Development and Evaluation of Massive Open Online Course (MOOC) as a Supplementary Learning Tool: An Initial Study

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***Abstract*—The popularity of Massive Open Online Courses (MOOCs) is prevalent among researchers and practitioners as a new paradigm of open education resource. Since the development of this technology may entail enormous investment, it is critical for institutions to clearly plan the process in designing, developing and evaluating MOOCs that fulfill the needs of target users while keeping the investment to a minimum. Evaluation plays a vital role in assuring that the developed product meets user's satisfaction. This study presents the process of developing a MOOC as a supplementary learning tool for students in a higher education and its usability evaluation which are rarely discussed in detail in prior literatures. Evaluation was done through a questionnaire and the items were adapted from Computer System Usability Questionnaire (CSUQ). The MOOC development process in this research which was based on the ADDIE (Analysis, Design, Development, Implementation and Evaluation) model and the MOOC usability evaluation results enrich existing literatures on MOOC. Overall, findings showed that users were satisfied with the developed MOOC with most of the items gained high mean score above 4.00. When respondents were asked to comment on the strength of the MOOC, the most prominent one turned out to be the MOOC's ability to make students' learning easier.**

***Keywords*—MOOC; development; usability evaluation**

I. Introduction

The evolution of Massive Open Online Courses (MOOCs) was first initiated in 2008 through a course of Connectivism and Connective Knowledge [1]. Since then, this technology has been adopted by numerous educational institutions through various MOOC platforms such as Coursera, Udacity, edX and many more. The advantage of MOOCs is not only as a modern form of online learning. They are also well known as an innovation in open distance education as a step forward in offering more learning opportunities and inspiring lifelong learning [2], [3]. This is possible due to the nature of MOOCs which allow free access and unlimited number of participants. As a result of the various benefits that this technology can bring forth, it is natural that MOOC has garnered immense interest worldwide.

However, despite the numerous benefits of MOOCs, the expensive and arduous production of this technology can be a concern and barrier to educational institutions [4]. Hence, it is imperative to have the design and the development process carefully planned to ensure that the developed MOOC involved minimum effort and investment while still satisfying the needs of the target user. User satisfaction can be evaluated to improve the quality of the MOOC. One of the key initiatives by the Malaysia government for higher education is to transform common undergraduate courses into MOOCs and to practice blended learning [5]. Therefore, educators who are not familiar with or have not used this technology yet can start an early practice by utilizing this technology as a supplementary learning tool for their students. This paper discusses the process deployed based on the ADDIE model in developing a MOOC and the usability evaluation among target users. The structure of this paper consists of a literature review, followed by methodology, results and discussion and lastly conclusion.

II. Literature Review

A. MOOC Development in Past Studies

The ADDIE model which refers to analysis, design, development, implementation and evaluation was generally employed by prior literatures when developing a MOOC. For example, Croxton and Chow [6] adapted the ADDIE model with systems thinking to develop a Web Design and Usability MOOC. During the analysis phase, target user was decided as the focus when designing the content. The design phase included setting objectives as well as strategies to achieve and to evaluate the objectives. After the content was developed, enhancement was identified and carried out during the implementation stage based on user feedback. Finally, the MOOC content was evaluated through formative and summative method. Rodriguez-Ch et al. [7] applied similar process based on the ADDIE model but with consideration of andragogical strategies to enhance interaction between elderly people and learning object. When designing the MOOC, storyboards were defined and the content was developed to include text, images, audios, interactions, animations, tests and quizzes. A study by Spyropoulou et al. [2] which also employed the ADDIE model for team-based development of MOOC assessed the content at every stage as well as at the end of all stages through interviews with the team members and surveys conducted with users.

There was also a previous research that constructed a MOOC life cycle which was similar with the ADDIE model. The life cycle comprised of exploration, planning,

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development, delivery and evaluation. Exploration level included identifying university's requirement as well as understanding target audience's needs and expectation through a pre-survey. Syllabus, goals and activities map were then outlined during the planning phase [8].

B. Successful MOOC Criteria

Among the criteria discussed by past studies for a successful MOOC are users must be engaged with the course and their intention and background need to be understood [9]. In addition, a MOOC needs to motivate users and encourage social networking, collaboration and peer supported learning among learners [10], [11]. A course outline with clearly defined objectives should also be provided including suitable content and assessment that satisfy learner's needs [12]. Furthermore, videos in MOOCs were stressed by prior literature to be in small chunks with less than 20 minutes of duration [11]. Past research also suggested for the materials in MOOCs to be downloadable [13].

