Challenges and International Opportunities with STEM based MOOC Development

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Massive Open Online Courses (MOOCs) provide both opportunities for world-wide student engagement and learning but also challenges for institutions that are developing them. In this paper, I address these various issues relating to MOOCs based upon two years of experience in developing them on the edX platform at Tokyo Tech. In particular, I discuss the Tokyo Tech Online Education Development Office's MOOC teaching assistant (TA) based development model and internationalization activities.

Keywords : MOOC, internationalization, e-learning, PBL

1. Educational Technology Expectation Cycle

In the field of new technology utilization, a graphical time based cycle developed by the advisory firm Gartner represents expectations of a particular technology over its life cycle, which ends in some cases when a technology reaches a productive phase[1]. The cycle consists of 5 stages starting with a technology trigger, followed by peak of inflated expectations, trough of disillusionment, slope of enlightenment and plateau of productivity. Massive online open courses (MOOCs), which became popular about 4 years ago have gone from inflated expectations and currently sits between the through of disillusionment and slope of enlightenment in the USA (Fig. 1). However, in Japan, I would speculate that MOOCs are actually somewhere along the peak of inflated expectations since MOOCs are not yet a household word in Japan. It should be noted that MOOCs is one of the latest in a series of education meets technology modes, e.g. previous items are open courseware, i-tunes U, learning management system (LMS) etc. In this article, I will discuss Tokyo Tech's creation of MOOCs for Science Technology Engineering and Mathematics (STEM) education, elaborate on online course development challenges, opportunities for online course use with internationalization partners and learning on campus.

2. Tokyo Tech's Edtech past and present

Tokyo Tech has a relatively long history with educational technology (Edtech) development as noted by its formation of the Center for Research and

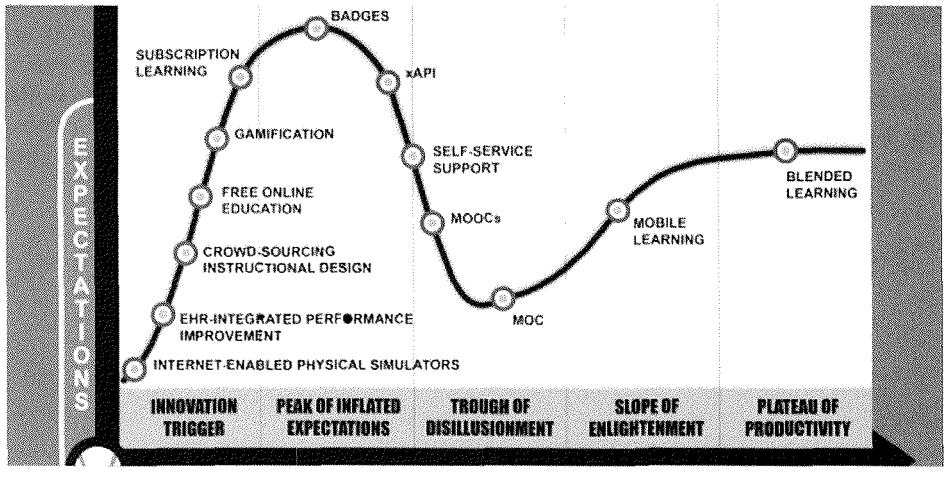

Fig. 1 2016 expectation curves on educational technology

Received July 25, 2016

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Development of Educational Technology (CRADLE) in April, 1973 for the advanced study on educational methods and use of technology in higher education. CRADLE developed distance learning technologies but did not become involved with the MOOC movement. CRADLE was dissolved in March 2015, in order to form the new Center for Innovative Teaching and Learning (CITL) that started on April 1, 2015. Similar teaching and learning centers have been formed world-wide at peer institutions with similar missions in the last several years to focus on improving student's learning as well as improving teaching in order to improve the quality of higher education overall. In summary, CITL's mission is to improve education quality through faculty development and education assessment at Tokyo Tech (Fig. 2)[2]. CITL also oversees the Online Education Development Office (OEDO). Actually, OEDO was formed in 2014 after Tokyo Tech joined the edX online course consortium founded by Harvard and MIT. OEDO was tasked with developing massive online open courses (MOOC)s for edX under the brand TokyoTechX[3]. To date, OEDO has developed two MOOCs offered in English and is working on developing several more courses both in Japanese and English languages[4].

