Next Generation Digital Engineering Education: MOOCs

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Abstract

Recent Industry 4.0 and technological developments have created disruptive changes in industries as well as our lives. Digitalization is one of the innovative results of recent Industry 4.0 developments, improving the quality of our life, increasing the productivity in industries. Those technological developments have also affected the educational system by transforming it to more digitized environment. For instance, according to the 2016 Chronicle of Higher Education report, the new "learning economy" of the future is defined on some technological trends. New trends in higher education systems and institutions are: developing innovative curricula, searching alternative learning pathways that can be implemented by online, distance, open and blended-based learnings as well as courses such as Massive Online Open Courses (MOOCs) and Open Education Resources (OERs). MOOCs is an online learning platform by which higher education gains new paths as well as lifelong learning opportunities. It also provides flexibility in education alternatives for students and cost efficiency for institutional education. In this work, we spotlight the digitization in higher education by focusing on digital learning platforms at universities.

Keywords
Engineering education, Next generation education, MOOCs, and OpenCourseWare

1. Introduction

Digitalization is one of the innovative results of recent Industry 4.0 developments improving quality of life, increasing the productivity in work. This digital transition has been causing seismic shifts. The higher education system also receives its share in this shift. The educational system is changing its content, tools, and methods, as well as the roles of educators and students. It goes on its way of developing shared learning offerings that harness the power of e-learning. By adapting digital teaching environment, higher education system provide students flexible learning and self-learning opportunities crossing borders in the educational system. Such flexible learning environment is also becoming a significant requirement under the possibility of pandemics, large-scale outbreaks of infectious diseases.

So far, education institutions usually adopted the digital technologies in order to efficiently management of administrative jobs at schools, scheduling of classes, budgeting issues, reducing operational costs, safety and security controls, etc. (Patton, R., and Santos, 2018). However, recently institutions have been seeing the power of technology for transforming the learning environment such that it results with better student outcomes. Hence, schools move rapidly to innovative environments by changing the role of faculty and understanding the novel educational delivery requirements and methodologies as well as the students of the future (Patton, R., and Santos, 2018). For instance, U.S. schools are now able to offer degrees to students in Latin America or China. Another example of Arizona State University, launched Global Freshman Academy with edX in 2015 (https://www.edx.org/gfa) offering a dozen online courses free of charge.

The wealth of digital technological developments have created digital educational resources. Massive Online Open Courses (MOOCs) and Open Education Resources (OERs) some of new practices in the educational profession. OERs are defined to be free digital learning resources which are open to any learners. The documents of OERs can be used to share, revised, combined, and adapted, etc. (Hylén et al., 2012). OER was first declared by UNESCO in 2002

at the 1st Global OER conference. After then, OER initiatives emerged paving the way for free online courses, such as OpenCourseWare (OCW) and Massive Open Online Courses (MOOCs) (https://epthinktank.eu/2013/10/01/open-education-oer-ocw-and-moocs/).

In this study, we aim to investigate digital technologies that is to be used in higher education system, to help remote education and digitized environment in order to benefit its advantageous especially in pandemic, and outbreak conditions. For instance, when classes are canceled, lockdowns take place, and unemployment increases due to an outbreak condition, demand for online education may increase. For instance, according to the classcentral.com due to the 2020 March CoronaVirus outbreak, interest for online education has increased drastically for MOOCs of Class Central. In addition, according to the Google Analytics, on Sunday March 15, MOOCs traffic increased by almost 900%. In total, Class Central had more than 3 million learners since March 14 (https://www.classcentral.com/report/surging-interest-in-online-education/). In this paper, we focus on digital teaching technologies, their history and usages at universities. Section 2 summarizes Open Education Resources, Section 3 explains Open Courseware, and Section 4 focuses on MOOCs. In Section 5 and 6, we explain differences between MOOCs and OCW and, the university implementations of MOOCs, respectively. In Section 7, we conclude the study.

2. Open Education Resources

Wikipedia defines the open educational resources (OERs) to be digital materials can be freely accessible and openly licensed utilized for educational purposes. OECD defines it as non-commercial educational resources that are technology-enabled and open for users for consultation and adaptation (http://www.oecd.org/education/ceri/36224377.pdf). It is free to use OERs over the Web or the Internet. They are utilized by students, teachers and educational institutions to support courses. OERs include learning objectives, reading materials, syllabus, curricula and all related contents. Since 2002 from the term when OER first emerged, it has been widely recognized by the worldwide community that it as an innovative tool providing lifelong learning opportunities for users.

