The MOOC Hype: Can We Ignore It?

Reflections on the Current Use of Massive Open Online Courses in Software Modeling Education

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Abstract. At the end of the 2014 MODELS Educators Symposium, a panel discussed the topic of the use of MOOCs (Massive Open Online Courses) in model-driven engineering education with the audience. Currently, there are no MOOCs that target software modeling. The panel argued if it would be worthwhile to investigate the idea of using MOOCs for modeling courses. Participants had different positions about the advantages and disadvantages of MOOC use in software engineering and modeling. This paper summarizes our positions on the current use of MOOCs in the teaching of software modeling and on its future use. We identified the need for a MOOC targeted at modeling to evaluate its benefits in the future. We agree about the challenges we face, such as time and costs, when developing qualitative MOOCs. We see possibilities to integrate MOOCs into existing lectures or into flipped-classroom settings. A key focus should be on intensive interaction between students and lecturers.

Keywords: online education, software modeling, MOOC, Massive Online Open Course, e-learning

1 Introduction

Since 2005, the International Conference on Model Driven Engineering Languages and Systems (MODELS) organizes the Educators Symposium. During this symposium, lecturers from all over the world discuss education topics related to model-driven engineering (MDE). These discussions considered new educational insights, current problems and challenges for the future. In 2014[6], the

[6] http://models2014.webs.upv.es/educatorsym.htm

subject of discussion was the use of Massive Open Online Courses (MOOCs) in our educational practice. The discussion about MOOCs was driven by a panel that was organized at the end of the symposium. To start the discussion the following abstract (first paragraph) of the panel introduction was published:

The current MOOC hype is already the second incarnation of the idea that electronic media and the internet can help to decrease the cost of education. While the mediocre outcome of massively funding research on e-learning (as it was called during the first wave washing over us at the turn of the century) has caused considerable disappointment, the idea of online courses seems to have wintered the depression that followed, and has recently resurged under the guise of democratizing higher education. Not surprisingly, the key insight of the first flood, that learning profits from teaching and that teaching means human interaction involving an actual teacher, is currently being rediscovered.

The critical point of view of the introductory speaker, Friedrich Steimann, caused the panel and audience to discuss different aspects of the current use of MOOCs in software modeling courses.

In this paper the organizers, panelists and audience have summarized their views on the current application of MOOCs and give suggestions for future use. Their view is summarized in the form of positions and therefore this paper does not claim to give the ultimate status quo or the overall evaluation of MOOCs in software engineering education.

In Section 2, we list questions that the panelists had about MOOCs and explain the context of each question. In Sections 3 to 7, we present our different positions. In Section 8, we conclude and propose future work.

2 MOOCs

The interest for popular MOOC initiatives such as Coursera, Udacity, or the MOOCs from universities like MIT and Stanford has grown enormously. These initiatives offer MOOCs on programming-related subjects such as programming in C++/Java, algorithms. To our knowledge, no specific courses on software modeling are offered. Do we want to see them in the (near) future? And, if so, what do we have to consider?

Although some observed 2012 to be ‘The Year of The Mooc’ [11] because of growing interest and popularity, there are many others who have questioned “Is software engineering ready for MOOCs?” [2]. Dasarathy et. al. discuss different topics in “The past, present, and future of MOOCs and their relevance to software engineering” [3]. In 2014 the topic of MOOCs still gives us enough reason to discuss and/or criticize. Based on what is emphasised in the literature, in this paper the positions focus on one or more of the following questions that help us to decide whether developing a MOOC is worthwhile:

Will a MOOC save costs? While some argue that MOOCs will be used for cost reduction, Schmidt et al. [14] show the effort that has to be put in the development process of a MOOC and mention “It took us two solid months of filming to produce 80+ individual videos that ran for 20 hours. In contrast, 40 hours are spent lecturing in a conventional semester-long Vanderbilt class".

How is it possible to grade students' assignments? A massive approach needs a different way of grading assignments. Two methods are mentioned often in literature: peer review and automated grading. Tillmann et. al. [17] explored the second one in their game based software engineering MOOC.

How to maintain the quality of a course? As indicated by the panel introduction, MOOCs may give universities the idea they could replace the lecturers and thereby decrease the communication between students and lecturers. Fox et al. [6] argue MOOCs can even improve students' engagement (along with other subjects connected to MOOCs) by introducing SPOCs (Small Private Online Courses).