3. edX courses and conferences

edX offers its members, depending upon their membership contract, two different websites for hosting online course creation and delivery. The main edX site (https://www.edx.org/) is for MOOCs, where the courses can be enrolled in for free and which also issues certificates for students that pass the course and pay a fee. In addition, member universities are also given access to another website called edX edge (https://edge.edx.org/), where online courses can be created using the same open edX Learning Management System (LMS) but with controlled course enrollment access. The edX edge site allows a course to be developed and evaluated before it is released to the public or to be developed for use on campus. This type of online campus course is referred to as a small private online-course (SPOC). In addition, edX also offers courses from institution for professional development called "professional education" which charge a fee[5]. edX's latest initiative is to support professional skills development for careers in a new platform initiative called a MicroMasters, where five-six graduate courses are offered in a series on a particular topic and taking them allows one to acquire a credential for a fee. The first edX MicroMasters credential is being offered by MIT starting in 2016. The MicroMasters can sever as a standalone academic credential or as part of the initial portion of a Master degree program if one applies and is admitted into the corresponding graduate program. A number of other edX member institutions are expected to also offer these types of blended graduate

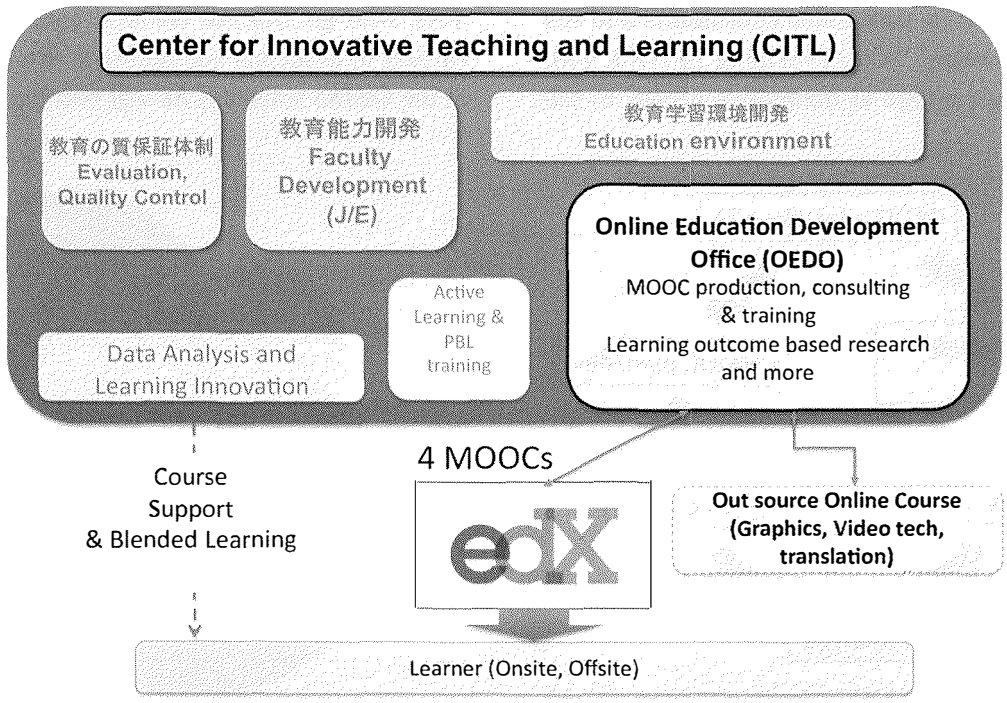


Fig. 2 T●ky● Tech's CITL, OEDO and edX activities

degree programs, where courses are initially taken online and later on-campus for top performing students, with more announcements expected in the fall of 2016.

In addition to hosting online courses, edX organizes annual conferences for members to learn about recent trends, exchange information and discuss best practices each fall in its edX global forum[6]. The global forum is a great way to network with the edX staff, world-class peer institutional members and discuss collaborations on what is the latest innovation in online learning. Furthermore, a second conference called Open edX is held every summer for the open source open edX community involved in the platform development to meet, discuss and share information. In June 2016, it was held at Stanford University and Tokyo Tech gave a paper on data analysis of our first MOOC using the edX insights MOOC data analysis tool based upon analysis of the first MOOC offered at Tokyo Tech. At the open edX conference, all presentations were video recorded, stored on youtube and the slides are shared with the greater community by uploading them to a website[7]. Since edX is a non-profit organization, materials are readily shared with the education community.

