Lessons we learned when creating four Massive Open Online Courses (MOOCs)

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ABSTRACT

Over the past two years, our team of three (one professor, one video editor, and one student) has designed, filmed, and launched four free Massive Open Online Courses (MOOCs) on the edX platform along with several YouTube short courses. In this paper, we will share our motivations behind these courses, along with details of our filming setup (recommended equipment and costs), timeline, workload, and finally enrolment statistics and feedback from students who have benefitted from the courses. We found that MOOCs are highly appreciated by students around the world if they are well-designed.

Keywords: Curriculum development, online learning, massive open online courses

1. INTRODUCTION

A Massive Open Online Course (MOOC) is a course which is designed to be accessible to anyone, anywhere in the world with an internet connection and a desire to learn. Since they were first introduced in the early 2000s, they have gained in popularity, with the major providers Coursera and edX (among others) each now providing thousands of courses designed by universities and creators worldwide with largely free content. While there is considerable debate over the efficacy of MOOCs versus traditional classroom-based education, we have found there to be widespread agreement among educators that the simple act of making learning materials available online to students around the world is uncontroversial. Because the COVID crisis forced much of our teaching here in Singapore online for a period of time anyway, our first motivation was to create high quality online learning materials for our students locally. As our institution (the National University of Singapore) had recently announced its involvement with edX, our secondary goal was to make our learning materials at a sufficiently high standard that students around the world might later find benefit. In this sense our motivation in creating our MOOCs was altruistic, although indirect benefits may ultimately flow to the university (prestige, admissions, etc.)

MOOCs have previously been considered by optoelectronics educators, and even in 2017 there were at least seven optics-related courses on Coursera and edX [1]. Examples of recent MOOCs, the construction of which has been described in recent literature include those on integrated photonics by AIM Photonics Academy [2], Introduction to Engineering Optics at National Univ. of Defense Technology (China) [3], and Silicon Photonics Design, Fabrication and Data Analysis at the University of British Columbia [4]. The use of at-home kits to add lab-like experiences to online learning has also been described [5]. We surveyed the available MOOCs on edX on 12 April 2023, and found that National University of Singapore was in the middle of the pack when it comes to the number of total offerings on that platform as presented in Table 1. Nonetheless, among the MOOCs offered by institutions with high numbers, we found the quality to be variable with some MOOCs largely consisting of recorded live lectures rather than bespoke videos. All of our university's MOOCs were created explicitly for the platform with professional video editing and careful content creation, so the four that our team created represent 20% of our institution's total offerings.

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Table 1: Survey of MOOCs on edX (representative, not comprehensive)

University	edX MOOC count on 12 April 2023	University	edX MOOC count on 12 April 2023
Harvard	163	TU-Munich	18
TU Delft	147	Sorbonne	17
MIT	145	IIT Bombay	15
Stanford	92	Cambridge	15
EPFL	80	Chalmers	15
Tsinghua University	72	Kyoto University	14
University of British Columbia	66	Cornell	12
UC Berkeley	27	Berklee College of Music	11
Georgetown	27	Wellesley College	11
University of Adelaide	25	Oxford	8
Seoul National University	22	University of Chicago	8
National University of Singapore	**20**	Australia National University	7
Imperial College London	20	Princeton	7
Arizona State University	19	CalTech	4

Table 2: Equipment List

Item	Approximate Cost (SGD)
4K camera with audio output socket + lens	1775+1270
Spare battery for camera	55
Camera tripod	50
Small LED light + light stand	279+35
Large light with diffuser + light stand	50+35
Microphone dual transmitter and receiver setup	794
Headphone for monitoring audio while recording	20
Pen display drawing tablet	850
Adobe Creative Cloud subscription (software used: Adobe Premiere Pro and Photoshop)	70.37/month

2. OUR SETUP

The equipment we purchased is shown in Table 2 with approximate costs. The expensive equipment is not really necessary to achieve high quality, since even a modern phone camera can work well, for example. But readers may be interested to know our actual setup. A dual remote microphone allows two people to be on camera conversing at the same time with their own microphones. A computer was also used but isn't included in the list. A student assistant (Ng) was hired and paid prevailing wages along with a videographer (Lim). Courses and videos were designed by Danner, who appeared in the videos as lecturer.

