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PAPER

MOOC – Micro-credential to Enhance Student Potential in Basic Circuit Schematics using ADDIE Model

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ABSTRACT

The development of digital-based education such as Massive Open Online Courses (MOOC) integrated with micro-credentials has expanded access to borderless education. The developed MOOC assists students in mastering the fundamentals of schematic circuit learning up to the application of systems using microcontrollers and sensors. This study aims to develop a micro-credential-based MOOC strategy that enhances students' potential through the implementation of the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The ADDIE model provides a systematic framework for the development of micro-credentials. The findings of the study indicate that (i) students' motivation towards the implemented MOOC was high (97.6%), (ii) the MOOC content was attractive (92.7%), (iii) video-oriented explanatory elements were highly engaging (90.2%), (iv) useful feedback on assignments and the level of assignment difficulty were positively rated (85.4% & 82.9%), and (v) the assessments were considered appropriate (73.2%). Overall, this MOOC has become a catalyst for enhancing learning experiences and 21st-century digital support materials, which directly support Sustainable Development Goal (SDG) 4 towards achieving quality education.

KEYWORDS

MOOC; ADDIE Model; TVET

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1. INTRODUCTION

The 4.0 Industrial Revolution has brought about major changes to the technical and vocational education (TVET) landscape, especially in the aspects of digital technology integration, automation, Internet of Things (IoT), smart systems and online learning. Educational institutions now need to provide students with technical skills and digital competencies that are relevant to the needs of the current industry. In the context of TVET education, the traditional teaching approach that is too lecturer-centered and relies solely on theoretical delivery is found to be less effective in developing 21st century skills.

The orientation of the TVET program for the Certificate in Information Technology (STM) at Community Colleges, the lack of Electric and Electronic Fundamentals (EEF) courses has created a knowledge gap among students, especially regarding the basics of electronics, reading schematic circuits and introduction to electronic components. This situation has a direct impact on the Mobile Application and Technology (MAT) course because students lack a good understanding of the integration between hardware and software in the development of smart systems. The absence of the EEF course has caused students to lack a good understanding of the basics of electronics that are important in the development of IoT-based applications and embedded systems. The conventional learning approach that only uses notes and PowerPoint slides also does not help students understand abstract concepts related to electronic circuits and smart systems. In addition, students face difficulties in self-study due to the lack of a systematic and interactive flexible learning platform.

In this regard, a micro-credential-based Massive Open Online Course (MOOC) has been developed using USM's Learning4Life platform to help students regain basic electronics skills in a flexible and structured manner. This MOOC is built in a modular manner starting from learning basic schematic circuits to improving the use of microcontrollers and sensors using Tinkercad simulations and Arduino Uno. This requirement also covers the requirements of SDG 4 which aims to ensure quality education to improve the quality of teaching and learning in an effort to achieve and build a better TVET future.

The micro-credential concept is gaining increasing attention in higher education and TVET due to its flexible, modular and competency-based nature. According to [1], micro-credentials can enhance digital learning and help educational institutions adapt to post-pandemic learning needs. This approach also supports lifelong learning and more specifically skills recognition.

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Thus, the use of MOOCs is among the mediums for developing learning modules in strengthening digital learning. A study by [3] found that TVET institutions in Malaysia are increasingly integrating IR4.0 technologies such as IoT, smart systems and digital learning platforms to improve student competencies through open distance learning (ODL) such as MOOCs.

In addition, [1] emphasizes that micro-credentials play an important role in providing a workforce with technical and soft skills that are in line with the requirements of IR4.0. The use of modular content, learning videos, simulations and authentic assignments increases the effectiveness of online learning. MOOCs provide many advantages to the TVET education system, especially in accelerating teaching and learning activities progressively. Some of the advantages of the innovations developed include access to borderless learning. MOOCs allow students from various backgrounds and locations to access learning materials without geographical restrictions. This opens up participation opportunities for students who do not have the opportunity to attend formal lectures but still attend virtual lecture sessions. Improving digital skills, The increasingly rapid digitization across technologies causes MOOCs to improve students' digital literacy skills. They not only learn about subjects they are interested in, but also acquire skills in using online learning platforms, digital communication and information management.