C. Usability Evaluation

Usability was defined in ISO 9241-11 as the degree of efficiency, effectiveness and satisfaction of a product being used to attain specific goals [14]. It is essential for any product development to undergo usability assessment so that the product can be enhanced towards realizing consumer satisfaction [15]. The objectives of doing evaluation includes to detect the system's problems as well as to access the system's accessibility and users' experience of the interaction [15].

The Computer System Usability Questionnaire (CSUQ) by Lewis [16] has high reliability level and can been used by practitioners as standardized measurements of satisfaction [17]. The questionnaire comprises 19 items which were classified into four categories. The first category namely overall satisfaction covers all 19 items, system usefulness category measures 8 items, information quality with 7 items and interface quality with 3 items. System Usability Scale (SUS) developed by Brooke [18] is one of the commonly adopted usability evaluation questionnaires. It is a simple usability assessment questionnaire that consists of 10 items.

Based on the analysis done by prior research on standardized usability questionnaires, CSUQ had been used in systems of virtual learning, e-learning and student' information while SUS had been applied in assessing serious games and augmented reality software [17]. CSUQ was also stated as one of the universal questionnaires that cover the three usability criteria i.e. efficiency, effectiveness and satisfaction [17].

III. Methodology

This section is divided into two categories. The first part presents the development of MOOC while the second part discusses the instrument and the sample for data collection.

A. MOOC Development

The process used for developing MOOC in this study was as outlined in Fig. 1 which was adapted from Rodriguez-Ch et al. [7] based on the ADDIE model. There were some modifications done to suit the context of this research.

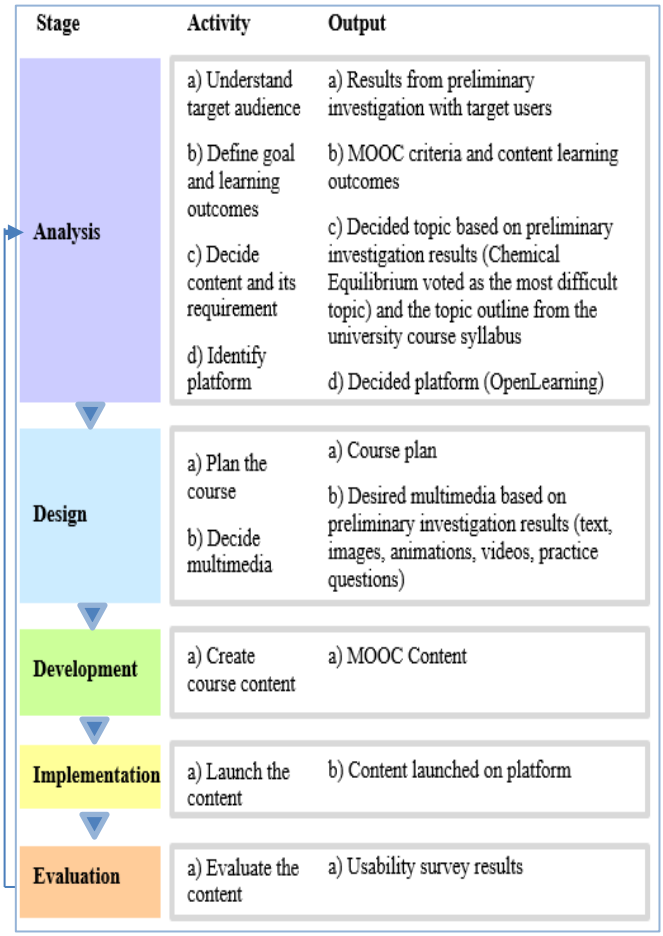

Fig. 1. MOOC Content Development Process.

1) Analysis: Since this research focused on developing and evaluating a MOOC as a supplementary learning tool for students in higher education, analysis was done to understand the needs of the target audience.

