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Implementation and reflection of a MOOC

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ABSTRACT: To catch the pervasive MOOCs wave, the Ministry of Education in Taiwan started calling for projects about MOOCs in 2014. *Easy to Learn Mechanics* (ELM) is one of the 99 courses to receive a grant. ELM includes nine topics related to classical mechanics in university general physics: mathematics, kinematics, Newton's laws of motion, work and energy, momentum and collisions, rigid body rotation, equilibrium and elasticity, gravitation and oscillations. Each topic has several modules, and there are 98 modules in total. Each module has a video lecture followed by a formative assessment. A summative assessment occurs at the end of the course. A forum is provided for communication between instructors-students and students-students. Students can study by self-learning and the learning outcomes can be monitored. This article demonstrates the implementation and reflection on ELM, which was run from September 2014 to September 2015. Results of questionnaires from learners were analysed. This information might be helpful for instructors who are interested in using MOOCs in the future.

INTRODUCTION

Due to considerable advances in scientific technology, digital products have grown rapidly, and with multi-disciplinary information floods, education has entered e-learning, leading to a wave of massive open on-line courses (MOOCs) [1-4]. For MOOCs, instructors divide the curriculum into many small modules. A video is first recorded and the video length of each module should not be so long that learners lose attention. A formative assessment is provided at the end of each module. Therefore, students can immediately recognise whether they have fully understood the teaching contents of the module after completing the test. If not, students can go back and re-watch the video and perform the formative assessment repeatedly, until they can fully understand the contents of the unit. This step-by-step learning strategy can lead to better learning outcomes. The course ends with a summative assessment and students can receive an approval completion once achieving the requirement of the course. All course materials including videos and handouts are uploaded onto a public Web platform, and students can self-study, i.e. arrange for their own learning time, places and steps. Because of the far-reaching network, students of varied ages may come from all over the world. A forum is available on the open platform allowing for instructor-student and student-student communications and discussions.

Distance learning originates from Salman Khan, the founder of the Khan Academy, who recorded the homework answers for distant relatives and friends as a video and uploaded the video on to YouTube. Currently, internationally renowned universities offer a wide variety of curriculum classes on famous open platforms, i.e. Coursera, Edx, Udacity, etc [5-8]. To catch the MOOCs wave, the Ministry of Education in Taiwan launched a four-year MOOCs programme in 2014. For the first-year project in 2014, there were 99 courses receiving grants [9]. *Easy to Learn Mechanics* (ELM) was one of the 99 courses [10].

This article shares the experiences and reflections on ELM, which has been offered three times from September 2014 to September 2015. This information might be helpful for teachers who will be involved in a MOOC in the future.

COURSE DESIGN AND PLANNING

General physics is a required course for freshmen of many departments in many colleges and universities. General physics covers a wide range of subjects, such as classical mechanisms, mechanical waves, thermodynamics, electromagnetism, optics and modern physics.

Departments with different majors may have different class designs of general physics, such as varied credits, lecture hours and academic years. Instructors arrange the lecture contents according to the teaching goals of the departments, e.g. the department of electrical engineering might have more emphasis on the electromagnetism part.

To learn general physics inevitably requires some basic mathematics skills. University general physics has deeper content in arithmetic, trigonometric, vector, calculus and integral than high school physics. Students in Taiwan's universities begin to use calculators to solve physics problems and, furthermore, they read physics textbooks in English.

ELM covers the contents of classical mechanics in university general physics. There are nine topics, i.e. mathematics, kinematics, Newton's laws of motion, work and energy, momentum and collisions, rigid body rotation, equilibrium and elasticity, gravitation and oscillations. Each topic has several small modules. Most modules have a video that can be watched in less than 15 minutes. There are 98 modules in total.

At the beginning of each module, there is an outline to help learners understand the contexts. Illustrations are included, so that learners can understand the context easily. Some sports-related examples were included to attract students' attention. A detailed derivation process is provided in problem-solving to enhance learners' computing and problem-solving ability. Formative tests at the end of each module and a summative test at the end of the nine topics are offered for learners to do self-assessments.