4. Online Course Development Challenges

The overall model for MOOC development follows a PDCA cycle as show in Fig 3 and takes about 6-18 months. Given limited financial resources initially, it was decided to develop MOOCs with graduate teaching assistants (TA)s, staff, video consultants and the instructor as a team[8]. Co-developing MOOCs with TAs had the advantage of immediate access to talented students but required time to develop their online course designing and video making skills. Instead of using TAs in one subject area, TAs with various backgrounds were recruited to provide a broader point of view. The TAs were trained using online course development training materials provided by edX as well as using hands on workshops relating to storyboarding and video creation. During the Spring and Summer 2016, we created two one credit courses offered on campus entitled: *Introduction to Edtech: Online courses and Introduction to Edtech:video-Making* using openedX. Both of these courses were offered in blended learning format, where materials are online and classroom time is used for supplemental lecture, demonstrations and for discussion.

With each course, we have developed a PDCA cycle (Fig. 3) which starts with development, course delivery, revision, and blended learning (campus use). Once a course is revised it can be operated in continuous or self-pace mode. We plan to re-launch our first two MOOCs in self-paced mode this fall. The reason for doing this is there appears to a large population of online learners, who want to take courses at their convenience, e.g. throughout the year independent of an academic calendar.

In the OEDO TA-Instructor-staff course development model (Fig. 4), TAs play an active role in course materials development, video recording, video editing, assessment and integrating the materials into the LMS under staff and instructor guidance. It is anticipated that a number of the OEDO trained TAs, who go into the doctoral course, will go on to careers in academia and industry. We anticipate some of the OEDO trained TAs will become academics and

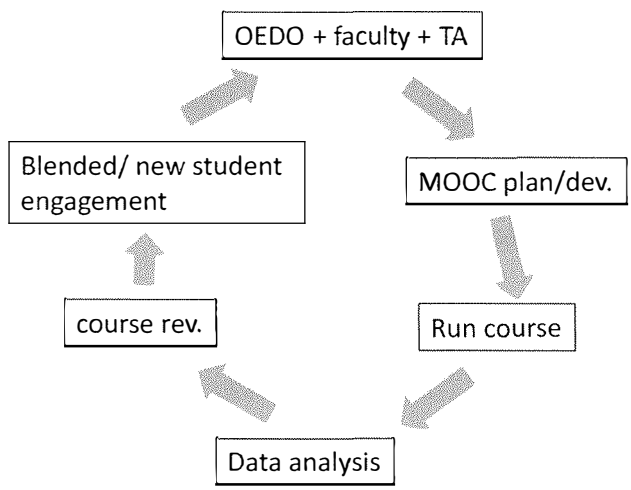


Fig. 3 PDCA cycle for MOOC process development and blended learning

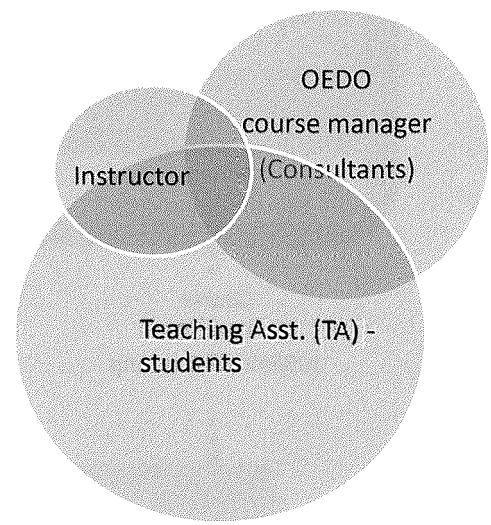


Fig. 4 OEDO online course development model

instructors in the future. So utilizing TAs for course development is in some cases training faculty of the future.

The OEDO education model is shown in Fig. 5. OEDO can be considered a 4th site on campus where students can learn about education and teaching by actually creating courses or serving as TAs in edtech courses. The other places where students can learn on campus us 1) in the lab by doing research or are educated thru research, 2) they also learn and socialize in their clubs and circles, and 3) finally they learn by taking courses in their degree program for credit. So TAs learn by project based learning (PBL) in OEDO by creating educational materials for MOOCs. Student feedback from participating in online course creation has been very good for the TAs, and so far about 70 TAs have participated in OEDO activities over the last two years. A challenge exists with the TA course development model, that is it takes more time to develop a course than with using experienced staff only, since the TAs need time to learn about course-creation first. However, at the same time, we have found that more experienced TAs mentor less experienced TAs as the students do in their labs. This type of mentorship provides an opportunity for learning by teaching among the OEDO TAs.

The author has experience both in developing online campus courses (SPOC) as an instructor working together with a course instructional designer as well as a course manager developing a MOOC with an instructor. It has been reported that developing an online course can take approximately 400 hours of an instructor's time[9] and tens of thousands of dollars. As a SPOC course instructor teaching using a blended course model, I can attest it takes a larger amount of time to develop an online course for credit than developing a traditional lecture style course probably by two times. One has to prepare for the in-class component i.e. lecture or discussion materials plus the out-of-class materials and homework. Working with an instructional designer, who thinks about designing the course and each lesson around learning objectives, has made the courses better by clearing stating what is learned in each weekly lesson.

