Pilot study of massive open online course (MOOC) implementation in electrocardiography (ECG) learning: perspectives from general practitioners

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ABSTRACT

Background: Cardiovascular disease (CVD) is Indonesia's primary cause of morbidity and mortality. Rapid detection and appropriate treatment of CVD cases are needed to reduce mortality. Electrocardiography (ECG) is a simple examination modality that can detect many cardiac abnormalities. General practitioners are expected to master the interpretation of basic ECG. Massive open online course (MOOC) is a breakthrough that can facilitate profound learning without temporal and physical barriers and support continuing medical education. This pilot study aimed to evaluate the implementation of MOOC in ECG learning among a limited number of general practitioners.

Methods: Consecutive sampling was used to recruit the subjects. Subjects were given ten weeks to finish all modules and quizzes. Pre-test and post-test were taken. User satisfaction was evaluated using a questionnaire. A focused group discussion (FGD) was conducted to explore subjects' learning experiences and perspectives toward the learning system using MOOC.

Results: 17 general practitioners participated in the study, but only seven could finish all the modules and quizzes. All subjects were aged under 30 years old. Those who could complete the course took 10–39 days. Post-test scores were significantly higher than pre-test scores (p=0.038). Although subjects agreed that MOOC was convenient, attractive, and suitable for general practitioners in clinical practice, they demanded an explanation of the quiz answers. They suggested that some modules should be optional.

Conclusion: MOOC learning was suitable for general practitioners to improve their ECG interpretation skills. Some features should be added to increase user satisfaction. A study with extensive subjects is needed to analyze the effectiveness of this ECG course.

Keywords: ECG learning media; ECG MOOC; learning experience; user satisfaction.

INTRODUCTION

Indonesia is the most populous country in South-East Asia and the biggest archipelago in the world. Indonesia has a population of more than 260 million and is made up of 17,508 islands.¹ The primary cause of morbidity and mortality in Indonesia is cardiovascular disease (CVD), which accounts for one-third of all fatalities. According to estimates, 3,299 and 2,555 years of life were lost per 100,000 people owing to early death from coronary heart disease (CHD) and cerebrovascular disorders, respectively.²³ Despite the significant prevalence of CVD in this country, there were only 1.5 cardiologists per 1,000,000 people in 2016. This places big burden on general practitioners to be able to diagnose cases and provide appropriate initial management to reduce mortality due to CVD.²⁴

Electrocardiography (ECG) is a widely-used and simple examination used in clinical settings to detect cardiac abnormalities quickly.⁵ It has been recorded roughly 200 million times yearly around the world. Healthcare professionals, especially general practitioners, frequently encounter ECG tracings.⁶ Quick and correct interpretation is essential because it affects clinical decision-making and patient outcomes. In Indonesia, the interpretation of basic ECG is a 4-level competence for general practitioners. A doctor must have to be able to perform ECG interpretation without supervision.⁷

Despite the wide-ranging clinical usage, diagnostic usefulness, and acknowledged significance of acquiring and maintaining ECG interpretation expertise, the accuracy of ECG interpretation is only 60–69%.⁸⁹ Lack of specified educational standards, standardized competency requirements, and restricted access to widely available, time-flexible, and evidence-based training platforms are obstacles to teaching ECG interpretation for general practitioners in clinical settings. Learning resources with feedback that can be accessed comfortably and flexibly may resolve the problems.¹⁰

Nowadays, the internet has triggered the development of online learning methods to address the time and physical barriers to learning.¹⁰ Roughly 220 million people have taken massive open...
online course (MOOC) courses, with 40 million new students enrolling in 2021. Of the roughly 19,400 courses offered, 1,416 are in the medical and health fields. MOOC enables learners to learn independently and flexibly by accessing well-structured modules for free without user quota limitation. However, course development is mainly dominated by developed countries. Thus, the content delivery language is mostly English. In Indonesia, there are very few studies that address it.

MOOC is an online learning method that can be comprehensive and sustainable in improving ECG interpretation skills among general practitioners. MOOC has excellent potential to increase the competence of general practitioners in Indonesia, which has quite a challenging geography, so physical limitations to attending training can be solved. Starting with developing a mobile learning application in 2019, the Department of Cardiology and Vascular Medicine of Universitas Gadjah Mada has advanced to the development of MOOC to support more comprehensive ECG learning. This course became the first ECG course in the form of MOOC in Indonesia. This study aimed to qualitatively evaluate the implementation of MOOC in ECG learning among general practitioners.

### MATERIAL AND METHODS

The design of this study was cross sectional study. The quantitative and qualitative data for this pilot study were taken prospectively using a pre-post evaluation, a questionnaire, and focused group discussions (FGD). Subjects were recruited using consecutive sampling. A briefing about the study procedure, MOOC operational instructions, and pre-test was held before starting the learning process. A duration of 10 weeks was provided for subjects to finish all modules and quizzes. After ten weeks, subjects were obliged to fill out the post-test and user satisfaction questionnaire. The user satisfaction questionnaire was adapted from Findyartini et al. A FGD was conducted to explore user learning experience and findings from the questionnaire.

ECG learning MOOC was based on Moodle learning management system named e-LOK (e-Learning: Open for Knowledge Sharing), which Universitas Gadjah Mada developed. Its curriculum was designed to be completed within 5-10 weeks with 2 hours allocation each week. It comprised five multimedia modules, five interactive quizzes, and a post-course evaluation. Modules covered in the MOOC included normal electrocardiograms, essential arrhythmia, cardiac chamber enlargement, ischemia and infarction, and other electrocardiogram abnormalities.