ELM is taught in Chinese. Physics terminology in English was also provided to reduce learners' confusion due to different English-Chinese translation on the one hand, and to promote learners' ability in reading English textbooks on the other. ELM can be a bridge connecting high school physics and college physics. High school-graduated students who want to preview college classical mechanics, freshmen who are taking regular courses on general physics and anyone who wishes to self-learn classical mechanics are welcome to register for ELM. Learners who register for ELM need to have the prior knowledge of high school-level mathematics and physics, and need to have a calculator.

PRODUCTION AND APPLICATIONS OF TEACHING MATERIAL

ELM contains nine topics and 98 modules. Each module has an approximately 15-minute video, a PowerPoint (PPT) of a handout and a formative assessment test at the end of the module. Each formative assessment test has five multiple choice items, which are related to the important concepts of the module. There is a summative assessment at the end of ELM. The summative assessment has 25 multiple choice items, which cover all the concepts in the whole ELM course. All the teaching material and pictures are homemade; therefore, no intellectual property rights are infringed. All the videos are in MP4 format, PPT handouts and assessment tests are uploaded onto an open Web platform known as *Ewant* [11].

ELM can provide students with self-learning on the Internet. Students are recommended to do the formative assessment tests first. If the formative assessment test of the module can be completed easily, the teaching material of the module can be skipped and the formative assessment test of the next unit can be performed. Otherwise, learners are recommended to watch the video of the unit and do the assessment again. Once the assessment test is completed, the formative assessment test of the next module can be followed. If there is still a problem, learners can post the problem onto a forum on the Web platform and seek the assistance of a peer, teaching assistants or the instructor. One week after the ninth topic, there is a summative assessment. Each learner can do the summative assessment twice and the higher of the two scores is counted.

The first time ELM was offered, only the summative assessment score was counted as the course grade. However, starting from the second running of ELM, each formative assessment score was counted as 0.5% of the course score, i.e. the 98 units' scores counted as 49% of the course score, and the summative assessment score represented 51% of the course score.

LEARNING OUTCOME ANALYSIS

Student's Background

From September 2014 to September 2015, ELM was run three times. The information provided from the total of 535 students enrolled was analysed by Ewant platform staff members. The distribution of the countries students come from is shown in Table 1. Except for the 8.41% of responses with incomplete information, students come mainly from Taiwan (76.26%). Mainland Chinese students accounted for 13.27% of the total number.

Course Complement Scenario

Eighty-five learners from among the 535 registered students completed the requirements and passed the course. The course completion success rate was therefore 15.9%.

Feedback Questionnaire

A questionnaire was uploaded onto the Ewant platform and could be filled out by students. The questionnaire contains three levels: basic information, learning experiences survey and satisfaction survey. A five-point Likert-type scale was used: very satisfied (5 points), satisfied (4 points), acceptable (3 points), unsatisfied (2 points) and very unsatisfied (1 point). In total, 29 questionnaires were filled out. The basic information on student gender, age, identity, education was obtained and is listed in Table 2. It was found that more men than women responded to the questionnaire, that most questionnaire respondents were aged between16 and 25 years, were from Taiwan and were Kaohsiung Medical University (KMU) students. The motivation for attending the ELM course is listed in Table 3. The top-rated motivation is *interest*. The statistical results of learning experience are listed in Table 4. Learners demonstrated that the MOOC promoted their ability, engagement and autonomy in Internet on-line learning.

Table 1: Countries distribution of learners.

Country	Number	Percentage (%)	Country	Number	Percentage (%)
Taiwan	408	76.26	Canada	2	0.38
Mainland	71	13.27	Belgium	2	0.38
Singapore	1	0.19	Central Africa	1	0.19
Malaysia	3	0.57	Surinam	1	0.19
United States	1	0.19	unknown	45	8.41

Table 2: Background of questionnaire respondents.

