

# Active Learning with the Use of MOOCs at Chalmers University of Technology – Experiences, Challenges and Future

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## Abstract

Chalmers University of Technology (Chalmers) has joined the MOOCs movement and is from 2014 a partner of the edX platform. The first MOOC that Chalmers offered (2015) was a course about the material graphene "Graphene science technology". The second MOOC offered at Chalmers was the MOOC "Sustainability in everyday life" (2015). This year 2016 Chalmers University of Technology is offering a MOOC "Sensing the planet". This MOOC is an energy and earth science course in two parts which aims at answering questions like What do your senses tell you about planet Earth? and Do we know enough about our planet? The aim of this paper is to report from Chalmers experiences of, and research on MOOCs and to discuss how MOOCs can be used to support active learning in engineering education. If we think of active learning as an approach to instruction in which students engage the material they study through reading, watching, listening, writing, discussing and reflecting it is natural to think of a MOOC as a valuable resource for active learning. Chalmers' research regarding MOOCs is presented and discussed. Chalmers conducts a strategic venture with MOOCs, opening for enhanced cooperation with other universities to achieve high quality in online web-based education, both on campus and at a distance. Chalmers basic assumption is that MOOCs of good quality, pedagogically well-planned and with engaging learning resources should have the potential to support active learning in engineering education. Several other universities in Sweden and the Nordic countries are now offering MOOCs and explore the opportunities and challenges with MOOCs. A conference "MOOCs in Scandinavia" was arranged in Stockholm 11 - 12 June 2015 (Karolinska Institutet, 2015). The 2nd MOOCs in Scandinavia Conference, June 9-10th 2016, is arranged by Chalmers University of Technology in Gothenburg.

**Keywords:** Active Learning; Engineering Education; MOOCs; blended learning; ICT.

## 1 Introduction

For a number of years higher education institutions in many countries have been offering open online courses that are freely available on the Internet, known as Massive Open Online Courses, MOOCs. Anyone with access to a computer connected to the Internet can take part in these courses. The international pace of development and interest in MOOCs is substantial. The number of MOOCs has increased dramatically in recent years (Open Culture, 2016; Open Education Europa, 2016; Bates, 2015). MOOCs of today deliver high quality content from some of the world's best universities for free to anyone with a computer and an Internet connection.

A MOOC is open with no barriers to entry or leave and there is no limitations in number of students. A MOOC is flexible in time, place and resources. It gives the participant possibility to choose between learning resources and to make own choices how to learn and engage. A MOOC is often organized with video lectures, quizzes, dialogue, interactivity through questions and discussion forums. MOOCs has also been reported as interesting for research communication, continuing education, lifelong learning among people, for increasing visibility, marketing and recruitment. Additional aspects on the impact of MOOCs is the possibility to support international collaborations and cross-cultural issues.

In several countries, as in Sweden, higher education is provided free of charge and Internet-based distance teaching and learning has been an established phenomenon for many years. In Sweden higher education offers a wide range of freestanding courses which can be studied in the context of lifelong learning. Continual professional development and other forms of continuing education therefore form part of the normal higher education system in Sweden and are, according to the legislation, free of charge. Higher education in Sweden is thus already relatively open and flexible.

Chalmers has joined the MOOCs movement and is from 2014 a partner of the edX platform (edX, 2016). Chalmers offered two MOOCs in 2015 and is offering two new MOOCs during 2016 and another new MOOC is planned to be released autumn 2017. The hypothesis is that MOOCs of good quality, pedagogically well-planned and with engaging learning resources have the potential to foster active learning.

This paper reports from and discusses the Chalmers experiences, challenges and future plans for using MOOCs to support active learning. Chalmers University conducts a strategic venture with MOOCs to gain further experience in developing, implementing and evaluating methods for teaching and learning within the MOOC format. At Chalmers there is an expressed need to focus even more on quality and modernization that meets expectations of individualized education and to develop the pedagogy in existing courses using modern educational technology and Internet in MOOCs, blended learning, flipped classroom and other innovative forms of education. Chalmers has a desire to, in a greater extent than today to become a modern edge cutting technical university with a global view on education and opening for enhanced cooperation with other universities to achieve high quality in online web-based education.

