Investigating the possibility to teach practical design with MOOCs

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ABSTRACT

MOOCs are giving people the ability to go through the same curriculum with the same professors as students in some of the best universities in the world, and all you need is access to the World Wide Web. This means that people everywhere can gain this knowledge at their own pace in their own homes, or at a local café. The phenomena of the MOOC have revolutionized online education, but in some educational fields it is still struggling. By looking at the elements in a practical based education in Design and Product Development at the Norwegian University of Science and Technology (NTNU), we have investigated the possibility of teaching this kind of education with MOOCs. The results show that MOOCs in the way they work today are not able to handle this education in the way it is given at NTNU, but using the technology within a MOOC do show some interesting possibilities that should be investigated further.

KEYWORDS: MOOC, Design Education, Flipped Classroom, Super Text

1 Introduction

Since the first MOOC saw the light of day in 2008 with the course Connectivism and Connective Knowledge (CCK08) by Siemens and Downes [1], the phenomena has grown quite extensively. Today several of the biggest Universities in America host some of the most prominent MOOC platforms, such as EdX, Coursera and Udacity, with several hundred courses and more than 5 million users worldwide [2]. With enrolment numbers ranging from 50.000 and up to over 100.000 per course [3], MOOCs are paving the way for a new way of spreading knowledge around the world and it is continuously evolving.

The first Norwegian MOOC was presented at the Norwegian University of Science and Technology (NTNU) in the fall of 2013 and later the same year Gunnar Bovim, the principal of NTNU announced that NTNU has budgeted 3 million NOK for development of new and innovative ways of education [4]. In the following years, there have been some debate on whether the MOOC is the future of education or not in Norway, and some of the discussion surrounds which courses that should feel threatened by the MOOC [4]. In this article we will investigate the feasibility of utilizing MOOCs to teach design and product development the way it is taught at NTNU.

Product development and design are areas of study that require a good deal of practice based learning and mentoring. The most common ways of learning necessary skills in these areas today often include the need for laboratories and workshops, materials for prototyping and good student-mentor contact. To investigate the feasibility, we will look at the following questions:

a) What are the main elements in the MOOCs of today?
b) What does available literature say about the effectiveness and quality of MOOCs?
c) What are the main elements in today's Design/product development education? Focusing on the education given at NTNU.
d) Is it possible to utilize a MOOC for teaching practical skills in the design education at NTNU?

2 Methodology

To begin with we will look at what defines a MOOC, where did the MOOC come from and how is it evolving. This will be done by gathering information from available literature and reliable websites in this area. This information is used to find the building stones that is used to build up a MOOC, and to get insight in what is being said about the effectiveness and quality in MOOCs of today. The literature will mainly be gathered from Scopus and Google Scholar, and effective search words utilized is: Mooc, flipped classroom, practical moocs, connectivism.

Next, we will dig into the Design and Product Development education given at NTNU to see what methods is being used, and how the education is built up in general. We will then use this information along with what we found out about MOOCs to see to what extent it is possible to utilize MOOCs for this education. Information about the education is accessible at the University home page, but we will also gather some information from professors and students.

3 What is a MOOC?

Massive **O**pen **O**nline **C**ourses (MOOCs) is a method of education that has been available since CCK08 was presented in 2008 [1], and the anagram can be described as follows:

- *Massive*: It needs to reach a big audience. The amount of participants can go from a low 2,000 and up to more than 100,000 participants.

- *Open*: It needs to be free and available to everyone, anywhere. Hence, there are no entry requirements.

- *Online*: It needs to be available online, which makes it possible to access it from all over the world.

- *Course:* It needs to be designed a course where students can learn and be tested. Usually the testing is given by online quizzes or peer-reviews.

Since 2008, the phenomenon has expanded greatly and one can say a milestone was reached when The New York Times gave 2012 the title the year of the MOOC [4]. Today many renowned universities around the world host their own platforms, aiming to educate the world by giving people the possibility to learn from the best from the safety of their own home. With the rapid expansion and development of MOOCs in different directions, discussions arose regarding how to better define the different MOOCs. The result came in 2012 when Downes coined the terms cMOOC and xMOOC [5].

3.1 cMOOC

The very first MOOC, CCK08, was what we today refer to as a cMOOC, or a connectivist MOOC. This MOOC was built on the idea of Connectivism presented by Siemens in 2004 [6]

In connectivism we look away from the more regular *sage-on-stage* version of education often used in Universities today and instead, you make a platform where the students are both teachers and learners. Connectivism builds on the basic thought that knowledge is distributed across a network of connections and that learning consists of the ability to construct and traverse those networks [7]. This means that knowledge is not a concrete mindset that can be transferred, because people interpret information differently.