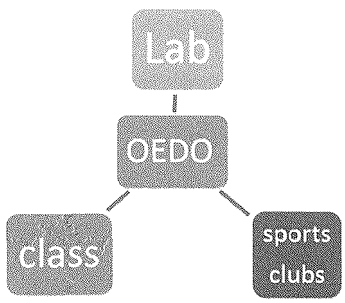


Fig. 5 OEDO teaching assistant (TA) position in student learning at Tokyo Tech

5. Opportunities

Working with TAs as they learn about teaching by actually creating a course is very rewarding. Some of the TAs have noted that creating a course is like taking a course itself, because of what they learn during course creation. As noted above, it usually takes TAs several months of preparations and undertaking various exercises to acquire the skills needed to prepare story boards, shoot video and edit it. Next comes creating assessments with instructor guidance and uploading the materials to the course website using the course LMS, open edX. This is followed by beta-testing the content and editing. Finally, when the course starts, the course discussion board is a great way to communicate with learners. It serves as dynamic quality control course content monitor, and an opportunity for TA discussion board monitors to develop their communication skills by responding to the posts[10].

With our first two MOOCs, initially we offered the courses online only and there was no direct linkage with on-campus courses. However, during the summer of 2016, the MOOC on Modern Japanese Architecture was taught on campus as part of a summer undergraduate course for international exchange students in blended learning format for credit[11]. It should be noted that in the field of Architecture, where the materials are graphical illustration and 3D models are constructed, the online course is a great format since it is serves as a digital textbook as well as an archive of teaching materials. The instructor can bring a lot of materials into the course using both images and video, which are typically not at their immediate disposal during a lecture.

At Tokyo Tech, which is a STEM institution, the gender balance is approximately 90/10 male/female ratio and also the students are predominantly Japanese. The MOOC provides both a more diverse group of learners based upon nationality, age, gender balance as noted in Table 1. The architecture course was evenly split between male and female enrollees, which is a gender balance that is not available on campus. So a MOOC offers an opportunity for greater

Table 1 Summary of TokyoTechX Two MOOCs offered on edX

	Deep Earth Science: Part 1	Modern Japanese Architecture
Start Date	Oct. 2015	May 2016
Course length	4 weeks	6 weeks
Enrollees	5,300	7,950
Ave. age	29	27
Female %	30	52
Countries	145	153

diversity and broader student base if it is run simultaneously with a campus course. The online course enrollees are also typically older and more experienced which can bring these experiences into the course to share on the discussion board or on homework and in peer instruction or peer review. The MOOC also offers a community of learners, where enrollees can also contribute to the course content. In the architecture MOOC, the students prepared a supplemental Japanese-English architecture dictionary list of terms, which they shared with the other students via the discussion board.

6. Internationalization

In the edX member community there are several opportunities for international engagement particularly with the other members at two edX conferences. At Tokyo Tech resulting from our online course activity and edX membership, we have hosted visitors, who are also edX partners from Caltech, Univ. California Berkeley, Univ. British Columbia and visited other universities that have online courses such as Univ. of Queensland, University of Melbourne, Nanyang Tech. Univ. and also Japanese universities. We regularly post our activities on our OEDO facebook page which allows for the information to be shared domestically and overseas.

In Japan, MOOCs are not well known as they are in the USA and EU. However, there are providers in Japan such as Gacco and JMOOC that provide courses in Japanese. The edX platform has few Japanese courses so we look forward to releasing a course in Japanese in 2017 on electrical engineering geared at high school and first-year university students. We hope the course will not only engage domestic students but also overseas students studying Japanese.

Given there are 1000s of online courses available in English and many more being created yearly, this is a rich pool of high quality instructional material that university instructors can access for their own courses if they wish or for use as reference materials. In Japan, where many Japanese students struggle with English comprehension and conversation, a MOOC video with an audio soundtrack and also transcript is an excellent resourse for language education in a variety of specialist fields. The video player allows for the video play speed to be adjusted. In the case of edX, the videos are stored on YouTube so access to the videos as instructional material is very easy outside of the MOOC.

The first MOOC we offered was on deep earth science taught by Tokyo Tech Prof. Kei Hirose. Although the MOOC was taught in English, it was created first in Japanese and then translated into English. It was easier for the Japanese TAs and instructor to discuss the course content and develop the course in Japanese before offering it as a MOOC in English. So far we have yet to offer courses in both languages but that is a possibility in the future. Therefore, the Japanese TAs involved in the course development had an opportunity to learning about earth science in Japanese and improve their English at the same time by preparing course materials in English. We also periodically hold TA mixers allowing interactions between international and Japanese TAs (Fig. 6).