From a higher education perspective - pedagogical perspective - there are clear benefits for universities to work with the MOOCs concept. Spread of knowledge and marketing MOOCs contribute to the development of pedagogy for online education and teachers involved will learn and improve skills for educational development and blended learning. Knowledge of how students learn will increase from studies on students' learning online which can be used in research on web-based teaching and learning. MOOCs also contribute to the development of technology in education. The technology level in a MOOC must be relatively high compared to conventional online courses enabling technological and methodological development. The underlying web-based technology contributes to the development of pedagogical methods of on-campus education and in blended learning (Bates, 2015). This is in consistency with other studies for example Garrison (Garrison, 2004) who concludes that blended learning is consistent with the values of traditional higher education institutions and has the proven potential to enhance both the effectiveness and efficiency of meaningful learning experiences.

The research question is how MOOCs – but also other web-based forms for teaching and learning; blended learning, flipped classroom etc – can foster active learning. Pedagogical aspects on the use of MOOCs are discussed and the paper tells about ongoing development and research at Chalmers regarding web-based/online teaching and learning including MOOCs and blended learning.

## 2 MOOCs at Chalmers University of Technology

The **1st MOOC** that Chalmers offered (2015) was a course about the material graphene "**Introduction to Graphene Science and Technology**". The background to developing this first Chalmers MOOC offered globally is that Chalmers is the coordinator of the Graphene Flagship in EU's huge research initiative on graphene. Excerpts from the description of the MOOC content at the Chalmers web (Chalmers MOOC, 2016, ChalmersX, 2016).

Previous knowledge needed to be able to benefit from this course is that the participants have an adequate knowledge of general physics and university level mathematics.

The participants are expected to devote 6 hours weekly to the course. Each week features a series of lecture sequences supported by interactive video tutorials and interspersed exercises or problems. Students will work on a homework assignment or quiz each week.

9600 participants/students from 127 countries all over the world registered on the MOOC 2015.

The **2nd MOOC** that Chalmers offered (2015) was the course "**Sustainability in Everyday Life**". Excerpts from the description of the course content at the Chalmers web (ChalmersX, 2016).

Previous knowledge needed to benefit from this course is that the participants should have passed compulsory school of at least 9 years and be comfortable working with a computer.

9000 participants/students from 156 countries all over the world registered on the MOOC 2015.

The **3<sup>rd</sup> and 4<sup>th</sup> MOOCs** which Chalmers offers 2016 are connected to each other, they are both about sensing planet earth. The two MOOCs are ***“Sensing Planet Earth – from Core to Outer Space”*** (started February 1<sup>st</sup> 2016) and ***“Sensing Planet Earth – Water and Ice”*** (starts March 21<sup>st</sup> 2016). The content is split in two courses with a length of four weeks each. Each course has an introduction that provides the necessary mathematical and physical background and a summary at the end will put together a complete picture of how we can monitor and measure the complex Earth systems. The MOOCs are run globally and are produced in a format suitable for smartphones thus allowing flexible studies. The MOOCs are customized to smartphones since the availability of smartphones is much bigger than the access to computers.

Previous knowledge needed: The target groups are high school teachers, high school students, the public and decision makers or professionals who are relying on Earth observations. High school students (and also much of the public) are expected to appreciate the MOOC and have sufficient knowledge of mathematics and physics to manage to follow the MOOCs. In the MOOC some of the homework/assignments are about collecting own data (temperature, weather, water levels etc) and practice active learning. The MOOCs are produced in a format suitable for smartphones thus allowing flexible studies.

Description of the course content in ***“Sensing Planet Earth – from Core to Outer Space”*** and the content in ***“Sensing Planet Earth – Water and Ice”*** can be find at the Chalmers web (ChalmersX, 2016):

Another **5<sup>th</sup> MOOC** at Chalmers about logistics is planned for a global release autumn 2017.

Thus, Chalmers today have experiences from producing four MOOCs and a fifth is on its way and will be offered globally 2017 (Chalmers MOOCs project, 2015). The MOOCs offered 2015 are now being evaluated and data and statistics are being compiled spring/summer 2016.

### 3 Chalmers perceived opportunities and challenges in providing MOOCs

Teachers involved in the planning – pedagogical and technical - designing, organizing, producing and implementation of MOOCs report of a lot of work but also competence development and enrichment of their teaching experiences which can be used at campus and in blended learning.