2.1 Chronology of OER

In 1994, H. Wayne Hodgins a leading expert on personal improvement, knowledge management, and learning and training technologies coined the term "learning object". Then, this term quickly got popularity among educators. One of significant roles of OER is that digital materials can be re-designed and re-used easily in a variety of conditions (http://www.oecd.org/education/ceri/36224377.pdf).

In 1998, David Wiley the chief academic officer of Lumen Learning, Education Fellow at Creative Commons, and former adjunct faculty of instructional psychology & technology at Brigham Young University coined the term "open content". Then, the term quickly got popularity by the internet users. One of significant roles of open content of OER is its property of open license for content, open source and free software movements that can be reformed (the Open Publication License) (http://www.oecd.org/education/ceri/36224377.pdf).

In 2001, Lawrence Lessig, who is the Professor of Law at Harvard Law School and was the former director of the Edmond J. Safra Center for Ethics at Harvard University, and some others founded the Creative Commons. It is a nonprofit organization dedicated to building a globally-accessible public commons of knowledge and culture (https://creativecommons.org/about/). People can share their creative and academic work, as well as access and build upon the work of others. They also released a flexible set of licenses providing significant improvement on the Open Publication (http://www.oecd.org/education/ceri/36224377.pdf).

In 2001, also MIT announced its OpenCourseWare (OCW) initiative. They released almost all the university courses for public's free access that can be used for noncommercial purposes. MIT OCW has played a significant role in the history of OER (MIT, 2001).

Finally, in 2002 UNESCO held a Forum comprised of several people wishing to "develop a universal educational resource available for the whole of humanity." In that forum it is the first time they used the term "open educational resource" to describe their efforts (http://www.oecd.org/education/ceri/36224377.pdf). Thus, UNESCO's 2002 forum is the milestone for OER.

The chronological flow of OER is summarized in Table 1. For instance, in 1999 University of Tubingen (Germany) and The Open University (UK) shared some of their educational resources for free. However, the most popular OER initiative is known to be the MIT since 2001. By 2002, MIT released 32 courses with open licenses. UNESCO convened a Forum in 2002 on the "Impact of Open Courseware for Higher Education in Developing Countries". After that forum, the term OER was coined. Later, many education providers have used OER concept by opening the courses' licenses and by sharing the resources via Internet for teaching.

Table 1: A Chronological history and development of OERs, (adopted from Butcher and Moore, 2015)

January 1999	University of Tübingen's (Germany) the first OER is shared by lecture video series on Internet,
2001	MITs' OpenCourseWare is announced in The New York Times
July 2002	UNESCO convened a Forum on the Impact of Open Courseware for Higher Education coining the term "open education resources," (OER).
September 2002	Massachusetts Institute of Technology (MIT) shared 32 courses on its OpenCourseWare platform.
November 2003	China Open Resources for Education (CORE) is developed for resource sharing for Chinese universities
January 2005	OECD released a report, Giving Knowledge for Free: The Emergence of Open Educational Resources, outlining 20-month study of the uses of OER.
September 2006	Khan Academy launched online, free video materials for secondary school curriculum
September 2007	University of Michigan Medical School and IT Department released Scribe that is a method for providing preclinical curricula materials as OER
January 2008	Cape Town Open Education Declaration called out to governments and publishers around the world to release education materials on Internet for free.
2008	The term MOOC was coined by Dave Cormier from the University of Prince Edward Island in Canada.
February 2009	OER Africa, University of Michigan and four African universities receive a grant from the Hewlett Foundation to support free health education.
August 2009	The governor of the state of California, passes California's Free Digital Textbook Initiative
September 2011	Stanford University offers three free massive open online courses (MOOCs), more than 160,000 enrollments took place.
April 2011	Bangladesh releases a full set of digital textbooks for grades one to 12
May 2011	Commonwealth of Learning specifies a broad policy to promote and inform the development and use of OER.
July 2012	Paris OER Declaration is released, calling on governments worldwide to openly license publicly funded educational materials for public use.

OER can be classified by it various "types" required within the education sector. Worksheets, course plans, course resources, reference articles and so on are significant contents in OER. OER also encompasses open courseware (OCW) usually referred for open online university courses and programs. In Section 3, we detail the OCW.