<table>
<tr><td>Gender</td><td colspan="6">Male</td><td colspan="6">Female</td></tr>
<tr><td>Percentage (%)</td><td colspan="6">62.1</td><td colspan="6">37.9</td></tr>
<tr><td>Age (year old)</td><td colspan="2">Below 15</td><td colspan="2">16~25</td><td colspan="2">26~35</td><td colspan="2">36~45</td><td colspan="2">46~55</td><td colspan="2">Above 56</td></tr>
<tr><td>Percentage (%)</td><td colspan="2">3.45</td><td colspan="2">62.07</td><td colspan="2">13.79</td><td colspan="2">6.90</td><td colspan="2">6.90</td><td colspan="2">6.90</td></tr>
<tr><td>Profession</td><td colspan="4">KMU students</td><td colspan="4">Non-KMU students</td><td colspan="4">Non-students</td></tr>
<tr><td>Percentage (%)</td><td colspan="4">48.3</td><td colspan="4">24.1</td><td colspan="4">27.6</td></tr>
<tr><td>Degree</td><td colspan="3">Junior high and below</td><td colspan="3">Senior high and vocational</td><td colspan="3">College</td><td colspan="3">Graduate school</td></tr>
<tr><td>Percentage (%)</td><td colspan="3">6.9</td><td colspan="3">20.7</td><td colspan="3">55.2</td><td colspan="3">17.2</td></tr>
<tr><td>Country</td><td colspan="3">Taiwan</td><td colspan="3">Mainland</td><td colspan="3">Malaysia</td><td colspan="3">Unavailable</td></tr>
<tr><td>Percentage (%)</td><td colspan="3">89.7</td><td colspan="3">3.4</td><td colspan="3">3.4</td><td colspan="3">3.4</td></tr>
</table>

Table 3: Motivations of questionnaire respondents.

Item	Percentage
Interested in new technologies	13.8
Course materials readily available	31.0
Interested in the topics	44.8
Course looks interesting	34.5
Curiosity	20.7
Needs in work	24.1

Table 4: Statistical results of learning experiences.

Item	Score
This MOOC promotes my ability in Internet on-line learning	4.17 ± 0.80
This MOOC promotes my engagement in learning	4.14 ± 0.74
This MOOC promotes my ability in self-learning	4.17 ± 0.76
This MOOC helps me to develop my own learning environments	4.21 ± 0.77
This MOOC helps me to develop my ability in scientific technology	4.07 ± 0.84
This MOOC let me organise learning activities at my own pace	4.17 ± 0.89
This MOOC’s flexible learning activities promote my learning	4.34 ± 0.72
I would be happy to share my thoughts in the forum of this MOOC	3.76 ± 1.02
I am willing to ask questions in the forum of this MOOC	3.72 ± 1.07
The interactive discussion in the forum of this MOOC can facilitate my learning	3.90 ± 0.98
This MOOC arouses my interest in mechanics	4.14 ± 0.92

Table 5: Statistical results of satisfaction.

Item	Score
Are you satisfied with the *course content* of ELM?	4.24 ± 0.87
Are you satisfied with the *video quality* of ELM?	4.34 ± 0.77
Overall, are you satisfied with this course?	4.24 ± 0.83
Does ELM help you to learn the fields of mechanics?	4.28 ± 0.75

Learners also believed that this MOOC was helpful for developing their own personal learning environments, promoting their technological capabilities and organising their own learning pace in Internet self-learning. The learning activities could be very flexible to facilitate learning. In the feedback on the forum, most learners were willing to respond and share their thoughts, felt happy to ask questions and thought this interactive discussion can promote learning outcome. However, the average score was not high, i.e. less than 4.0. Overall, learners felt that this MOOC inspired their interest in learning mechanics. The statistical results of the satisfaction survey are shown in Table 5. Learners felt satisfied with the *curriculum*, *video quality* and the whole ELM course. If there were to be other MOOCs on physics offered by the same instructor, 86.2% of the questionnaire respondents expressed willingness to register for the courses.

TEACHING PRACTICE AND REFLECTION

Completion of a MOOC not only needs financial support, but also needs a team working together with their talent and time. In the production of teaching materials, intellectual property rights need to be considered [12]. All the ELM illustrations were simplified and home-made; therefore, intellectual property rights were not violated. How fancy to make the videos look depends on the funding, manpower and time. Many multimedia techniques can be applied to make the videos. However, when the resources are limited, having solid course content is more important than having an appearance. Making corrections repeatedly is inevitable while making videos. However, perfectionism needs to be avoided to reduce frustration and to move forward.