Firstly, the subject of the MOOC content was decided to be Chemistry as it was revealed to be one of the most challenging subject among 90 university students in a previous research [19]. Preliminary investigation was then conducted through an online survey among students who recently completed their Chemistry course in a higher institution in Malaysia. 73 students completed the survey and when asked to rank the difficulty of each topic, Chemical Equilibrium obtained the highest number of vote as the hardest topic. Therefore, the MOOC content to be developed was aimed to assist students in learning this topic in this university.

Since students also learned the topic through offline mode with their lecturer, the MOOC content served as a complementary learning tool. The goal of the developed MOOC was for learners to attain the learning outcomes listed in the Chemistry syllabus specified by the university which were in line with Bloom's Taxonomy. The developed MOOC content was decided to be launched at OpenLearning, the Malaysia's official MOOC platform [12].

2) Design: Once the content, goals and requirements had been determined during the analysis phase, a course plan was designed. According to the results of the preliminary studies, more that 50% of respondents chose graphic, online notes, animation, online quizzes and video lectures as the supplementary learning materials that they preferred to have. Taking this into account, the MOOC content which was divided into sections was designed to have these elements in each section. However, practice questions were opted instead of quizzes since the lecturer preferred quizzes to be conducted offline.

To inculcate collaboration and peer supported learning among users, a discussion forum need to be utilized. As recommended by M. E. Ismail [12], emphasis was put on the design of the content during this stage. Since a MOOC needs to be able to engage students, therefore, the videos have to be short, clear and interesting [21]. Attractive graphics and animation that were related to the content should also be incorporated as displayed in Fig. 2.

3) Development: The structured course plan was presented to the lecturer first before development ensued. As there were relevant video lectures found online, they were used and linked in the MOOC content to minimize production cost. Nonetheless, the videos were not made to be downloadable to respect copyright issue. The notes on the other hand were made available in text form on the platform as well as in downloadable pdf format. Notes and practice questions were designed and constructed together with the lecturer. All content was made sure that they aligned with students' Chemistry syllabus.

Peer collaboration and supported learning were encouraged through a few activities that allow users to ask questions and discuss problems with other participants as presented in Fig. 3. Reminders were included to notify students that their participation in discussions will carry marks.

4) Implementation: The content was uploaded on OpenLearning platform following the guidelines provided by the platform. The homepage of the content was as shown in Fig. 4. A user account was then created to test the content where amendment and improvement were made to eliminate any mistake and weaknesses.

5) Evaluation: Once the MOOC developer felt satisfied, the content was then evaluated among target users. Since the ADDIE model is an iterative process, the cycle started again with analysis phase where the findings obtained during evaluation were analyzed to improve the MOOC.

B. Research Instrument and Sample

The purpose of evaluating the MOOC content was to identify the content's flaws and users' satisfaction [20]. The evaluation was done through a survey and the questionnaire used had two sections with the first section focused on demographic information such as gender and user's MOOC experience. The second section on the other hand comprised close-ended and open-ended questions about the developed MOOC content.

The close-ended questions consisted of general questions about user opinion on the MOOC content as well as modified items of computer system usability questionnaire (CSUQ) developed by Lewis [16]. The open-ended questions were included to gain better insight of user's satisfaction towards the developed MOOC.

For the usability measurement, CSUQ was chosen since it has high level of reliability and it is suitable in the context of this research. The original items by Lewis [16] which had gone through reliability and validity process were modified to suit the context of this study. Additional items were also added to further understand user's impression, satisfaction and expectation of the MOOC content. Overall, 28 items were used for this research and they were classified into three categories namely MOOC usability, MOOC quality and MOOC interface. Each item was measured using a five-point Likert scale anchored on '1 = strongly disagree' and '5 = strongly agree'.

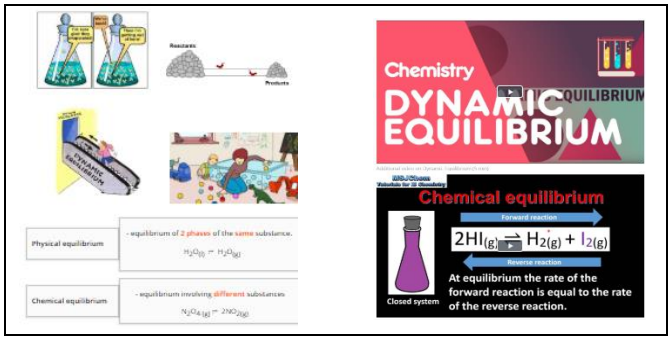

Fig. 2. Graphics, Animation and Videos used in the MOOC Content.