There are several steps in producing a MOOC; planning, structuring, designing, coordinating, producing and implementing the course. These steps include a lot of tasks that need to be thought through and decided about: the pedagogical concepts; the course content including the learning objectives, course moments, homework, quizzes, hands-on exercise and interaction/communication in the MOOC. Concepts of letting students carry out experiments and submitting their results via the MOOC platform may be desirable and need to be planned and decided how to carry out and follow-up. The way in which students will be examined in must also be decided and produced.

When planning and creating a new MOOC there is often no teaching material that can be used unchanged. The teachers have to rethink the pedagogical setup and the course material, learning resources have to be arranged and put together in a new way in order to adapt to the digital components used in the MOOC. The tasks of creating, structuring, writing and presenting the content have to be done in the same way one would create any new course. The teachers have to plan and coordinate lectures and course moments and decide about all MOOCs resources needed to give the course. In the planning the teachers have to take into account the heterogeneous MOOC student groups: high school students, high school teachers, decision makers etc. and it has to be thought throw how to manage to keep students’ interest, to retain students in the MOOC.

Additionally the MOOC communication is challenging. The challenges are how to manage and support valuable communication in student-teacher, student-student, student group interaction etc. Possible ways for interacting with MOOC students could be: e-post, social media, online forums, chat forums etc. However e-post is not possible when there are a large amount of students, social media needs to be directly embedded in the MOOC platform and it requires resources in terms of moderation and thus skilled moderators. At Chalmers among others graduated students were/are trained and educated and are the persons who will take the role of forum moderators in the MOOC forums in order to find out where students had problems with the MOOC content.

Thus, substantial time allocation is needed by core staff, which means that a considerable amount of teacher's resources and time is needed.

In building the MOOCs a considerable amount of content production, recorded/filmed lectures and other learning resources/educational materials have to be produced and of high quality. A lot of videos have to be produced – teaser videos, course content/knowledge videos, follow-up videos that provide a summary of the most frequent questions related to a course moment in order to meet the students' activity and questions in the MOOC forums.

Since a MOOC requires well-prepared content of high quality the teachers' benefit from a production support team. At Chalmers there is a support team for blended learning. During 2014 Chalmers set up a central support team to promote and facilitate information and communication technology components in teaching. The Chalmers Engineering Education Research department, the Chalmers library and the Learning Centre (a Chalmers network) work together in this team (Chalmers support for blended learning, 2015). The team offers support to teachers who want to work with MOOCs and/or blended learning and the support includes both technological and pedagogical aspects on the MOOC content and how the content is communicated to course participants.

The Chalmers teachers report that the development of MOOCs benefits from the possibility to discuss and get help from the pedagogical and production support team at Chalmers.

Chalmers teachers/researchers involved in the MOOCs production and/or in blended learning have started to report of their findings at a yearly Chalmers conference (Chalmers conference on teaching and learning KUL, 2016) and at some other national or Scandinavian conferences on teaching and learning (Swedish Development conference for engineering education, 2015; MOOCs in Scandinavia conference, 2015, Sweden's conference for the development of higher education NU2015).

Conference contributions from Chalmers during 2015 are *Developing a MOOC at Chalmers: Motivation and first experiences from a teacher's perspective* (Janssen and Stöhr, 2015), *Flipping a PhD course using movies from a MOOC* (Svensson et al, 2015) and *Using learning analytics in virtual learning environments* (Demazière et al, 2015). The first conference paper describes an action research program aimed to evaluate the benefits and challenges of MOOCs for teachers at Chalmers. The second conference paper is about flipping a course using MOOC videos and the paper reports that students experienced the MOOC videos and learning activities as very useful for their learning. The third conference paper discusses the use of learning analytics in virtual and blended learning environments.

## 4 Discussion

The Chalmers experienced possibilities and challenges with MOOCs is the subject of this paper. However parallel to the work with MOOCs at Chalmers there is also since some years an ongoing Blended learning initiative/project at Chalmers (Chalmers support for blended learning, 2015).

There are two main educational/pedagogical issues, which are related to the restrictions that accompany any online course. These issues are communication and interaction which relate to teacher-student communication and the way how students can be actively involved in the lectures. How student support should be given is also often discussed.