Students of the college general physics class in Taiwan have varied physics backgrounds. Some students have studied calculus, but some have not done so yet. Furthermore, some students may come from foreign countries with different education systems than in Taiwan. The first topic of ELM is mathematics related to mechanics. Most of the general physics textbooks have *vector* mentioned in the first or third chapter [13-15]. As well as vectors, a *review of trigonometric functions* and *quadratic equation solver* and *calculus of polynomial functions* are covered in the first mathematics topic of ELM; thus, ELM may also be used as a bridge between senior high-school and university. Students can learn ELM at their own pace, according to their own circumstances, to reduce gaps between peers and to reduce frustration in learning at school. Reduction of frustration in the classroom and increase of some self-confidence can make life in college more colourful.

General physics covers much content. Textbooks on general physics are usually very thick. The credits of general physics vary from two to eight depending on the majors of departments. When teaching hours are limited, the contents taught in the general physics class can be selected to match the majors of departments. For example, a department of electrical engineering may focus more on electromagnetism. In such situations, if students can self-learn the mechanics, it would be much appreciated.

MOOCs taught in traditional Chinese in Taiwan have a very small market. The number of people enrolled in ELM in the three times it had been arranged varied from 130 to 238. Even though the enrolled number was not huge, it was still about two to four times the regular number of the students in the entity classes taught by the instructor, i.e. 50-60. It is a pleasure to see that many students can take advantage of the MOOC for mechanics self-learning.

Some stakeholders might have a negative view of MOOCs because of the low completion rate [16]. Instructors are often encouraged to make efforts to increase the number of registered students and promote the completion rates. Based on the motivation of MOOCs for students' self-learning and decreasing the gap between students' background, students should be able to learn according to their own needs. Like books in a library, students can read the parts, which they need and skip the parts they do not need. It might not be necessary to read a book from the beginning to the end nor do all the exercises in a book; therefore, it is expected that the completion rate would not be high, especially, when there are no credits offered by MOOCs or students seem not concerned about certificates or credits. On the contrary, if students can receive credits or certificates after completing the class and students do care about certificates and credits, it is natural and can be expected that the completion rates would be promoted [17].

For some basic subjects, e.g. general physics or calculus, some might think that a MOOC run by a so-called master teacher is enough for the whole school, country or world. However, each subject covers much content. A class or a textbook having the same titles, e.g. calculus or general physics, may have different content. Some textbooks having the same titles can be found on the shelves of bookstores or libraries. Instructors can arrange the content of classes based on students' needs, while they can also design the style of classes. Even the same theories of basic physics, different methods of explanation, e.g. drawing a picture or demonstrating an experiment, etc, can be provided to make students understand and memorise the theories easily. Instructors may teach MOOCs with the same titles in different languages. Therefore, even the class with the same titles still needs different instructors' efforts.

Some may also worry about the reduction of teaching time or number of staff members in college and increasing the rate of unemployment due to MOOCs. In fact, it does not mean that there is nothing to do for the instructors who run MOOCs after uploading the teaching material including videos, PPTs and tests onto the platform. The instructors still need to spend time in interacting on-line with students and participating in discussions with students no matter whether they are registered or not. Accordingly, instructors' working hours might not be reduced, but might be increased in order to answer students' questions [12].

On the other hand, face-to-face teaching on campus cannot be completely replaced by distance teaching. Instructors usually do not have the background information on students registering for MOOCs. Instructors on campus can know more about students and can give more concern to students, e.g. providing some comforting words, giving them a hug, patting someone on the shoulder, or just sitting aside them quietly and listening, etc.

The interactions between students and instructors on campus still play an important role in education. In addition, there are experimental programmes requiring laboratory equipment. This do-it-yourself educational model cannot totally be replaced by on-line courses. Providing more laboratory courses on campus and giving students more practical chances of operation are appreciated. Due to teaching hours being limited and students' self-learning being encouraged, flipped-classroom (FC) now attracts lots of attention as it transfers teacher-based to student-based teaching strategies. FC combines the advantages of MOOCs and face-to-face self-learning on campus [18-20].