3. TIMELINE

We found that a single course takes approximately 6 months to one year to design and film, with filming taking place during perhaps one 3-hour block per week. The number of videos in each course ranged from 12 (Semiconductors for Beginners) to 35 (Electricity Distribution) with videos varying in length from 1-2 minutes up to about 30 minutes. The

course which has the most relevance to optics education is Semiconductors for Beginners, which assumes a high school level of physics and culminates with the primary learning outcome of understanding the internal workings of a solar cell. For a video of about 10 minutes in length, it took approximately 2 hours to prepare the materials, 30 minutes to an hour to film, and 2 hours to edit. (Note that a 10-minute video may correspond to a 20-to-30 minute lecture due to "speeding up" of writing, as described below.)

The main work carried out by the student assistant was to check videos for accuracy, write multiple choice questions to be interspersed between videos, and then key questions and solutions into the edX platform interface. On average, it took 30 minutes to 1 hour to write appropriate questions following any given video. For more complex videos, it took up to 2-3 hours. To draw circuit diagrams used in some of the questions and the solutions, CircuiTikz, a LaTex package, is used to ensure that the circuit elements look professional. The questions range from simple conceptual and factual questions to design and analysis problems, which are broken down into simpler questions to give students a glimpse of the design and analysis procedure, to summative, reviewing all the content taught in the MOOC towards the end.

4. RESULTS

We found widespread interest in the courses. Within two years (and with the more recent courses only offered in recent months), over 12,000 students worldwide have enrolled as shown in Table 3. When students use the edX platform, they also have the option of paying an amount we can set, for a "Verified Track", such that they have verification of a particular performance level. Of the 12,194 students, we found that fewer than 170 chose the verified track at USD 139 each. Our university does not currently have a programme that provides a specific benefit for these students (for example, MOOC completion in this way cannot lead to course credits), so specific motivations of those choosing the verified track are unknown. Nonetheless, it provides partial cost recovery.

Table 3: Enrolment data

Course Name	**Dates**		**Cumulative Enrolment**	**Average (Unique) Enrolment**
Semiconductors for Beginners	02 Feb 2021 –	12 Apr 2023	3,748	33 new students per week
Circuits for Beginners	07 Sep 2021 –	12 Apr 2023	6,727	81 new students per week
AC and Switching Circuits	05 Apr 2022 –	12 Apr 2023	721	14 new students per week
Electricity Distribution	16 Aug 2022 –	12 Apr 2023	998	29 new students per week
Total			**12,194**	

5. LESSONS LEARNED

Four types of videos provided variety: *Concept Demonstrations, Worked Problems, Field Trips, and Bench Demonstrations*. *Concept Demonstrations* introduce a topic in a fun way to students before equations and numerical problems are introduced. They show first principle concepts and then immediately test students with multiple choice questions which help them learn new vocabulary words and understand the basics. Then *Worked Problem* videos show whiteboard style lectures using a tablet computer – sometimes with handwritten text and sometimes with typewritten text and animations. We typically edit the videos in such a way that there is rarely a pause in the audio while an equation or other text is being handwritten on-screen. The text writing is "sped up" so that the audio flows continuously. For about 95% of our videos, we did not use a script. Grammatical errors and things spoken poorly were fixed in editing – we found that this was more efficient in terms of time use than writing a script and then reading from a teleprompter. We sometimes would then make *Field Trip* videos, to visit an industrial site or equipment room where concepts taught in the course were used in "real life" situations. From an engineering education standpoint, we feel this is a nice advantage of the MOOC format because it allows students to see situations within the course itself which are typically difficult to access in a traditional course. We also used a laboratory for *Bench Demonstration* videos where measurements of

devices and circuits are carried out. Occasionally two cameras were used in these videos so that editing cuts could be hidden by a camera angle change.

CONCLUSION

We have described our filming setup, time and cost commitments, and enrolment outcomes for four MOOCs created over the last two years. Nearly 12,000 students have benefitted from the material.