Hence, the best way to increase knowledge is to be part of a big network where people continuously contribute and share their opinions, and to be able to orientate this said network. CCK08 made this learning network using weblogs, wiki pages, twitter and other similar tools [7]. It also let the students create their own smaller groups and communities within the course where they could discuss and learn for example in their own languages.

3.2 xMOOC

The other type of MOOCs are referred to as xMOOCS, where the X stands for extended according to Downes [8]. This kind of MOOCs are often ordinary lectures that are filmed and put online, and therefore, an extension of something that already exists.

Today the lectures in xMOOCs are usually given by short video clips (10-20 min), and the assignments given during the course can be evaluated automatically. The amount of learning from a course is measured by the scores achieved from the automated tests, and by doing a bigger, final test, some courses can give you a certificate for the completed course. Furthermore, some MOOC distributors are starting to explore the possibility of giving actual credits for completing a course for a small fee [9].

As in cMOOCs, xMOOCs also incorporate the use of online discussion forums for sharing knowledge and group work, but it is not used as extensively as in the cMOOCs. The main knowledge source in xMOOCs are the lectures. Another way of looking at the difference between cMOOCs and xMOOCs can be put in the words of George Siemens, "cMOOCs focus on knowledge **creation and generation**, whereas xMOOCs focus on knowledge **duplication**." [10]

3.3 Super Text

Super text was first described by Terwiesch and Ulrich in 2014 [11]. They claim that it is possible to separate the MOOC the technology it inhibits. By technology, we are here talking about the short videos, automated tests, online communities and social networking usually used to describe the MOOCs. According to Terwiesch and Ulrich MOOCs are just one application, and in their research on MOOCs effect on business schools it is not the MOOC that can be a problem, it is the super text.

To describe this technology, we can first look at video lectures. Video has been around for decades and video lectures is nothing new either, but with the first MOOCs these videos were chopped up into smaller pieces which gave the possibility for semi synchronous learning. This means that instead of having to concentrate on big parts of the curriculum the students are now able to focus on smaller pieces at a time.

After each video or batch of the course, you can have short assignments adapted to the learning objectives, and all of this can be controlled by a course administrator. By having the possibility to use course administrators to run the course and help the students the original authors of the content, usually professors, will have more time to create new content, do research or make the physical lectures more active.

This means that the super text technology does not necessarily focus on the massive and open part you find in the MOOC, but rather the parts of it that can improve the efficiency of learning in a classroom. An example of this can be seen in the way MOOCs are used to flip the classroom.

3.4 Flipped classroom

In a flipped classroom, you switch or flip around the traditional way of teaching. Instead of having regular lectures the students will be given videos and articles to read upfront, and the lecture time is used for active learning. Instead of being a "sage-on-stage" the lecturer will be more of a facilitator and this can give increased connection between the lecturer and the students. There have been little research done regarding the actual effect of having a flipped classroom compared to a regular lecture, but several indirect researches such as student and instructor satisfaction surveys have shown positive results [12]. In some flipped classroom courses it has also been shown that the final exam results and scores were improved compared to the regular course. [12] [13]

The material needed for this way of teaching can be expensive and it takes time to create and distribute, but with the ongoing expansion of MOOCs a lot of this material is already available for use. An example on the use of MOOCs to flip the classroom can be seen in the way Khan Academy has been implemented and piloted in several schools with positive results [14].

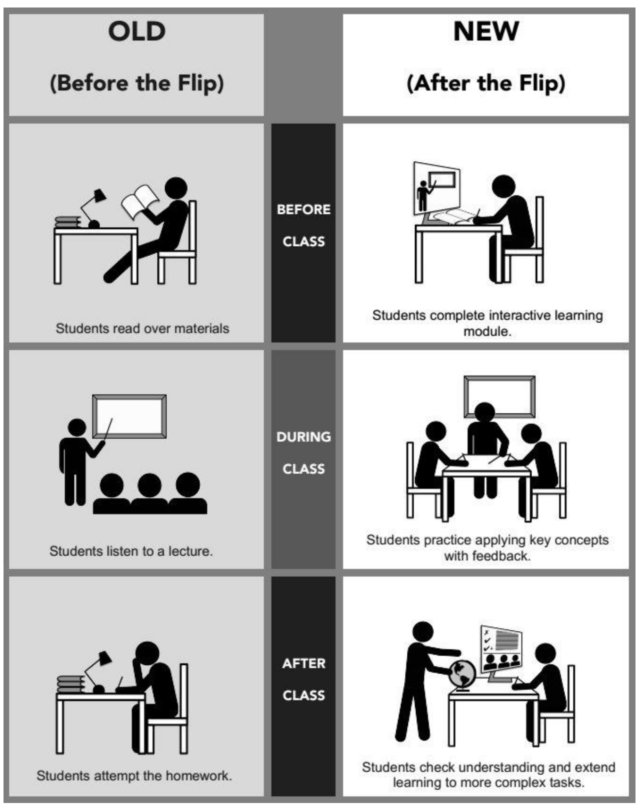

Figure 1: Pre-Flip vs. Post-Flip [15]