2.2 Benefits of OER

Benefits of OER can be summarized as follows (https://courses.lumenlearning.com/):

- It provides opportunities for open and flexible learnings by facilitating informal and lifelong learning by also providing learning opportunities for disadvantaged and excluded learners.
- It expands interdisciplinary teaching by integrating resources from multiple sources.
- By providing teachers to reach high quality learning materials, it results with increased efficiency in teaching. Also, because of the possibility of collaboration and sharing in OER, it has the opportunity of further enhancing the quality of the resources by the exposure of large number of learners and educators.
- OER is cost-efficient. It saves both time and money in course content development. It reduces duplication and promotes inter-institutional collaboration and sharing.

OER allow students not to purchase a hard copy textbook and to have learning materials right from the start of their courses. This is a significant point because, as the results of the Florida Virtual Campus' 2016 Student Textbook and Course Materials Survey, the cost of textbooks is negatively impacting student access to required materials (Figure 1). According to the survey, 66.6% did not purchase the suggested textbook and 37.6% receive a poor grade; 19.8% fail a course due to the cost of textbooks. That cost also affects student's time to graduate and/or access to it. The statistics show that students take fewer courses with 47.6%. They do not register for a course with 45.5%. They drop a course with 26.1%. Or, they withdraw a course with 20.7%. Hence, OER will also help students to get rid of textbook costs.

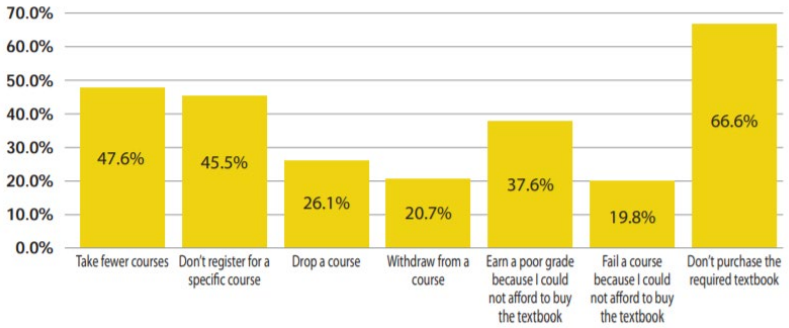

Figure 1: Impact of textbook costs on students results of Florida Virtual Campus' 2016 survey (source: https://www.flvc.org/documents/96858/931951/2016+Student+Textbook+Survey.pdf/591cf5b0-bbe8-406d-acd8-b23d89b8577f)

3. Open Courseware (OCW)

Although the statements OER and OCW are usually used interchangeably, they are different from each other. OCW is usually organized as courses and includes syllabus, handouts, teaching materials (slayts, videos, etc.), and other related teaching materials. According to Terrel and Caudill (2012), OER resources can be "any digitized form". Therefore, OCW can be assumed as a part of a larger subset of OER. As mentioned previously, since its inception in April 2001, the MIT OCW plays an essential role in general OCW.

OCW is an educational concept. It allows everybody freely access of all learning materials provided by universities and colleges. Since it includes educational content, planning materials and evaluation tools, OCW is typically an online course. However, there is no access to teacher assistance. It solely involves lecture notes, course outlines, reading lists, assignments, demonstrations and students' work. The main idea for motivation of MIT for OCW in 2001 was that top universities should share the core academic course materials on the Web. Although this idea seemed to be antithetical by the most universities at that time, MIT licensed these materials in an open source model and encouraged the users downloading and modifying them.

OCW is accepted to be beneficial by large educational community. However, due to its one-way delivery environment, it's criticized by the community. It lacks interactions among teachers and students in classrooms. Cueva, Rodriguez, and Marban's (2016) study on how to integrate social technologies in OCW and it would affect the level of acceptance and expectations of OCW. They found that by the implementation of collaborative learning design and supporting technologies, OCW can be enhanced from effectiveness of social and collaborative learning. For instance, in order to include interactions among students, teachers, peers, Small Private Online Course (SPOC) platform can be combined with OCW and classroom interactively.

In principle, OER can be seen as ideal step to develop Massive Online Open Courses (MOOCs). However, MOOCs are designed or developed not like the principles of the OER principle. Namely, MOOCs are not modifiable and shareable as well as they are not able to be remixed, etc. In Section 4, we give detail information on MOOCs.

4. Massive Open Online Course (MOOC)

A MOOC is collection of teaching materials combined with learning assessments. In some cases, it includes platforms and activities for interacting of students with each other. The goal of a MOOC is to provide learners with a complete and well-organized package, with comprehensive online teaching materials with syllabi, lectures, quizzes, etc.

MOOCs, and OCW in general provide new learning opportunities for community. Besides, MOOCs are expected to be great innovation for further development of formal higher education, continuous professional development, and opening up education.