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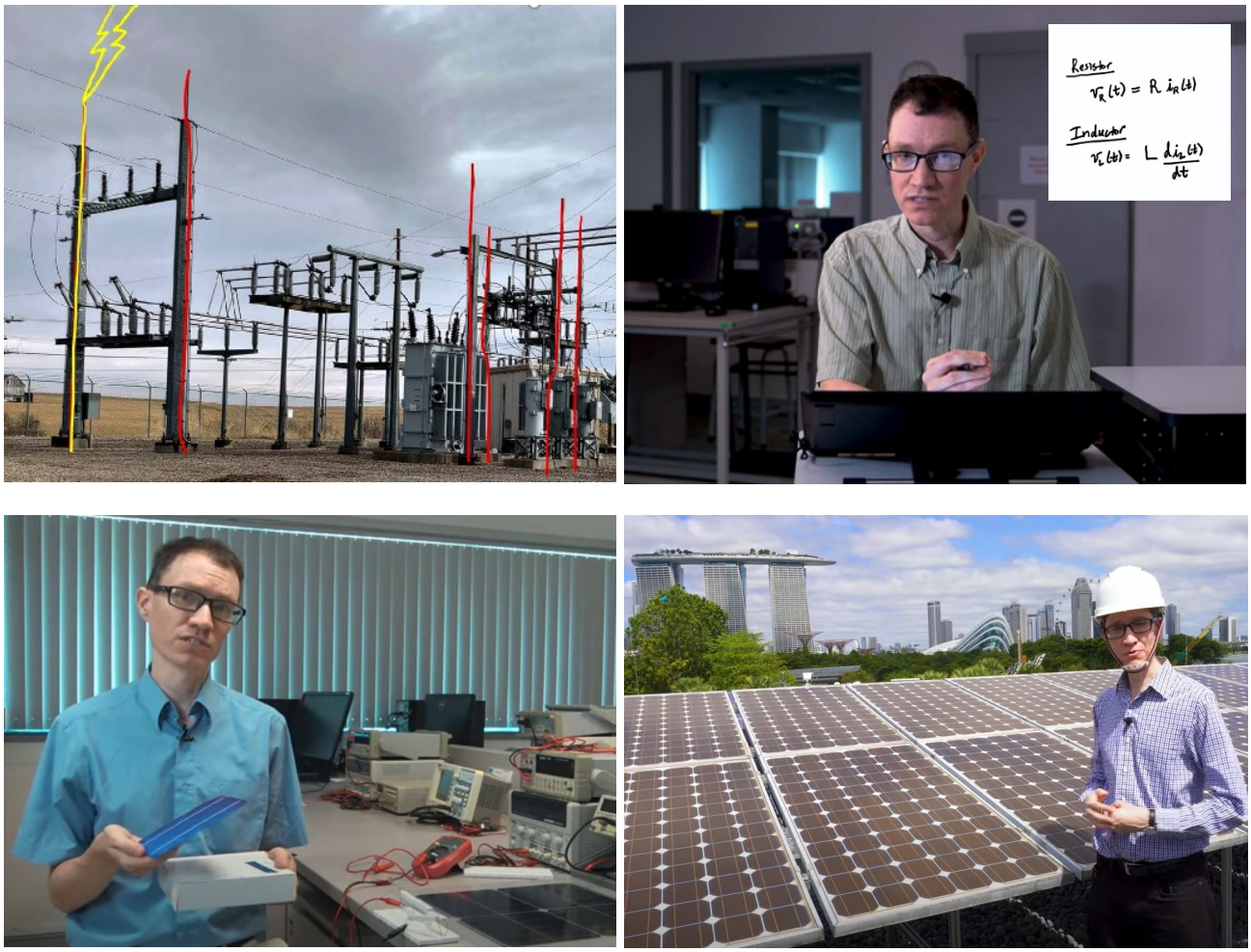

Figure 1. (clockwise from top left) Concept Demonstration on lightning, Worked Problems in basic electronics, Field Trip to Marina Barrage solar farm in Singapore, Bench Demonstration of a solar panel.

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