The positions in this paper continue the discussion above and aim to reflect on our current use of MOOCs in the software modeling context and explore possible future use.

3 *We should distinguish between kinds of MOOCs and leverage MOOC content and design principles for flipped classroom courses* (Vadim Zaytsev)

It is widely known that MOOCs or any other automated content delivery/ consumption system, opens many doors for learning analytics. It should be pointed out that some statistics work differently for the MOOCs: for instance, such courses usually score an exceptionally high satisfaction extent of around 80–90% among the students — this is at least partly due to the evaluation being done among the students who actually succeed in finalising the course. Filtering occurs on each stage. Consider an example: 17000 registered, 7000 watched a lecture video, 2000 watched all lectures, 1000 did some homework, 500 took the exam [12]. Among students who start being engaged in some way beyond simply expressing interest, a success rate of 20–45% is typically considered acceptable. Increasing active teacher involvement does not significantly improve the rates either [18]. For normal presence courses such percentages are usually considerably higher, which means that less dissatisfied students drop out before the final evaluation. Hence, pro-MOOC arguments based on their successful evaluation, should never be considered out of their context.

One of the recent trends in distance learning and massive online courses is recognizing the distinction between xMOOC and cMOOC: the former are, in Keith Devlin's words, "textbooks on steroids", basically e-learning platforms for delivering knowledge and distributing learning activities over space and time, while the latter are collaborative efforts involving teaching staff and an interested community. xMOOCs gravitate toward concrete decisions, leading to frameworks such as Coursera, MiriadaX, Udemy, Udacity, Edx. They are easy to assess, compare and ultimately draw a conclusion whether they should be ignored, adopted or feared, based on the compatibility level of desired learning objectives/activities with the functionality offered by the framework. cMOOCs, on the other hand, are harder to measure and to compare, since they are built around interaction among students, not between students and content.

cMOOCs in general are built on top of several well-known concepts such as "autonomous learning" [9] (creating an environment that encourages learning), "self-determination" [13] (rewarding learning activities in a continuous tangible way) and "computer-supported collaborative learning" [8] (cooperative form of education when subjects learn from one another while assisted by automated tools). Social and web 2.0 technologies make it rather unproblematic to set up and the existing research on gamification helps to properly design learning activities. Supporting yet extracurricular activities such as teachers' blogging (in addition to compulsory lecture videos), social exposure of results (whose solution gets the most likes?) and discussion boards generally receive positive evaluation [7] and have been shown to improve students' results [5]. What is also interesting: students who have already completed such a MOOC, express interest in maintaining the community beyond the course [7] and actually stay subscribed to the community at least for some time [5]. (This is not that surprising and corresponds to the experience we have had with informal activities and social network maintenance of learning activities). What is also important, the most active contributors of such online communities exhibit approximately the same statistical traits as their less active peers (so they do not alienate the silent majority and do not turn to trolling) and globally produce high quality content [10].

In either kind of MOOCs, students often demand other assessment methods besides traditional testing, such as detailed feedback and peer reviewing [7]. Some of these requests are impossible to fulfil due to the massive nature of the course, but for the rest of us it means that the setup can be reused for the flipped classroom paradigm: it is not massive, usually under 100 students per course, it relies on autonomous consumption of content, it profits from online community support, but at the same time can utilise instructors' time to answer questions, provide feedback and further adapt to students' demands. Indeed, leveraging MOOC content for the flipped classroom has been pointed out earlier as one of the options for traditional educators [15].

4 *MOOC tools can be used to improve traditional teaching by motivating students to learn by themselves and by making a better use of the time spent in classrooms* (Frédéric Boulanger)

MOOCs are often considered only as tools for delivering online education to large virtual classes. However, it is still difficult to assess their efficiency for this task and compare them fairly to more classical classroom settings. Another potential use for the technologies that were developed for MOOCs is to improve traditional teaching by reducing the time spent in classrooms, raising the motivation of students, and taking advantage of cooperative work of students. The ideas exposed here come from my experience as a professor in a French “grande école” (engineering school with a competitive entrance examination) in the field of Computer Science.