Although the MOOCs have originated in 2008, the phenomenon has become effective since 2012 when the acronym appeared on media (Moe, 2015). We provide the chronology of MOOC in the following subsection.

4.1 Chronology of MOOC

To check the chronological flow, first MOOC was developed by Stanford University in 2011. Its start point was in July 2011, when Stanford professors Sebastian Thrun's and Peter Norvig's joint course — CS221 Introduction to AI — was offered online for free at ai-class.org (https://www.classcentral.com/report/mooc-hype-year-1/). Now that course is in Udacity, an EdTech startup founded by Thrun, later on. The CS221 course was offered for both on-

campus at Stanford and for online students. In both ways, the students are graded in the same manner. Ten days later, Thrun and Norvig released a video explaining how the course would work. The word "MOOC" or "Udacity" has never been declared until that time.

A month later, two more online courses were released by Stanford professors one of which was taught by Andrew Ng who would be the co-founder of Coursera. He taught a Machine Learning introduction course at ml-class.org which is now in Coursera. The other course, Databases introduction, was taught at db-class.or by Jennifer Widom which are now redirected to Lagunita, Stanford's MOOC platform.

Within a month of its first announcement, 58,000 learners enrolled to Peter Norvig's AI class. On 10th of October in 2011, three online courses of Stanford delivered as live. Nearly 100,000 students followed the course (https://www.classcentral.com/report/mooc-hype-year-1/). Later, on December 19th, 2011, in order to offer online courses, MIT announced an initiative that is MITx led by Anant Agarwal, who would later become the CEO of edX.

On 18th of January in 2012, Coursera's website went live. Their mission was stated to be: "We are committed to making the best education in the world freely available to any person who seeks it." The platform's founders are Stanford professors, Andrew Ng and Daphne Koller. At the time, the Coursera's business model was not clear whether or not it was a non-profit business. A few days later, a media company, Inside Higher Ed, focusing on university news, revealed that Coursera could be for-profit. In that article, for the first time, the word "MOOC" appeared (https://www.classcentral.com/report/mooc-hype-year-1/).

On January 23rd, 2012, a new for-profit platform was announced by the team of AI class. It was the Udacity, led by Sebastian Thrun. The Udacity's initial two courses were: CS 101: Building a Search Engine and CS 373: Programming a Robotic Car. Udacity was more project oriented compared to Coursera. On 20th of February in 2012, Udacity went live with the course of CS101 - Building a Search Engine. It was taught by a professor at the University of Virginia (https://www.classcentral.com/report/mooc-hype-year-1/).

A month later, Coursera announced Princeton, the University of Michigan, and the University of Pennsylvania as its new university partners. On 23rd of April, Coursera's first courses started. That day was accepted to be the birth of the Coursera's platform celebrated as its anniversary.

On 2nd of May in 2012, the universities Harvard and MIT announced the foundation of EdX. Each university invested $30 million to support the platform. The EdX was developed by the MITx. One month later, a $1-million investment for EdX would be done by the Gates Foundations (https://www.classcentral.com/report/mooc-hype-year-1/).

In 2012, due to intense MOOC releases, The New York Times declared the year 2012 as "The Year of the MOOC" (https://www.nytimes.com/2012/11/04/education/edlife/massive-open-online-courses-are-multiplying-at-a-rapid-pace.html). Figure 2 shows the number of courses provided by MOOCs all over the world since 2012.

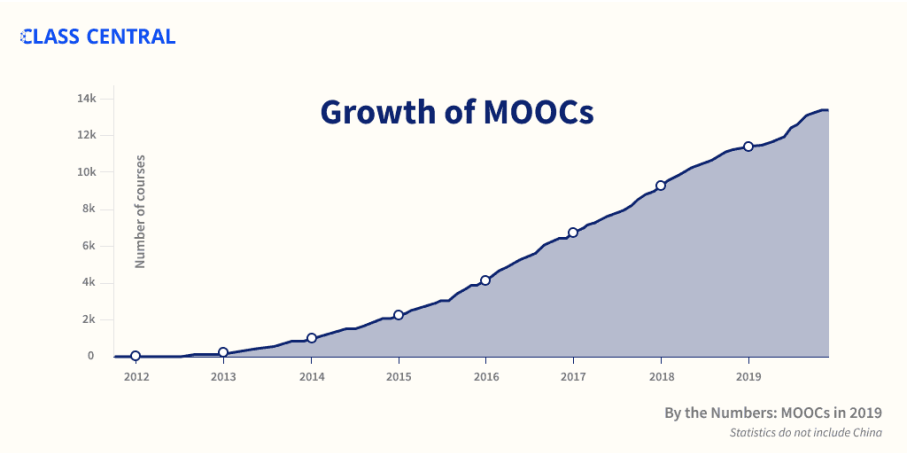

Figure 2: Number of courses provided by MOOCS all over the world (source: https://www.classcentral.com/report/mooc-hype-year-1/)