Figure 1. Micro-Credential Competency-based learning platform used in Malaysia

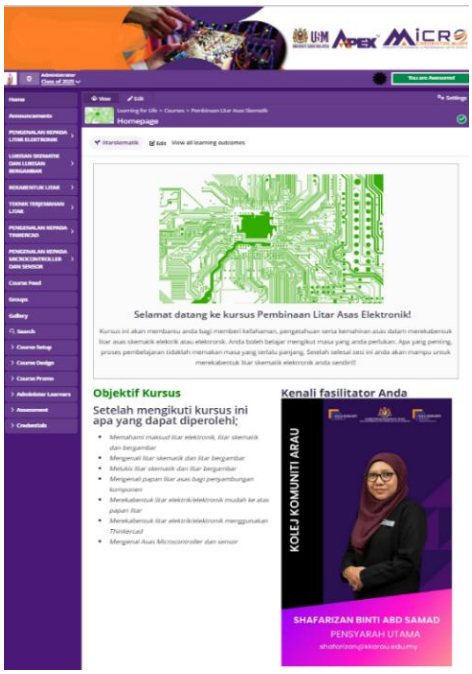

Figure 2. The initial interface (front page) of the MOOC through the OL LMS that has been designed

The most significant difference with formal education is that MOOCs offer students the flexibility to learn at their own pace. This is very beneficial for students in terms of time management and other commitments.

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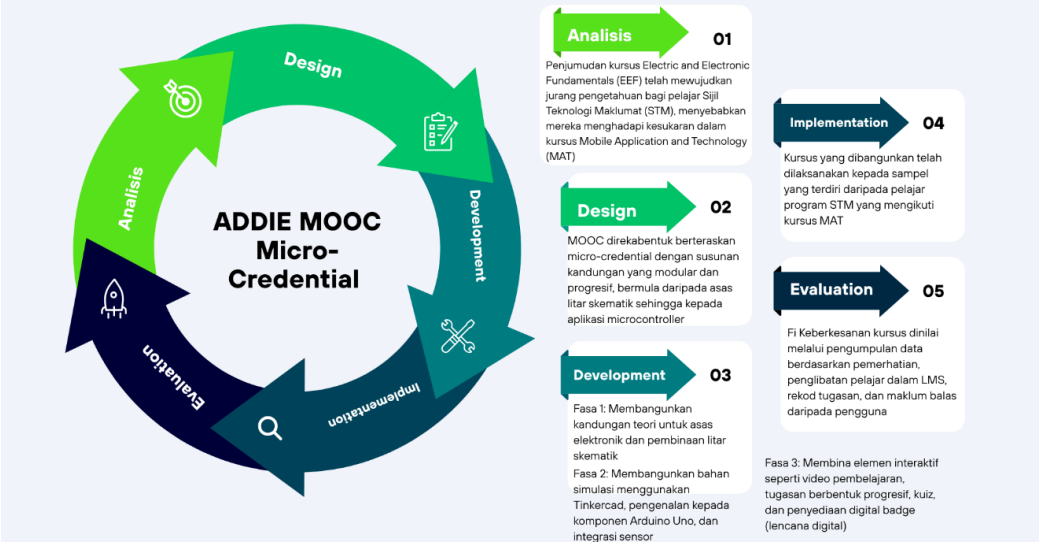

Figure 3. MOOC-Microcredential Development Model using the ADDIE Model

The comprehensive ADDIE model for the development of a MOOC Micro-Credential for learning schematic circuits is designed in detail based on the USM Micro-credential Development Guidelines. The first phase involves the development of basic electronic content and the construction of schematic circuits. The second phase focuses on the use of Tinkercad simulations, an introduction to Arduino Uno and sensor integration. The third phase involves the development of interactive activities such as learning videos, progressive assignments, quizzes and digital badges.

Since MOOCs are online learning activities, various technological elements can be combined to enhance learning activities. Therefore, the researcher took on this responsibility to evaluate the effectiveness of using MOOCs on student engagement and understanding, identifying the impact of using Open Learning LMS on student self-learning.

2. METHOD

2.1 Methodology

In general, this study is to identify and study empirically and systematically related to the use of MOOCs as an e-learning platform in Community Colleges. The study sample consists of students in the Information Technology Certificate program who are taking the Mobile Application and Technology (MAT) course. Data was collected through observation, student involvement in the LMS, assignment records and user feedback. Data analysis was conducted descriptively to identify the effectiveness of the developed innovation.