3.5 MOOCs in the literature

When going through the literature for this article there are some elements that is more discussed than others, mainly the discussion tend to develop around the problem about completion rates, the problem of grading MOOCs and the problem of student interaction. There are of course more than these three problems being discussed regarding MOOCs, but these three are the most interesting for answering the questions stated in this article.

First, let us have a look at the completion rates. More or less of all the MOOCs are troubled with low completion rates. On average the enrolment of a MOOC lies around 43.000 people, with a completion rate of 6,5% [16] but with several thousand people attending even a small percentage will be a decent amount of people.

Second, there is the problem of grading. With thousands of students participating in a course, it is impossible for a professor to grade all the assignments. The solution so far is to utilize automated assignments and quizzes online, and peer-reviews where the students grade each other [17]. How effective these grading methods are is still under research, and there is ongoing research on how to improve the grading of MOOCs in both quality and application.

Third, you have the student interaction. With big MOOCs, you eliminate the possibility of interaction between the instructor and learner for feedback. This leads to more cooperation between students on forums online, but this kind of interaction can still inhibit problems as it is asynchronous and voluntary [18]. Some researches believes that this may be one of the reasons for low completion rates in many courses, because students are not able to keep pace and are not able to find the adequate support and advice [19].

4 Design and product development education at NTNU

There are many ways of teaching design and product development available today. In this article we are taking a closer look on the education given at NTNU, and to get a good overview the courses are listed in table 1 for courses given at the Department of Engineering

Table 1: Product development courses at Department of Engineering Design and Materials

Course code	Lecture hours	Lab hours	Specialization hours	No. Of Projects	Group Work	Workshop required	Evaluation form
TMM4245	2	6	4	1	Yes	Yes	Work
TMM4125	3	6	3	1	Yes	No	Work
TMM4220	2	6	4	1	Yes	No	Work
TMM4150	2	6	4	1	Yes	Yes	Work
TMM4115	2	10	0	1	Yes	Yes	Work
TMM4121	4	8	0	1	Yes	Yes	Work
TMM4130	2	4	6	0	No	No	Written exam
TMM4155	2	10	0	1	Yes	No	Work

Design and Materials (IPM), and table 2 for courses given at the Department of Product Design (IPM). Note that IPM has more courses available in the database, but the courses listed in table 1 is the only courses directly related to product development. All courses listed are given in the school year 2014/2015.

In table 1 we can observe that for the 8 courses listed, 7 courses (87%) include projects and group work and 4 courses (50%) requires a workshop. Workshops are required to build physical models and products in different materials, and the students need to complete a workshop-learning course before they are allowed to use the facilities. Some courses also require special software for 3D-modelling and rendering.

Looking at the amount of hours set for lectures, lab or specialization it is clear that the practical part of the courses play a significant role. The average amount of hours spent on lectures per course is 2.4h, compared to 7h in lab and 2.6h in specialization.

In table 2 there are 23 courses listed, where all include some sort of project work. 11 courses (48%) require group work, and 15 courses (65%) require a workshop. In addition the students can choose to work in groups in 4 of the courses (17%) and 4 additional courses (17%) might need a workshop dependent on the type of project given. Here there might also be need for special software in some courses in the same way as at IPM.