The communication/dialogue differs from direct communication in a physical classroom, where students can ask questions/comments directly during or after the lecture, lecturers in online course can take questions/comments only after a certain time delay. In some online courses it is possible that students contact the lecturer directly, but given the large number of students in a MOOC, effective handling of questions and comments can only be achieved via forums. Because of the very large numbers participating and commenting, moderation of individual comments by the instructors offering the MOOC is rarely possible. This requires that user-forums are being moderated; the most frequent questions being filtered out and answered in dedicated follow-up videos which have to be recorded while the course is running.



Considering that a student of a MOOC will watch (video) lectures alone it is obvious that the communication from the teacher to the student is basically a one-to-one communication. This differs from usual classroom teaching, where the lecturer tries to address the group and (in some cases) can even approach sub-groups individually by flexibly selecting educational approaches depending on how well students receive that form of input. Thus, not only scripts and lecture notes of the MOOC need to be written under the consideration that one needs to address a single person, but also the way how lectures are organized and filmed needs careful planning.

Computer-marked assignments where students complete an online test and receive immediate computerized feedback are often used in MOOCs. These tests are usually offered throughout the course, and may be used just for participant feedback.

Examinations in MOOCs are based on computer automated testing - multiple-choice, computer-marked questions etc - but sometimes peer assessment has been used and/or in addition. In connection with examination identifications of students over the internet demands extra efforts. Examinations need to be performed in a legally and fair manner. The identification is often carried out using electronic identification systems.

MOOCs normally award some kind of recognition when a participant has completed the course, often based on a final computer-marked assessment.

Active learning is learning which engages and challenges students thinking using real-life and imaginary situations. It takes advantage of the opportunities for learning, investigating and exploring, events and life experiences and focused learning and teaching.

In particular, students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation. Active learning engages students in two aspects – doing things and thinking about the things they are doing (Bonwell and Eison, 1991). In active learning environment learners are immersed in experiences within which they are engaged in meaning-making inquiry, action, imagination, invention, interaction, hypothesizing and personal reflection (Cranton, 2012).

Further the educational methods, technology and web-based course moments used need to be pedagogically well thought out to meet the students' needs for active, engaging, interactive and collaborative learning. If we think of active learning in this way then it is natural and logic to think of a MOOC as a possible resource for active learning. Montgomery et al (2015) report from a three-year action research study where the purpose was to explore the digital challenges of student engagement in higher education using blended learning. The study report of four pedagogical opportunities for digital intentionality in virtual spaces and which they suggest could be used for future innovation: designing digital resources, scaffolding student learning, learner customisation and promoting the lived experience. The authors tells that intentionality regarding learner engagement is critical in the design of virtual spaces, since with the privileges of student flexibility in learning time and space, comes increased responsibility for individual student motivation. The authors suggest that lessons learned could be effective in the development of higher educational experiences for on-campus students as well as promoting greater engagement in online formats involving more global populations in e.g. MOOCs.

As mentioned a MOOC is open to everyone with the possibility to use a computer and/or a smartphone. No registration is needed. This fact means that being the teacher you can encourage students to study selected parts of an existing MOOC as a way to awake interest/get them interested in your subject and/or prepare for class, to start discussions etc. It is not necessary to follow the whole MOOC – the teacher can advise the students in how they can choose to take part in what they find interesting without any obligations. This is a way to share and reuse already produced learning resources of good quality. The two Chalmers MOOCs *Sensing Planet Earth* which are offered spring 2016 are aimed to be used by college teachers in this way. In the way the MOOC is structured makes it possible for high school teachers to choose and work with selected parts, certain course moments, videos etc of the MOOC advising their students to engage in active learning with selected material in the MOOC as a complement to the face-to-face teaching and learning at campus.

According to above a MOOC of good quality, pedagogically well-planned and with engaging learning resources has potential to support active learning. If a student's interest and engagement can be captured at depth this is an important foundation for the student's continued learning; the students' creativity and willingness to learn.

Regarding research there are so far relatively few research publications on MOOCs. There is need for more research on factors that influence student learning in virtual learning environments e.g. a MOOC.

Quantitative studies are needed that seek to quantify learning gains. There has not been a great deal of published information about the use of learning analytics (Bates, 2015) but learning analytics have the capacity to collect and analyse large amounts of data about participants and their performance, enabling for feedback to instructors about areas where the MOOC content or design needs to be improved.