For this brief study, the instrument used in this study was a questionnaire. [6] also explained that questionnaires are a commonly used method to obtain information. Therefore, the Course Experience Questionnaire (CEQ) questionnaire was used for online teaching evaluation (MOOCs) where students have direct experience with each task given through the Open Learning portal.

The Course Experience Questionnaire is an instrument developed in Australia by Ramsden (1991) and is used in teaching as a benchmark for learning experiences for educational institutions and as a formative assessment that aims to improve the study program through the medium used. Through study [7], the CEQ questionnaire has gone through a process of translation and adaptation tailored to the study environment.

Therefore, the questionnaire for this study is an adaptation through study [7] which consists of 2 parts, namely Part A (background information) and Part B (evaluation of MOOCs).

3. RESULT AND DISCUSSION

The development of a micro-credential-based MOOC using the ADDIE model was evaluated for its effectiveness through feedback received from a target group of 25 students. This group was made up of students who had actively used the MOOC platform throughout two (2) semesters of study for the relevant course. The data obtained was analyzed descriptively to see the frequency and percentage to measure the dimensions of the effectiveness of the developed platform.

3.1 Respondent Demographic Profile

Based on the analysis of background data on 25 respondents, the gender breakdown shows an almost balanced distribution, with 52.0% (13 people) being female students, while 48.0% (12 people) were male students. In terms of age breakdown, the vast majority of respondents were in the 18 to 20 year old age group, which was 76.0% (19 people). The

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remaining respondents consisted of students aged 23 to 24 years old, 12.0% (3 people), while the age categories of 21-22 years and 25 years and above recorded 4.0% (1 person) and 8.0% (2 people), respectively. In terms of race distribution, 92.0% (23 people) of respondents were Malay, while the rest consisted of Chinese (4.0% / 1 person) and Indian (4.0% / 1 person).

Table 1. Respondent profile among students using MOOCs

Category	N=25	Percentage (%)
Gender		
Men	12	48.0
Women	13	52.0
Age		
18-20 year	19	76.0
21-22 year	1	4.0
23-24 year	3	12.0
25 and above	1	4.o
Tribe		
Melayu	23	92.0
Cina	1	4.0
India	1	4.0

3.2 Analysis of the Dimensions of Effectiveness of MOOC Online Teaching

To assess the extent to which this micro-credential-based MOOC strategy is able to enhance student potential and overcome the gap in basic electronic knowledge after two semesters of use, six (6) evaluation items from the Course Experience Questionnaire (CEQ) were examined. Student responses (N=25) are summarized in Table 2 below.

Table 2. Frequency and percentage table for MOOC assessment items

Item	Impact Measurement Statement	Frequency	Effective (%)	Ineffective (%)
S2	This MOOC-based course/subject motivates students to do their best.	24	96.0%	4.0%
S16	The lecturers work hard to make these MOOC-based lessons very interesting.	23	92.0%	8.0%
S14	Lecturers are good at applying MOOC explanation elements that are developed based on videos.	23	92.0%	8.0%
S13	Lecturers usually provide useful feedback on students' current progress regarding tasks.	21	84.0%	16.0%
S12	Lecturers work hard to understand the difficulties students experience with tasks.	21	84.0%	16.0%
S6	Lecturers spend a lot of time assessing student work.	18	72.0%	28.0%

3.3 Discussion of Analysis Results According to ADDIE Phases

Statistical findings from 25 respondents who have gone through the learning process for two semesters prove a very positive alignment with the objectives of the ADDIE model instructional design.

3.3.1 Impact of Long-Term Self-Motivation (Items S2 & S16)

A total of 96.0% (24 students) admitted that this MOOC-based subject successfully maintained their motivation to do their best throughout the two semesters. The appeal of the interactive modular content was also strongly supported by 92.0% of students. This proves that the Design and Development phase which integrates the digital badge system as a micro-credential recognition has successfully provided a positive psychological impact for students to learn independently (self-paced learning).

3.3.2 Effectiveness of Digital Multimedia Materials (Item S14)

A total of 92.0% of students stated that the short video-oriented explanation elements (3–5 minutes) were very interesting and effective in assisting the learning process. The use of visual simulations (Tinkercad) and video tutorials developed in the Development phase were proven to help visual students master the abstract concepts of schematic circuits and the integration between hardware and software.