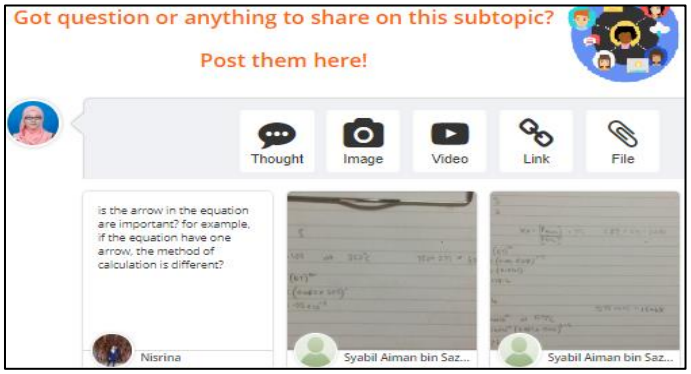

Fig. 3. Activities to Encourage Collaboration.

Fig. 4. MOOC Content Homepage.

The Cronbach's alpha for MOOC usability category was 0.876, for MOOC quality category was 0.855 and for MOOC interface category was 0.774. Since all the values exceeded 0.7, this indicated that the instrument used were reliable and the responses obtained had internal consistency with the respective items [22]. The quantitative finding obtained from the data collection was analyzed using descriptive analysis.

Since this is an initial study, purposive sampling method was done where all 21 students in one section were asked to use the MOOC content for 1 hour 30 minutes before they completed the questionnaire. They were first year Diploma in Mechanical Engineering students who currently undertook the Chemistry course in the university that the developed MOOC was targeted for. They had never heard of MOOC before the data collection so this was a new technology for them.

IV. Results and Discussion

This segment is organized into three sections. The first section presents and discusses MOOC usability evaluation results, the second section explores students' preference and opinion about the MOOC content and the third section explains research limitations.

A. MOOC Usability Evaluation Results

MOOC usability evaluation in this research had three categories i.e. MOOC usability, MOOC quality and MOOC interface. To interpret the quantitative data obtained from the questionnaire, the mean, mode and standard deviation of each item were studied using descriptive analysis. Mean score 1.00 to 2.33 was interpreted as low, 2.34 to 3.66 as medium and 3.67 to 5.00 as high [22]. On the other hand, mode represents the score with the highest frequency while standard deviation shows the dispersion of the data obtained.

1) MOOC Usability: MOOC usability items in the questionnaire measure the degree of effectiveness and satisfaction that students felt when using the MOOC Content. The results for MOOC usability in this research was as presented in Table I. Overall, all of the items obtained high level of mean above 3.67 except for two items i.e. U3 and U10.

The mode value for U3 which was 3 depicted that many respondents were not sure on whether the MOOC can make them learn the topic better or not. It was probably due to this being their first time in using MOOC and the time spent on the MOOC content might not be sufficient enough for them to be certain. Nonetheless, the number of students who agreed that they can learn the topic better when using the MOOC were more than those who disagree and neutral. In comparison with this item, user's perception that they can learn the topic faster when using the MOOC showed more positive result. This proved that MOOC can serve as a supplementary learning tool that can expedite students' learning and understanding process.

As for the item U10, despite the medium level of mean, the mode score was 4 and more than half of the respondents approved that they gained additional information from their friends through the MOOC. Based on the standard deviation values though, data for item U3, U4 and U10 were quite dispersed. Generally, the findings revealed that students were satisfied with the MOOC, with how easy it was to use the MOOC and to learn the topic through the MOOC.

2) MOOC Quality: MOOC quality in this study refers to the extent of user's perception that the MOOC has clearly defined objectives, suitable content and assessment. Table II summarizes the results for each item under MOOC quality category.

All of the items displayed high mean score except for moderate level of mean for Q12. Even so, the mode for Q12 was 4 and there was higher number of students who felt that the practice questions were sufficient than the total number of those who felt the opposite or was unsure. Regarding the practice questions and the hints provided being useful to them, strong approval was displayed based on the mean and the mode score. This finding demonstrated the importance of providing clues to assist students whenever they have difficulties in solving problems. The questions were also mostly approved for being clear and easy to understand.