So far, more than 800 universities are estimated to have launched at least one online course. By those universities over 9,000 MOOCs are announced (from Class-Central, Jan 2018). Although there has not been an increase in new learners, the number of paying users is observed to increase. This is probably because that in order to increase the number of paying users in their quest for sustainability, MOOC platforms change their business models https://www.openuped.eu/images/Publications/The_2018_OpenupEd_trend_report_on_MOOCs.pdf. There are several MOOC providers all over the world. We mention some of significant ones in Section 4.2.

4.2 MOOC Providers

Most of the current MOOC providers are developed in the US. Hovewer, some of European universities have also joined those US initiatives. For instance, OpenupEd (http://www.openuped.eu/) is a paneuropean MOOC, and FutureLearn LTD (http://www.futurelearn.com/) is launched in the UK. The Open University and the Australia based SEEK Group jointly owned the FutureLearn after its investment. FutureLearn has become the UK's biggest MOOC platform by its almost 10 million users. After a number of prominent US universities have begun offering MOOCs, e.g., Coursera (https://www.coursera.org/) by Stanford University; eDx (https://www.edx.org/) by MIT and Harvard University, the FutureLearn has been launched in 2012. In order to differentiate from their earlier versions, cMOOCs, the MOOCs are sometimes referred to as xMOOCs. While cMOOCs usually acts as a coach for learners designating their own learning outcomes, xMOOCs are content-based. Figure 3 shows some of well- known MOOC providers around the world.

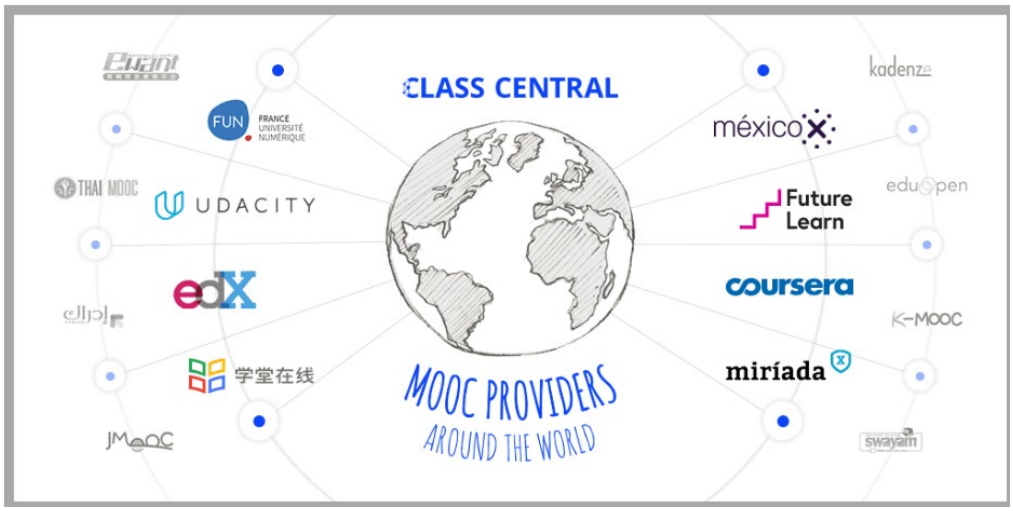

Figure 3: MOOC providers around the world (source: https://www.classcentral.com/report/mooc-hype-year-1/)

According to the classcentral.com, in 2019 total number of registered users for the top six MOOC providers are as follows:

1. Coursera — 45 million.
2. edX — 24 million.
3. XuetangX — 14 million.
4. Udacity — 11.5 million.
5. FutureLearn — 10 million.
6. Swayam - 10 million

In 2019, classcentral.com also announces the distribution of courses across subjects as in Figure 5. Forty percent of courses are declared to be the subjects business and technology that are the easiest to monetize.