Table 2: Courses given at Department of Product Design

Course code	Lecture hours	Lab hours	Specialization hours	No. Of Projects	Group Work	Workshop required	Evaluation form
TPD4134	2	2	8	1	Yes	Yes	Work
TPD4200	3	5	4	1 - 2	Yes	Optional	Work
TPD4100	2	8	2	1	Yes	Yes	Work
TPD4102	2	8	2	1	No	Yes	Work
TPD4121	2	8	2	1	Yes	Yes	Work
TPD4127	2	8	2	4 - 6	Optional	Yes	Work
TPD4129	2	8	2	1	Yes	Yes	Work
TPD4144	2	4	18	1	No	Optional	Work
TPD4142	2	7	3	1	Yes	No	Work
TPD4190	0	0	24	1	Optional	Yes	Work
TPD4195	0	0	12	1	Optional	Optional	Work
TPD4505	0	0	12	1	No	No	Work
TPD4111	2	8	2	1	No	Yes	Work
TPD4112	2	8	2	1	No	Yes	Work
TPD4113	2	8	2	1	No	Yes	Work
TPD4185	2	8	2	1	Yes	Yes	Work
TPD4105	2	8	2	1	No	Optional	Work
TPD4123	3	6	3	1	Yes	Yes	Work
TPD4155	4	16	4	1	Yes	Yes	Work
TPD4165	2	2	6	1	Yes	No	Work
TPD4500	0	0	24	1	No	Yes	Work
TPD4175	2	8	2	1	Optional	Yes	Work
TPD4150	2	6	4	1	Yes	No	Work

Looking at the hours in the courses at IPD, the average amount of hours set for lectures is 1.8h, which is a bit less compared to IPM. For lab work the average is 5.9h, and the average for specialization is 6.2h. We can see that the average amount of hours in lab work is less at IPD than at IPM, but that the average amount for specialization is quite a bit more. In general, this does not have any significant impact on making a difference between IPM and IPD regarding amount of hours spent on practical work because both lab hours and specialization hours is utilized. Hence, the important thing to notice is that the amount of hours spent on lab and specialization together is quite significant compared to hours used on lectures.

At IPD they wish to give the students knowledge, experience and personality connected to design. The way they do this is by focusing the education on group work and practical work as we have seen in the table above. This focus on group work can also be seen at IPM. Furthermore, the student interaction is of importance at IPD. The students have their own workspace in big classrooms where they have easy access to other students for feedback and idea generation, not to mention that the faculty members are also quite accessible

5 Discussion

From the previous chapter we can see that practical work is a big part of the design and product development education at NTNU. This does not necessarily mean that practical skills are needed to learn design and product development; rather it means that some areas of these educational fields are practical and we focus on these areas at NTNU.

From what we have seen on the theory about MOOCs, they mainly use short lectures and automatic quizzes for teaching, which is not very suited for learning practical skills. There are MOOCs that offer practical hands-on skills today, but these are mainly in the field of programming and computer skills [21]. The reason probably relies on the fact that it is easier for a computer to evaluate a code or a program to see if it works correctly, compared to analyse a picture of a hand made object. Recently, with the development of remote laboratories [21], it is now also possible to learn practice-based electronics. This shows that the MOOC is still evolving and working to overcome the problems it faces, but the practical skills needed for programming and electronics are not the same as the skills we need in the design education at NTNU.

Furthermore, it is still a long way before we are able to give over 50.000 people or more in one course access to physical workshops where they can learn how to operate machines and make models. It might never happen at all, but new technologies give new opportunities and 3D modelling and 3D printing could be a solution.

We have also seen that the student interaction you get with MOOCs can give problems. At NTNU this interaction is very important as it is a part of the education in general. Not everything can be taught in a lecture or by doing assignments, some things needs to be discussed and tried out. For example aesthetics or riding a bike. In active discussions ideas pop up and you can quickly assess it, by using online chat rooms you can easier get feedback from a huge diversity of people but it can take time and you might even forget what the original idea was.

Overall it seems like todays MOOC is missing the necessary functionality to handle some of the most important elements of the Design education at NTNU, but does this mean that we should let the thought of MOOCs go? Not necessarily.

Even though a MOOC itself might not work, we still have to look at the possibilities with Super-Text and flipped classrooms. In fact, some courses at IPD already utilizes instruction videos to teach the students how to use some of the machines in the workshop today. As noted in chapter 4 the amount of hours spent on lectures at both IPD and IPM is quite low compared to lab and specialization. By utilizing a flipped classroom model, it could be possible to clear out the hours spent on lectures and by this make more room for lab, specialization and more active work. One would still have to look at the effect vs. price since making and maintaining the videos can be costly, but then again the videos could also be published online as a sort of MOOC, with the intention of promoting the education.

One last interesting thought, is what will actually happen with design in the case we get a future where people from all over the world can learn design together from the same course (MOOC). Will we still have what we now look at as "Norwegian Design", "Danish Design" etc., or will we face a situation where everything is "world design"?

6 Conclusion

Looking at the information provided in this article we can see that in the way MOOCs work today, they are not able to teach Design and Product Development in the way it is taught at NTNU. However, utilizing super text and flipping the classroom do show some interesting potential. Finding out how this would work in practice would need further investigation and could be an interesting topic for another paper.

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