To have many people study together and exchange learning experiences at the same time on the Web is a major feature of MOOCs. However, making the forum more active is still a challenge. In these three rounds of ELM, the most common issues on the forum were related to problems with the platform, e.g. could not log in, could not watch the videos, could not download files, etc. The second and third common issues were about the error corrections of the teaching material and the course contents needed to be explained, respectively. Most of the time, the interaction was between the instructor and students, and there were fewer interactions among students. Answering questions understandably takes up a lot of time. Not only thinking about the questions is required, but also typing the answers is needed. If no bonus is provided, students would rather do something else than answer the questions.

Eliminating cheating is an important issue in running MOOCs. Currently, tests in real classrooms are still an acceptable method to evaluate the learning outcome of MOOCs. However, holding tests in real classrooms reduces the flexibility of MOOCs. MOOCs have the advantage of self-learning anytime and anywhere. On the contrary, several large spaces are needed to hold real-class tests. In addition, test schedules are fixed and tests might be missed, if there is time conflict. Even though students are available, students may lose interest in attending tests held far away from the place of residence. Furthermore, if a registration fee for tests is required, the interest will be much lower unless individuals have a strong motivation. Novel techniques to recognise the real person who watches the videos and completes all the requirements on-line will be appreciated.

Because the maintenance of MOOCs needs considerable funding support and manpower, the course registration fee paid by students seems reasonable. Several courses have already started to take registration fees. However, many MOOCs are still free of charge. One of the major missions of MOOCs is for people who cannot attend college because of the lack of funds, living in a poor town, having health problems, etc. to have the opportunity to take higher education classes. Furthermore, the gap in the educational resources between city and rural areas can be reduced. Setting up a reasonable policy to take a user fee from the well-off and provide a *non-fee* for the disadvantaged is still a challenge.

Although a lot of time has been spent and efforts have been made by the instructor to run the ELM MOOC, there are still many opportunities for the instructor to enjoy learning new things from making a MOOC. The videos in ELM were originally recorded using POWERCAM software that record the PPT, and a video recorder to record the live stream video and voice of the instructor. It takes time to combine the information from these two modalities. Afterwards, a broadcasting system was brought in.

The editing of the films using the broadcasting system becomes much easier and more efficient than that using POWERCAM combined with a video recorder. During the video recording, some ideas would be stimulated to increase the efficiency, e.g. using cards to mark the beginning of the video sequence, so that it is clear to know which sections to cut and which sections to keep without repeated rewinding. As time went by, the instructor became much more confident in facing the camera.

Some of the curriculum design would need adjustments. For example, the formative tests were designed like game-playing. Only after a test had been passed could the next text be attempted. However, students who just want to watch the videos and do the tests on some specific modules need to do all the tests from the beginning. In this situation, students might feel the process is too burdensome and choose to give up. This rule was changed later and now students can browse freely.

CONCLUSIONS AND SUGGESTIONS

From September 2014 to September 2015, ELM was made available three times. There were 535 students enrolled, with most (76.26%) coming from Taiwan. The top motivation was …*interested in the topic*. Eighty-five students, i.e. 15.9 % of the registered students, received a certificate of course completion. From the analysis of 29 questionnaires based on a 5-point scale, the students felt that ELM was helpful in self-learning mechanics (4.28 ± 0.75). Overall, the students felt satisfied with this course (4.24 ± 0.83). If other MOOCs on physics were to be offered by the same instructor, most of the questionnaire respondents (86.2%) expressed their willingness to register for the courses.

Although much time and effort is required, running a MOOC promotes the instructor's ability in teaching. Furthermore, ELM is helpful in reducing the gap in educational resources between cities and rural areas and promoting students' abilities in self-learning. ELM can also help students overcome frustration in learning physics. Thus, students can enjoy learning, increase self-confidence and experience a more colourful college life. If financial support were to be available, the instructor would like to provide ELM continuously. In the future, the instructor wishes to find a helpful strategy to stimulating interaction in the forum and giving students credits after completing the course.

In the entity classes of physics on campus, ELM might be helpful in enhancing students' learning outcomes by being applied in the flipped classroom. Furthermore, more laboratory classes are suggested to enhance and strengthen students' practical skills.

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