Tokyo Tech participates in several regional peer institution consortiums such as the Asia Oceania Top University League on Engineering (AOTULE)[12] and Asian Science and Technology Pioneering Institute of Research and Education (ASPIRE)[13]. In the future, it would be of interest to offer online courses to selected universities using the edX edge site within the Asia Oceania region, where the time differences is limited although we have difference in our academic calendars. Therefore, there appears to be room to innovate further and offer a Regional Online Open Course (ROOC) to select universities, which would be somewhat in between a SPOC (on-campus) and

Fig. 6 OEDO Japanese and International TA Mixer, Fall 2015

MOOC (open to the public).

In summary, we have learned a great deal about online course making by actually making courses with TAs, course instructors, and edX personnel on the edX platform. We have observed our MOOC development model creates a community of learners and offers TAs an opportunity to learn by teaching as well as chances to improve their communication skills and experience real-life project based learning. Their work relating to course creation is available within the course for everyone to see, which motivates them. We think there is further room for innovation in the online course space by offering courses with peer institutions and are examining the prospect of starting a domestic/international teaching assistant exchange program in the near future relating to online course development.

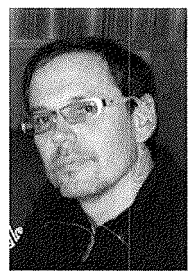
7. Acknowledgements

The author wishes to thank Tokyo Tech Executive Vice-Presidents Kiyoshi Okada and Toshio Maruyama for their guidance and support, the Center for Innovative Teaching and Learning (CITL) Director, Prof. Akira Matsuzawa, and OEDO Staff: Assoc. Prof. Hideki Mori, Hideo Morita, Michiko Moriyama, and Saya Goto, as well as technical staff Yuki Yoshihara and Hitomi Tachiki.

References

1) E-learning Hype cycle, http://elearningfeeds.com/2016-elearning-hype-curve-predictions/
2) Tokyo Tech Center for Innovative Teaching and Learning (CITL) website: http://www.citl.titech.ac.jp/
3) "Tokyo Institute of Technology Joins edX MOOCs Consortium founded by MIT and Harvard University" http://www.titech.ac.jp/english/news/2014/029068.html
4) OEDO homepage and facebook : http://www.citl.titech.ac.jp/oedo/ https://www.facebook.com/oedotitech
5) edX Professional Education, https://www.edx.org/professional-education
6) edX global forum, http://globalforum.edx.org/
7) OpenedX con 2016 https://openedx.atlassian.net/wiki/display/COMM/Open+edX+2016+Presentations
8) 森　秀樹, 吉原祐貴, 森田英夫, クロス スコット ジェフリー：学生ティーチングアシスタントとの協働によるMOOC制作の試み, P3a-BHAL-03, 日本教育工学会　第31回全国大会 Sept. 2015
9) Hollands, F. M., & Tirthali, D. (2014). MOOCs: expectations and reality. Full report. Center for Benefit- Cost Studies of Education, Teachers College, Columbia University, NY. Retrieved from: http://cbcse.org/wordpress/wp- content/uploads/2014/05/MOOCs_Expectations_and_Reality.pdf
10) Utilizing Discussion Board Management of a MOOC on Japanese Architecture to Enhance Student Learning, R. Cruz, H. Mori and J.S. Cross, Paper to be presented at the Japan Society of Education Technology, Osaka Univ. Sept. 17-19, 2016
11) Tokyo Tech's Modern Japanese Architecture Course Syllabus on Opencourseware: http://www.ocw.titech.ac.jp/index
12) AOTULE Website http://www.aotule.eng.titech.ac.jp/
13) ASPIRE League Website http://www.aspireleague.org/

Biography



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Jeffrey has three degrees in Chemical Engineering from three different US universities Kansas State University, 1986; University of Arkansas, 1989; and Iowa State University 1992. He has worked in Japan for over 20 years in industry developing non-volatile memories at Fujitsu Labs and Fujitsu Ltd. and at Tokyo Tech. He conducts research on biomaterials as well as creates and manages international research exchange programs for students and faculty. Recently, Jeffrey has turned his attention to online learning, where manages the Tokyo Tech Online Education Development Office (OEDO) creating MOOCs on edX. Born and raised in Kansas City, Kansas, US, he is an avid BBQer and Boy Scout Leader in the Scout Association of Japan.