Apart from that, majority of the users strongly agreed that the MOOC gave them messages to correct their mistake and let them recover quickly and easily. This is in line with the criteria of a good MOOC stated by prior studies in giving immediate feedback to users [10]. Furthermore, positive results were also achieved on students' satisfaction with the notes and the video lecture being useful to them, the organization of the content as well as the effectiveness of the MOOC in helping them learn the topic. Overall, it is noteworthy that the findings obtained showed that students were generally satisfied with the quality of the MOOC content even with minimum level of investment spent. On the flip side, the data for some of the items were pretty dispersed based on the standard deviation values.

TABLE I. MOOC Usability Results

No.	Items	Mean	Mode	SD
U1	Overall, I am satisfied with how easy it is to use this MOOC.	4.43	4	0.507
U2	It is simple to use this MOOC.	4.33	4	0.577
U3	I can learn the topic better when using this MOOC.	3.62	3	0.805
U4	I can learn the topic faster when using this MOOC.	3.86	4	0.964
U5	I feel comfortable using this MOOC.	4.14	4	0.573
U6	It was easy to learn to use this MOOC.	4.29	4	0.561
U7	I believe I am able to learn the topic productively when using this MOOC.	3.95	4	0.590
U8	I have fun learning the topic through this MOOC.	4.14	4	0.573
U9	I can share my knowledge with my friends through this MOOC.	3.95	4	0.669
U10	I gain additional information from my friends through this MOOC.	3.48	4	0.981
U11	Overall, I am satisfied with this MOOC.	4.29	4	0.561

3) MOOC Interface: Apart from the MOOC content quality, interface can also play a vital role in boosting students engagement and their learning process [23]. Hence, it is one of the aspect that MOOC developers need to be concerned with. There was only three items in MOOC interface category which were adapted from the original items of computer system usability questionnaire (CSUQ) [16]. The high level of mean score and the 4 mode score for all items as shown in Table III indicated that users liked the MOOC interface and agreed that the interface was pleasant and had all the functions and capabilities they expected it to have.

B. Students' Preference and Opinion about the MOOC

When students were asked about their preferred time of accessing the MOOC, the results shown in Fig. 5 were somewhat as expected as they would choose after school hours due to them being full time students. Regarding the type of device that they used to access the MOOC, more than half of them use both mobile phone and laptop.

Fig. 6 presents the percentage of students for their preference on whether they want the video lecture to be downloadable or not and whether they want the video lecture to be recorded by their lecturer. Not more than half of them actually need the video to be downloadable. It was probably because the MOOC content could be easily accessed at anytime and anywhere. In contrast, slightly more than half of the students wished the videos to be recorded by their lecturer. From one of the open-ended questions, when respondents were asked to share their opinion on how the MOOC content can be improved, Participant T said, "Video by lecturer also help student to understand". Since English is not the native language among students, another respondent expressed that understanding foreign English accent could be a problem at times. Hence, this is one of the aspects that can be considered for improving the MOOC content. Since the usability results were generally positive, it seems that this issue was not that critical and students still found the MOOC to be useful and effective for them.

Other suggestions for improvement shared by respondents include addition of interactive game, notes in .pdf format, more examples in notes, instruction on how to use MOOCs and making the MOOC compatible with all mobile phone types and iOS devices. Participant Z suggested a game format where users can win or lose points and finally gain something from the points they collected. This fun element can be one of the ways to enhance students' motivation and engagement.

Through other open-ended question, respondents were also requested to comment on the strength of the MOOC. Fig. 7 illustrated the frequency of some of the strength stated by students. Many of them conveyed that the MOOC makes it easier for them to learn the topic. One respondent shared that it was easy to just refer to one place to get all the information needed about the topic while Participant S added, "It feels like you have a pocket size notes even though it is a bit slow on the phone".

A few students also expressed that learning became easier as they could learn the topic anytime and anywhere. Similarly, Participant F said, "Easy to access, easy to learn and flexible in study time. Overall, comfortable study method." These responses were consistent with the well-recognized benefits of MOOCs mentioned in past studies.

C. Research Limitations

The results in this study are not meant for generalization due to limitation in sample size and sampling method. Survey respondents are also students who use the MOOC content to support their traditional learning. As MOOC users can also be someone who only learn through MOOC without face-to-face instruction, the results in this research cannot be generalized for MOOC in general. Since this is an initial study, follow-up research will be performed with a larger sample size.