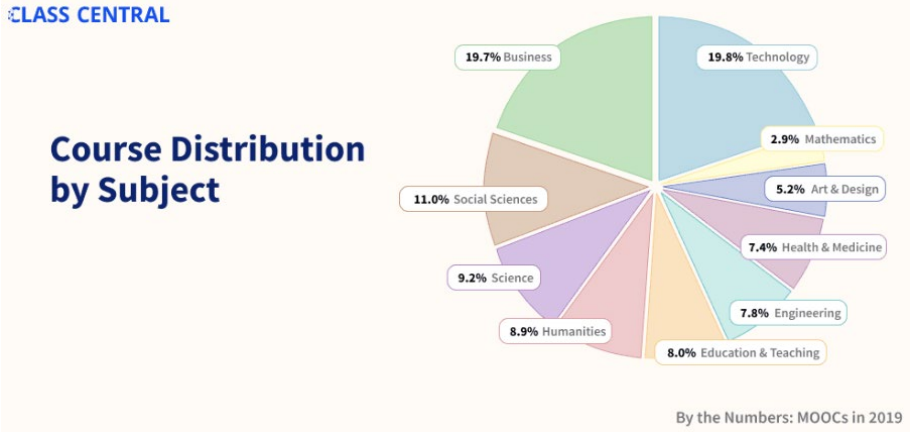

Figure 4: Distribution of MOOC courses across subjects (source: https://www.classcentral.com/report/mooc-stats-2019/)

4.3 Common design features of MOOC

With the recent technological developments, common design features of a modern xMOOC contain the below contents (https://opentextbc.ca/teachinginadigitalage/chapter/section-7-4-design-models-for-moocs/).

4.3.1 Platform software designed specially

Modern MOOCs use platform software designed specially. It allows registration of very large numbers of participants. That platform is able to provide facilities for storing and sharing of digital materials, automating assessments and tracking student performances. It also usually allows collecting and analyzing of student data.

4.3.2 Videos for lectures

Recent MOOCs usually use standard lecture mode and they are downloaded online by learners on demand. The video lectures of MOOCs are usually available over a period of 10-13 weeks. In the initial version of MOOCs, lectures were often 50 minutes. However, after some recent experiences, MOOCs consider shorter recordings (e.g. around 15 minutes videos). They provide more video segments by becoming shorter in length. Their available period length is also narrowed which are lasting in only five weeks. Different video recording methods such as lecture capture, full studio production, or desktop recording by the instructor can be utilized.

4.3.3 Assignments

In the modern MOOC design, student assignments are usually online tests. They receive immediate feedback in the computer environment. These tests are usually offered in order to assure an insight and feedback for learners. The tests may also be done to determine the award of a certificate. Most recent xMOOC assignments include multiple-choice and computer-marked questions so that the results can be provided immediately. However, some MOOCs may also have open-ended, text or formula boxes for learners to enter their answers. For instance, by that, writing codes in a computer science course, or mathematical formulation in any engineering courses, etc. would be possible.

4.3.4 Peer assessment

Recent MOOCs implementations may have random assignment procedures of students for small groups for peer assessments. This procedure can be followed when there are open-ended or evaluative assignment questions.

4.3.5 Supportive materials

In some cases, downloadable slides, supplementary files, web pages, online articles, etc. may be included through the course.

4.3.5.1 A shared comment/discussion environment

MOOCs usually have environments where learners can ask questions and for help, or evaluate and feedback on the content of the offered course.

4.3.5.2 Slight discussion moderation

Discussion or comments are moderated at all participants rather than to individuals. Due to large number of learners, it is usually impossible for instructor to moderate individual comments. Therefore, some instructors may prefer no moderation. Instead of that, learners may rely on others to respond to questions or comments. Some instructors may comment and post answers based on 'sampling' the participants' comments. Some instructors may involve volunteers or paid TAs for responding to participants. However, usually participants moderate the comments/questions of others.

4.3.5.3 Badges and certificates

After the final computer-based assessments, most xMOOCs award some successful completions. However, very few MOOC badges/certificates are recognized for credit. Even the institution offers MOOCs, mostly, they are not accepted for admission purposes. Coursera is exploring a unique long-distance option that uses student identification to validate his/her participation for its programs.

4.3.5.4 Learning analytics

The xMOOC platforms can provide useful big data for instructors about participants' learning performance. By providing immediate feedback about the participants to instructors, they can identify the areas where the MOOC requires improvement. It may also provide automated clues, hints on individual's success.

As a result, xMOOCs are novel teaching models transferring high quality content information by computer-based environment, assessments for student feedbacks, and automation providing all key transactions between users and the learning platform. Although mostly there is no direct interaction between a participant and the instructor, general comments and responses may be posted by instructors based on participants' comments anyway.