Qualitative studies are needed that describe the experience of learners within MOOCs, which indirectly can give insight into what they have learned. To develop deep, conceptual learning, there is a need in most cases for intervention by a subject expert to clarify misunderstandings or misconceptions, to provide accurate feedback, to ensure that the criteria for academic learning, such as use of evidence, clarity of argument etc are being met, and to ensure the necessary input and guidance to seek deeper understanding (Harasim, 2013). Further, Firmin et al (2014) have shown that when there is some form of instructor encouragement and support of student effort and engagement, results improve for all participants in MOOCs.

What students do in a MOOC is interesting and crucial for their learning: which forums do the participants visit, how do they engage in different forums, how do they use the learning resources - for example how many times do they look at the videos - what "tracks" do the students leave in the MOOC. To research and get knowledge of how students actually learn in a MOOC is urgent.

As reported in the previous section "Chalmers perceived opportunities and challenges in providing MOOCs" Chalmers has started several research initiatives on MOOCs.

Concerning the MOOCs development and research several tracks can be discerned: How the MOOCs developing process including teachers, developing team, production team etc proceeds; How do teachers experience to teach with MOOCs, positive experiences/pedagogical challenges; How find out and understand what the students do in the MOOCs and how do they learn; How succeed in getting valuable interactivity supporting student learning in the MOOC; How manage the moderation in a good way to support students and How manage to keep, retain students in a MOOC.

A positive fact that have potential to promote the Chalmers and Swedish MOOCs development is a recent report from the Swedish Higher Education Authority. In the spring of 2015 the Swedish Government gave the Swedish Higher Education Authority (UKÄ) (The Swedish higher education authority, 2016) the task of analysing the possibilities and potential obstacles to the introduction of open online education (MOOCs) in Swedish higher education. This task also included proposing whether, and if so how and to what extent, MOOCs could be included in Swedish higher education and what consequences this could have. According to UKÄ's proposition, all state universities and several other higher education providers should have the opportunity to organise open online courses. Several higher education institutions would need extra funding to be able to offer these courses and UKÄ proposes that the state allocates special funds to be used for the development of digital teaching and learning in higher education.

UKÄ considers that Swedish higher education institutions should, like their counterparts in other countries, be given the possibility of arranging open online courses (MOOCs). It is UKÄ's opinion that these courses would, among other things, offer new possibilities of providing knowledge to large groups in the community and that they can help to deal with major social challenges. At the same time the international visibility of the higher education institutions would be raised.

There are also international initiatives and several organizations (EADTU European Association of Distance Teaching Universities, 2015; EADTU:s HOME-project, 2016; EUA European University Association, 2015; MOOCs worldwide use, 2016; MOOCknowledge, 2015; Open Education, 2015) occupied with the possibilities of MOOC:s, and in a broader perspective blended learning, web-based learning, e-learning. For example the

European commission 2013 launched a comprehensive initiative regarding open education (Opening up Education, 2013). This initiative is intended to promote digital competence, the use of open learning resources and education and access to digital resources in both schools and universities. The MOOC consortium Openup Education is coordinated by the European Association of Distance Teaching Universities, EADTU, and is growing rapidly.

## 5 Future plans for the use of MOOCs at Chalmers

The MOOCs offered so far at Chalmers have had a focus to attract participants from a broad and global arena.

Chalmers will continue to follow the development of MOOCs and how they can be used online and/or in blended learning at campus. There is obvious advantages following the development thus supporting and encouraging competence development about blended learning among teachers at Chalmers.

Experiences and findings from the MOOCs project and blended learning project are communicated at conferences - at Chalmers internal KUL conference, national and international higher education, pedagogical conferences. In addition publications in scientific journals will help sharing experiences and further knowledge building about teaching and learning in MOOCs and other forms of web-based teaching and learning and how they can be used foster active learning in higher education.

Several other universities in Sweden and the Nordic countries are now offering MOOCs and explore the opportunities and challenges with MOOCs. A conference "MOOCs in Scandinavia" was arranged in Stockholm 11 - 12 June 2015 (Karolinska Institutet, 2015). The 2nd MOOCs in Scandinavia Conference, June 9-10th 2016, is arranged by Chalmers University of Technology.

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