Reducing the Time Spent in Classrooms Many educational organizations have shrinking budgets and may try to save money by increasing the number of students per teacher. However, it is also possible to reduce the number of hours spent in classrooms while maintaining a good supervision ratio. In many courses, there are parts that can be self-learned by students and that are a pain to teach in classrooms. For instance, learning the basics of a programming language is better done by reading a book and running examples and exercises on a computer than by listening to a teacher or looking passively at slides. However, simply asking students to read a book and make exercises before attending a lecture may lead to failure because of a lack of motivation. Using online material and making the students work on a project that they can achieve by learning from the online material works better, and it prepares the students to learn more advanced topics during the lecture. It also relieves the teacher from describing boring details about the syntax of a language or the basics of some scientific or technical field.

The technologies associated with MOOCs can be of great help for this kind of online teaching because they allow for interactive content, and even personalised content according to the results of each student. The difficult part is to find the right sequence of classroom sessions and online work. A first lecture is necessary to explain how the class works and what is expected from the students. Some feedback by a human teacher is also necessary to keep the students motivated and help them to avoid getting stuck in their progression. However, this feedback can be reduced by encouraging cooperative work among students.

Motivation and Cooperative Work Working on a project can be a good motivation for self-learning, and the availability of online material and immediate feedback to the progress of the students can drive this motivation. It can be improved further by encouraging cooperative work among students. I often notice that, during practical lab sessions, students help each other to achieve the goal of the session. It can happen because I am already busy with another group, or just because those who understood some point are willing to explain it to others, and also because students sometimes prefer to learn from other students than from a *professor*. When such clusters of students gather in front of a screen and start discussing a topic, I keep an ear on what they say in order to fix any possible misunderstanding, but I generally do not have to interfere in their discussion because they find their path to a correct answer, sometimes through detours that I would not have thought of.

Using online material with problems to solve and immediate feedback about the correctness or the quality of the solution can therefore be made more efficient if the students are encouraged to work together. One possibility is to organize their work in sessions where they meet during predefined time slots. It seems that having to report on their progress to an educator is also a source of motivation.

Advantages and drawbacks The main advantage of using MOOC-like online material associated to projects for self-learning is that when students come to the next classroom, they already know the basics of the field and have been exposed to issues that make them more sensitive to what you will explain during the lecture. Other advantages are less boring lectures, both for the students and the teacher, and the increased motivation that comes from achieving different goals during the projects and exercises. Competition between groups of students to develop the best algorithm or the most efficient solution to a problem can also drive motivation.

There are minor drawbacks, the main one being the extra amount of work required to prepare the online material. You cannot just put the equivalent of a text book on a web site. You have to prepare a series of exercises that lead students toward some knowledge of the field you teach, and some projects to make them use what they learned to solve exciting problems. For this, you need to discriminate automatically between correct and wrong answers, and detect early when they take a path that will prevent them from succeeding in their project. Another issue is to detect the loss of motivation. Contrary to MOOCs that can drop 90% of the students between the initial subscription and the final exam, I have to take all my students to the end of the journey, with an expected rate of failure of less than 10% at the exam. Tutoring by a real educator seems to be necessary to avoid students getting lost and coming (or *not* coming) to the lecture without mastering the assumed prerequisites.

Conclusion One of the main challenges I am facing when teaching algorithms, programming, system modeling, programming languages semantics or computer architecture is to make students interested in the topic I have to teach. Focusing on practical sessions proved to be efficient, but students tend to be demotivated by the initial learning phase where they have to get familiar with the basic notions on which the rest of the course relies to explore more advanced and interesting topics. Using online resources which allow them to find the required information to make exercises and solve problems, and providing them with tool-kits for evaluating their results, allows the students to learn at their own pace, with a more focused attention. MOOC technologies can therefore be used to replace some lectures by self-training sessions, and to keep classroom time for more advanced topics to which the students have been made receptive through their own experiments. Encouraging cooperative work among students by organizing scheduled work sessions is also a great way of taking advantage of their spontaneous tendency to share the knowledge they have just acquired. However, at least in my context, interaction with an educator is necessary to keep students motivated and to show them how advanced concepts can be useful for solving some of the issues they met during the practical sessions. Preparing online material and the tool-kits used for practical sessions also requires more work than preparing slides for a regular lecture, but spending less time in classroom and having more interested students may be worth it.