3.3.3 Ongoing Monitoring and Progressive Feedback (Items S12 & S13)

The aspect of providing useful feedback on assignments recorded 84.0% effectiveness, while lecturers' efforts to understand students' difficulties with tasks also recorded 84.0%. This advantage was directly contributed by the

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Implementation phase through learning analytics on USM's Open Learning LMS Learning4Life platform which allows lecturers to monitor student progress in real-time and provide just-in-time interventions.

3.3.4 Cyberbullying Assessment (Item S6)

A total of 72.0% of students assessed that the assessment process and the time spent by lecturers to assess their work were effective. Although the on-the-spot monitoring method provides a new and challenging teaching style, the automation of the system for awarding digital badges once the assignment reaches 100% successfully provided academic satisfaction to TVET students throughout the two semesters. The discussion should link the product testing results to supporting theories or relevant previous research. Explain the product's advantages, the technical challenges encountered during development, and how the product performed when tested directly with users or target audiences.

3.4 Improvement Suggestions

Although the data shows that the level of motivation (96.0%) and video appeal (92.0%) are at a very high level, the aspect of task assessment (72.0%) shows the greatest room for improvement. Therefore, the following recommendations are put forward

a. Improving the Quality of Practical Audio-Visual (Development Phase): 92.0% of the feedback on the video elements, the quality of existing video recordings needs to be improved in terms of image resolution, audio clarity, and the use of modern editing techniques such as green screen or online interactive applications. This is important to ensure that the step-by-step demonstration (practical) of electronic circuits, Arduino Uno, and sensors can be clearly seen by students independently.
b. Providing More Comprehensive Self-Assessment (Design Phase): Considering the lowest assignment assessment score (72.0%), the assessment instruments in the Open Learning LMS need to be diversified. In addition to automated objective quizzes, subjective assessment elements based on authentic problem-solving and IoT-focused assignments need to be increased to test students' in-depth understanding of abstract electronic concepts.
c. Virtual Integration of TVET Practical Elements (Implementation Phase): Since practical is the heart of TVET education, the constraints of online learning can be overcome by strengthening the integration of simulation software such as Tinkercad. MOOC platforms need to provide hybrid modules where students are required to complete 100% correct digital circuit simulations before being allowed to test physical hardware in the Community College laboratory.

3.5 Suggestions for Further Study

This existing innovation development study is limited to simple descriptive analysis (percentage/frequency) and a small sample size (25 students) over two semesters. To further strengthen the scientific value of this research paper, the following further studies are suggested,

a. Experimental Effectiveness Study (Quantitative)
   It is suggested that future studies use Quasi-Experimental Design. Researchers can divide students into two groups, namely the Experimental Group which includes students who use the micro-credential based MOOC strategy + Tinkercad simulation. Then there is the Control Group which is for students who learn using conventional methods (PowerPoint slide lectures and static notes). The purpose of this design is to test statistically (using t-test or ANOVA) whether there is a significant difference in grade achievement in the Mobile Application and Technology (MAT) course between the two groups.
b. Exploratory Qualitative Study
   Further qualitative research through Focus Group Discussion Sessions with students and lecturers is highly recommended. This study involves an assessment of two groups, namely i) Student Side. The purpose is to explore their real experiences in managing time throughout two semesters to complete the course in order to obtain a digital badge. Second, the Lecturer Side with the main objective is to examine the issues, challenges of cybergogy design, and time constraints faced by TVET lecturers while monitoring student learning analytics in real-time on the Open Learning platform.
c. Cross-Institutional Usability Study (Sample Size)
   Since this study only focused on one program at a Community College, it is proposed that this ADDIE-based MOOC-Microcredential model be tested at several other Community Colleges throughout Malaysia that also offer Information Technology Certificate programs. This is to ensure that the study findings have a higher level of generalizability in the context of national TVET education.

4. CONSLUSION

Overall, the development of this micro-credential-based MOOC has successfully provided a flexible, interactive and structured digital learning platform to help students master the basics of electronics and smart systems. This innovation not only helps to overcome the knowledge gap due to the stagnation of EEF courses, but also supports the transformation of TVET education towards more dynamic digital learning and responsive to the needs of IR4.0. This study also shows that the integration of LMS, Tinkercad, Arduino and sensors can increase student engagement, motivation and

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understanding of electronics and IoT concepts. Therefore, the micro-credential-based MOOC approach has the potential to be expanded to other courses in the fields of technology and TVET.

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