5. Differences between MOOCs and OCW

Differences between MOOCs and OCW can be explained as follows:

- MOOCs are copyright licensed so they cannot be used freely by others for teaching. However, OCW is licensed under Creative Commons (http://www.creativecommons.com/) whose goal is to have as many people as possible taking and using the content. Hence, users can utilize the contents either for teaching or learning.
- MOOCs are designed for learners where they can take assessments and earn "certificates of completion". However, OCW is for both learners and teachers. They utilize any parts from the OCW based on their needs.
- OCWs do not offer teaching for a whole course. They provide only materials However, MOOCs do offer entire course for teaching.
- Many MOOCs are offered on a time-limited basis. Namely, they are like "real" courses. They have defined starting and ending dates and are available all 24/7/365 time.
- Although both are for supplement or complement of a "real" course, only OCW carries the licensing allowing instructors adapt content for their own teaching.
- MOOCs are not free and they usually offer some sort of certification/badge for participants completing the course requirements such as exams, assignments, etc. OCW does not provide any certificates/badges.

6. University Implementations of MOOCs

Many universities offer MOOCs as well as online degree programs. According to the MoocLab's World University Rankings by MOOC Performance 2020, the ranking of top ten MOOC provision is shown in Figure 5 (https://www.mooclab.club/pages/wurmp-full-list/).

RANK	Institution		MOOCs	Learning Pathways	Micro-Credentials	Degrees	Average World Ranking*	Country
1	Delft University of Technology	More	94	10	9	0	98	Netherlands
2	University of Pennsylvania	More	134	16	4	1	14	USA
3	University of Illinois at Urbana-Champaign	More	138	15	1	4	54	USA
4	Coventry University	More	73	0	0	15	618	United Kingdom
5	University of Michigan	More	132	11	4	2	21	USA
6	University of Washington	More	43	12	8	0	36	USA
7	Massachusetts Institute of Technology	More	176	9	3	0	3	USA
8	Deakin University	More	38	1	1	9	282	Australia
9	Harvard University	More	132	11	3	0	4	USA
10	University of California, Berkeley	More	55	7	6	0	15	USA

Figure 5: MoocLab's MOOC Performance of World Universities by 2020 (source: https://www.mooclab.club/pages/wurmp-full-list)

Figure 5 shows the world university rankings based on MOOC performance. According to that figure, Delft Univ. of Technology is ranked first as the MOOC performance. These rankings evaluate the institutions based on the courses offered by three leading MOOC platforms - Coursera, EdX and FutureLearn. The universities are ranked based on five performance indicators. These are: the number of MOOCs provided by the university, the provision of learning pathways, micro-credentials, degrees and the institution's average world ranking. For the MOOC performance rankings, the below ratios are considered.

- Number of MOOCs (10%)
- Number of Learning Pathways (15%)
- Number of Micro-credentials (20%)
- Number of degrees (20%)
- Average world ranking (35%)

We also summarize some MOOC implementations specifically at well-known universities below.

6.1 The Massachusetts Institute of Technology (MIT)

MIT's offers 2,400 free online courses. They use a combination of lecture notes, audio, and video resources. Engineering courses include courses for almost all disciplines from aeronautics and astronautics to mechanical engineering and nuclear science (https://ocw.mit.edu).

There so many undergraduate and graduate courses especially in the Electrical Engineering and Computer Science ranging from Introduction to Computer Science and Programming to specific programming languages (e.g., Java and C++).

6.2 UC Berkeley

UC Berkeley offers free online courses for a wide range of disciplines such as english, blockchain technology, marketing, data analytics, and statistics. The university has also partnered with edX. Hence, their free online courses are featured there. Besides UC Berkeley, Harvard and MIT also provide online courses including engineering, chemistry, biology, economics, business, medicine, social sciences, and many more under edX.

6.3 UC Carnegie Mellon

Carnegie Mellon's Open Learning Initiative (OLI) offers courses for various subjects and disciplines (https://oli.cmu.edu/). Some of technical courses are: engineering statistics, data science, business, coding, media programming and principles of computing. Carnegie Mellon's OLI has a student program where the courses are $25 each. However, they also offer Independent Learner courses that are free and open to everybody. Besides the lectures, they also offer resources for learning activities, exams, and itemized lists of objectives. The courses are free and there is no interaction with instructors. Also, they do not provide any credits or certificates/badges.

6.4 Harvard University

Harvard University also offers a wide ranging from programming to data science to security and more of free online courses via their Open Learning courses. Some of the offered courses are free and some of them are charged for tuition at reduced rates. Harvard University also provides its online courses under edX.

