous pedagogical tools we have explored need to be further developed in medical education.

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