5 *We should experiment with multiple forms and levels of MOOCs to understand how to best teach modeling in the future* (Birgit Demuth)

The MOOC hype is discussed controversially in Germany. There are only a few professors and universities who support and drive the development of MOOCs. There are several reasons for this observation. Academicians are concerned about the necessary related drastic change in education. Related issues are high launch costs, the underlying business model and privacy of student data. Furthermore, teachers wonder how they are able to ensure the educational quality of their courses and to automatically grade the performance of students. The academic position to MOOCs was studied and summarized in the Dagstuhl Manifesto 2014 [4]. Eight partially provocative positions were identified and explored by the international workshop participants. The included state of the art report confirms my observation that most of the MOOCs both on commercial and non-commercial MOOC platforms focus on the "end of high school - first year of university" level. For example, one can find quite a few MOOCs on basic programming principles. But to the best of our knowledge, there is no MOOC that teaches object-oriented modeling concepts in the form of an xMOOC or cMOOC (explained in Section 3). Most generally, modeling skills are typically not the subject of the first year of a computer science curriculum. However, we see another reason for the scarcity of modeling MOOCs: modeling is a higher thinking skill. In the framework of the revised Bloom's taxonomy of educational objectives [1] the verb *model* means to *create* something and therewith can be classified as an activity of the highest level of cognitive processes. Besides the ability to abstract complex facts, modeling requires social skills such as communication with different stakeholders and conflict resolution skills. A modeling MOOC has to rely on very high social interactivity to produce positive outcomes.

This primary challenge is strengthened when one considers that future students belong to the digital natives for whom it is normal to use electronic educational technology. We should experiment with multiple forms and levels of MOOCs to gain the experience on how to teach modeling the best in the future. MOOCs could help to manage courses with large-scale enrollments. But before we start, we have to establish the organizational requirements. A meaningful alternative way may be to practice the flipped classroom concept, in particular if we are able to supervise groups of students in face-to-face meetings. Then, the face-to-face events can be dedicated to the collaborative work in modeling.

6 *Use MOOCs for engagement, motivation and research* (Dave Stikkolorum)

In my opinion, MOOCs have been proven to work quite well. In The Netherlands, the Open University[7] uses MOOCs on a large scale. In fact, it is their selling point. Leiden University uses MOOCs in their education and research[8]. The experience with MOOCs is on both student and lecturers side. Also, different joint projects like 'Netwerk Open Hogeschool-Informatica'[9] are using MOOCs or MOOC-like environments to support their long distance learning. These organisations and initiatives use blended learning and flipped classrooms.

In my own experience I used MOOCs for students that wanted to broaden their knowledge and skills further than our program (software engineering) could offer, such as the "From Nand to Tetris Course"[10] - building a general-purpose computer system from the ground up. For a course in Game Development mixed with Simulation, students are referred to Udacity's "Intro to Artificial Intelligence". In the latter situation, the MOOC is more used in a blended situation than 'stand alone'.

What students need is a challenging and motivating environment that stimulates learning. MOOCs can enrich students' way of studying by offering them flexibility (learning whenever and whatever they want) and exercises. MOOCs can also offer modules that are not part of the students' standard programs and give them the possibility to study subjects to broaden their knowledge.

In our research group (LIACS, Leiden University and Chalmers/Gothenburg University) we explore students motivation and reasoning about software design. We see possibilities in using MOOCs in combination with game elements, as we see for example in [17]. We already started to upscale our "Art of Software Design" game [16] to an online game [11] in which competition elements are easily thinkable.

A huge benefit for research is to actually use the data that students generate in a MOOC for analysis on their studying and/or learning behaviour. Often we have to deal with the fact that we only can observe a small amount of students from a particular student population. MOOCs can give us opportunities to study larger amounts.

In the future, MOOCs can be used as 'add-on' for modeling courses or students' programs. However, we agree there are challenges in the level of effort needed to create a MOOC. We are aware that developing online systems with trustful grading and helpful feedback is a time consuming activity.

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[7] `http://www.ou.nl`
[8] `http://leidenuniv.onlinelearninglab.org/`
[9] `http://www.noh-i.nl`
[10] `http://www.nand2tetris.org/`
[11] `http://editor.models-db.com`

7 *The key challenge will be in supporting participant engagement while exploring shared modeling activities, where the specific details of the modeling context intersect with the currently available infrastructure supporting MOOC development* (Jeff Gray)

How can we engage a large community of learners and support their sharing of modeling experiences using current modeling tools and existing MOOC infrastructure?