6.5 Stanford University

Stanford Online offers a wide range of free online courses via Stanford's OLI (http://oli.stanford.edu/learn-with-oli). The topics include: software security, big data analytics, computer science, statistics, quantum mechanics, computer networking, etc.

6.6 Georgia Tech

Georgia Tech works with the MOOC provider Udacity which AT&T invested on. In spring 2014, the university launched its online MSc program in computer science. Besides, in Jan. 2017, they also announced their analytics based master's program that is the second low-cost online program. The program was offered by EdX donated by AT&T and Accenture.

Recently, Georgia Tech and MIT provide a choice for certain courses. The students can either enroll for the traditional on-campus course, or the completely online course. These MOOCs online courses would be offered by edX. The courses on edX.org are the same version of the courses that are open freely to all community. Georgia Tech's this case is the first, where on-campus students can earn credit from a MOOC.

Starting from 2015s, Georgia Institute of Technology in USA has constructed virtual Teaching Assistants (TAs) for some of its online courses called 'Jill Watson' developed by using IBM Watson APIs for that purpose (Goel and Polepeddi 2016). Those virtual TAs can respond to student questions without informing the students that they were AI agents (Figure 6).

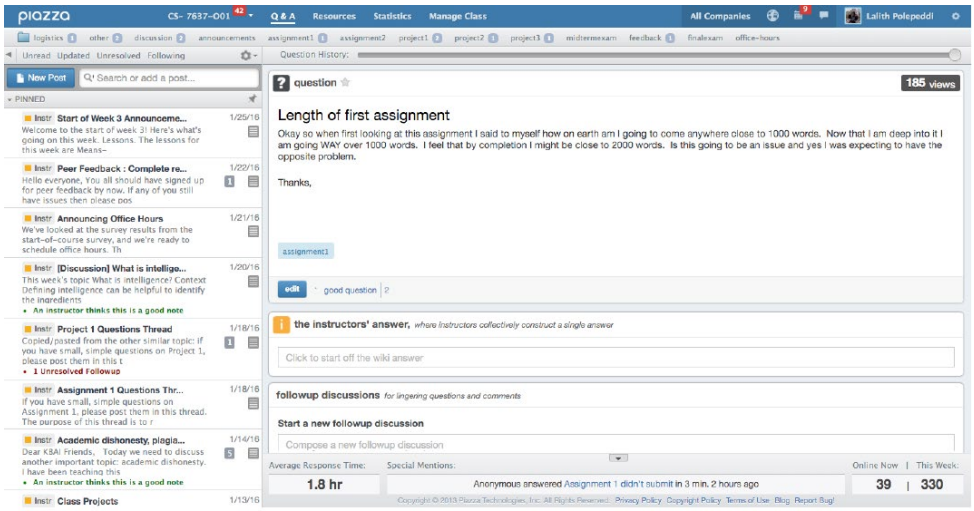

Figure 6: A screenshot from an online course of Georgia Tech and a class forum m where students ask questions, discuss ideas, and give feedback (source: Goel, A. K., and Polepedd, 2016, 2019)

Although, the MOOC version of a course is usually different from the on-campus version, or the professors who teach a MOOC do not even teach the same course on campus, pilot implementation of MIT and Georgia Tech. have been promising. Either on-campus or online student can earn real credits. In a questionnaire result, students rated the online course as significantly and less stressful than their on-campus classes. In that result, at Georgia Tech, no significant differences were observed based on the test scores of two versions (https://www.classcentral.com/report/mit-georgia-tech-moocs-show-up-on-campus/).

6. Conclusion

In this wok, due to the 2020 Coronavirus outbreak issue, we aimed to bring the digital teaching subject on board. For instance, Class Central has documented how American universities are moving towards online teaching, and how researchers are using MOOCs to disseminate information during pandemic. Thus, data and practice show that outbreak days have been accompanying a significant surge in online education.

MOOCs is an online learning platform building new paths to higher education and expanding continuous lifelong learning opportunities. It also provides flexibility in education alternatives for students and cost efficiency for institutional education. In this work, we discuss digitization in higher education by focusing on digital learning platforms at universities.

According to the vice-president and pro vice-chancellor (teaching and learning) at the University of Hong Kong (HKU), Ian Holliday, "Online learning has become central to our teaching model" (https://www.timeshighereducation.com/features/will-coronavirus-make-online-education-go-viral). Therefore, education institutions should adapt their education system towards more digitization and should be prepared for emergency conditions towards remote teaching tools.

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