TABLE II. MOOC QUALITY RESULTS

No.	Items	Mean	Mode	SD
Q1	The duration it took to complete this MOOC is just right.	4.00	4	0.548
Q2	The MOOC gives me messages for me to correct my mistake.	4.33	5	0.730
Q3	Whenever I make a mistake, I can recover easily and quickly.	4.24	5	1.091
Q4	The information provided in this MOOC is clear.	4.10	4	0.539
Q5	The information provided is easy to understand.	4.19	4	0.512
Q6	The content provided meet the requirement of the course syllabus.	4.29	4	0.644
Q7	The content is well-organized.	4.48	4	0.512
Q8	The video lecture provided is useful for me.	4.33	4	0.658
Q9	The notes provided are useful for me.	4.33	4	0.730
Q10	The practice questions are useful for me.	4.10	5	0.889
Q11	The practice questions are clear and easy to understand.	4.19	4	0.750
Q12	The number of practice questions are enough.	3.62	4	1.024
Q13	The hints given when I got incorrect answer are helpful.	4.29	5	0.784
Q14	This MOOC is effective in helping me learn the topic.	4.14	4	0.478

TABLE III. MOOC INTERFACE RESULTS

No	Items	Mean	Mode	SD
I1	The interface of this MOOC is pleasant.	4.00	4	0.548
I2	I like using the interface of this MOOC.	4.00	4	0.548
I3	This MOOC has all the functions and capabilities I expect it to have.	3.76	4	0.700

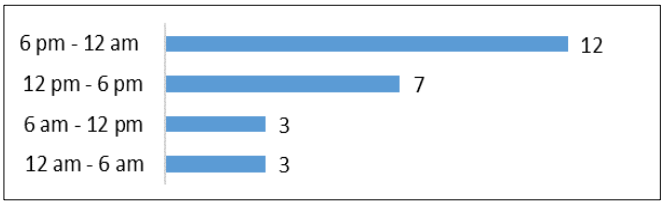

Fig. 5. The Number of Students who Chose the Preferred Time for Assessing MOOC.

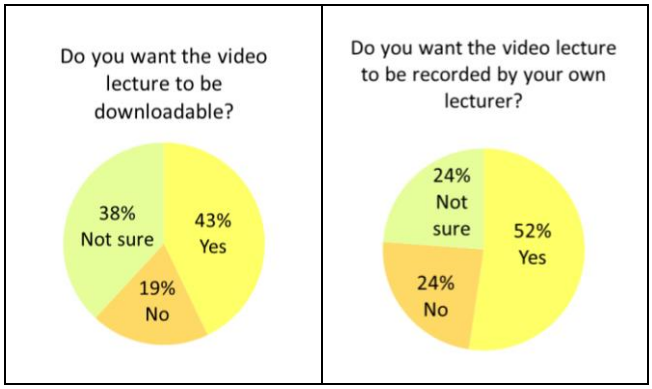

Fig. 6. The Percentage of Students for their Preference regarding the Video Lecture (n=21).

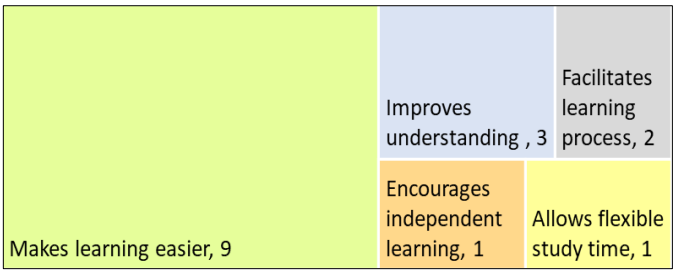

Fig. 7. The Frequency of the Strength of the MOOC Content Mentioned by Students.

V. Conclusion

The purpose of this research was to develop a MOOC and evaluate its usability among target users. From the findings, 25 usability items in this research displayed positive results with high level of mean, while three items gained moderate mean score. The three items measured students' perception on whether the MOOC enable them to learn the topic better, allow them to gain additional information from friends as well as provide enough practice questions. For future work, the results obtained from this research will be used to improve the MOOC content. Next, follow-up study will be done to evaluate the MOOC with larger sample size. Hopefully, the results presented in this study will enrich existing literatures on the usability of MOOC.

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