Several lessons were learned from designing and teaching a 6-week MOOC that served the training needs of high school teachers across the United States. The CSP4HS [12]course was supported by a Google CS4HS (Computer Science for High School) grant and focused on introducing a new high school course called Computer Science Principles, which is being piloted by the College Board in the US. This MOOC had over 1,200 registered participants, of which about 50% played an active part in the community, and only about 10% completed all of the course requirements. The course had participants from 45 US states, as well as representation from six countries. The CSP4HS course was built with several different tools that enabled both asynchronous and synchronous participation: the core lessons were hosted on Google's freely available Course Builder platform; asynchronous interaction with the course participants was facilitated by a Piazza discussion forum; synchronous coordination of participant interaction was enabled by Hangouts on Air (for large broadcasts) and Hangouts (for group office hours). The course was rather low-budget, costing under $25,000 with support from one graduate student, four undergraduates (two who were Film majors), and four content experts who were also high school teachers. To support the course, over 95 videos were produced (over 30 hours of video, which took over 100 hours to record).

A key lesson learned from the CSP4HS MOOC was the need for deeply engaged interaction among the participants, through both synchronous and asynchronous approaches, to develop a Community of Practice among the participants. This observation is also supported by recent research on MOOC effectiveness. Many new studies are being reported in the literature about MOOC practices that are most effective; in fact, there is a new ACM conference in the area focused on "Learning at Scale" – where learning scientists meet computer scientists[13]. One specific practice that has been studied recently is interactive engagement pedagogy, which can be described as "where students interact frequently in small groups to grapple with concepts and questions."[14] As evidenced by several studies of MIT edX courses that used interactive engagement with online tools, it is possible for multiple types of learners with different motivations

[12] Computer Science Principles CS4HS: `http://csp-cs4hs.appspot.com`

[13] Learning at Scale, `http://learningatscale.acm.org/`

[14] David Chandler, "Study: Online classes really do work," MIT News Office, `http://newsoffice.mit.edu/2014/study-shows-online-courses-effective-0924`

and background preparation to achieve results similar to peers taking the same course face-to-face[14].

The benefit of engaged interaction among MOOC participants seems rather intuitive, but the way that this would be implemented in MOOCS for a modeling course is not clear. In traditional modeling courses that are face-to-face, there may be a need for more feedback to students as they explore some activity using a specific modeling tool. Providing feedback to students using a visual modeling tool may pose new challenges to MOOC instructors (who may be even in different parts of the world), such as how the instructor views the content of the student's modeling work (screenshots or live streaming of the student's screen?), how the instructor offers feedback on a student's work, and the ways that students remotely interact with other participants in the course. The idea of modeling through experience, rather than imitation, can be helpful to students in a modeling course that is face-to-face. It is not clear how a small group of students can be engaged together to explore a modeling experience while physically separated on a MOOC. For a truly effective experience, the modeling tools used in a course may need to support team-based project collaboration to enable the type of engagement that is suggested by effective MOOC practice. It is also not clear how the modeling tool experience can be integrated into the underlying infrastructure supporting a MOOC. In essence, modeling tool support is often lagging behind tools for teaching programming – there are often challenges when teaching modeling in a face-to-face context that may be compounded when a modeling course is moved to a MOOC, given the desire to support online engagement among participants.

The traditional activities associated with MOOC construction (e.g., preparation of videos and online lecture outlines, creating a web-based asynchronous discussion forum) do not seem to be the challenging part for online modeling courses. The key challenge will be in supporting participant engagement while exploring shared modeling activities, where the specific details of the modeling context (e.g., nuances of a particular modeling tool used in the course) intersect with the currently available infrastructure supporting MOOC development.

8 Conclusion and Future Work

Although the panel's introductory speaker warns us of the negative effects a MOOC could have, our positions make clear we cannot ignore the MOOC hype. In contrary, we clearly see possibilities for the application of MOOCs in future curricula. We identified opportunities for more 'in depth' lectures while MOOCs are used for preparation on one side and exercising (modeling through experience) on the other side.

There is no doubt interaction between the lecturer and the students has a key value. We even see possibilities to increase students' engagement by using MOOCs in flipped classroom constructions and blended learning scenarios.

From the positive experience in software engineering targeted MOOCs, it seems possible to develop a MOOC course on modeling to investigate and evaluate if our educational practices benefit from the use of MOOCs, especially with concern for the level of support for collaborative learning.

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In Memory of Robert France

We sincerely regret that Robert France is no longer with us. He passed away while preparing this paper. We want to thank Robert France, not only for his contribution to the MOOC panel, but for all his contributions to the Educator Symposium over the years. He was given a Special Lifetime award by the MODELS conference in early 2015.

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