The data obtained were computerized and analyzed using SPSS version 25 and analyzed using univariate and bivariate. The Shapiro Wilk normality test was used to test the distribution of the data. Paired T-test was carried out to analyze the relationship between pretest and post-test. A p value of < 0.05 was considered significant.

### RESULTS

A total of 14 subjects started the ECG learning process using MOOC. All subjects were aged under 30 years old, as shown in Table 1. The subject is dominated by female general practitioners, namely around 76%.

Of all the subjects, as many as seven were able to complete the course. Other subjects should have completed the course to the end. The subjects’ pre-test and post-test scores were 72.86 and 82.86, respectively, as shown in Table 2. The average course completion duration was 25.29 days. There was an increase between the subject’s post-test and pre-test scores with a value of < 0.005, which indicated that the increase was statistically significant as shown in Table 3.

User satisfaction evaluation is depicted in Figure 1. A few subjects disagreed that the MOOC interface was attractive and that the quizzes were per the modules. They found that some electrocardiograms were not in good resolution, the teaching video was not made explicitly for the course, some interface was not loaded due to an unstable internet connection, and no discussion forum. Quizzes were challenging and not explained in the modules. The subjects’ evaluation from the FGD was summarized in Table 4.

### DISCUSSION

Cardiovascular disease (CVD) is Indonesia’s primary cause of morbidity and mortality. CVD accounts for one-third of all fatalities. Electrocardiography (ECG) is a widely-used and simple examination used in clinical settings to detect cardiac abnormalities quickly. ECG tools are available in almost all health services in Indonesia. General practitioners must be able to interpret ECG without supervision. However, the accuracy of ECG interpretation still needs to improve.

The development of ECG learning media is urgently needed to improve the accuracy of ECG readings among general practitioners. The development of online-based learning media such as MOOCs can overcome geographical and time constraints.
Table 4. Subjects’ evaluation of ECG learning using MOOC

<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategory</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational quality</td>
<td>Advantages</td>
<td>Video content was comprehensible and comprehensive despite the short duration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SCORM format of modules’ slides and quizzes was interesting</td>
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<tr>
<td></td>
<td></td>
<td>Applicable content which meets the knowledge requirement for general practitioners and facilitates a review</td>
</tr>
<tr>
<td></td>
<td>Disadvantages</td>
<td>No explanation for quizzes’ answers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quizzes were challenging and not explained in the modules</td>
</tr>
<tr>
<td></td>
<td>Suggestions</td>
<td>Teaching video should be recorded explicitly for the course, not reproduced from another event</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Summary points should be added before or after the video</td>
</tr>
<tr>
<td>Interface and design</td>
<td>Advantage</td>
<td>The design was nice</td>
</tr>
<tr>
<td></td>
<td>Disadvantage</td>
<td>Some electrocardiograms were not clear upon zoom-in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flexibility in terms of time and place</td>
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<tr>
<td></td>
<td>Advantages</td>
<td>The platform is convenient through handphone or laptop</td>
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<td></td>
<td></td>
<td>Administrators responded quickly and provided enough assistance</td>
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<td></td>
<td></td>
<td>No real-time or live question feature upon watching a video or reading the modules</td>
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<tr>
<td>Accessibility</td>
<td></td>
<td>The discussion forum was not active and questions were not discussed</td>
</tr>
<tr>
<td></td>
<td>Disadvantages</td>
<td>SCORM form requires a stable internet connection</td>
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<td></td>
<td></td>
<td>Quizzes using two platforms were ineffective</td>
</tr>
<tr>
<td></td>
<td>Suggestions</td>
<td>The registration process was hampered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Users were provided with modules in PDF format</td>
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</tbody>
</table>

limitations often encountered among general practitioners. In this study, the completion rate of the course is 41%. It was high compared to other MOOCs. In a case series study in the United States, the course completion ranged from 4.3-11%. However, in those cases, the enrolment number was high (around 5000-20000). Half of the subjects in this study failed to complete the course due to limited time and forgot to work on the course. Therefore, making the course duration longer with daily reminders can be the answer to increasing the completion rate.

On average, seven subjects who finished the course took 26 days (10 to 39 days). The duration is considered within the normal range since other MOOC completion can be made within 4-8 weeks. The age range of those who completed the course was 23-25. They participated in the post-test, user satisfaction evaluation, and FGD. There was a significant 1-point improvement in the post-test scores compared to the pre-test scores (p=0.038). Although further research regarding the effectiveness of this course still needs to be carried out with a more extensive subject, the development of online ECG learning is one of the answers to the obstacles to ECG interpretation among general practitioners. This MOOC-based ECG learning will be beneficial to implement widely, especially for health workers in rural areas making it difficult to attend training that requires them to come physically.

This research is a pilot study of an online-based ECG course. This study has several limitations in the form of small research subjects. Therefore, research with more significant subjects and multicenter is needed to assess the effectiveness of this online-based ECG course. Furthermore, the system of MOOC needs to be maintained well to ensure updated and improved content. Further development is imperative to increase users’ engagement and enrolment. User testing that includes many users is sought to validate the MOOC’s effectiveness in improving users’ ECG interpretation skills.

CONCLUSION

ECG learning using MOOC significantly improved the ECG interpretation skills of general practitioners as measured using pre-post evaluation. Users were satisfied with the MOOC content, but some designs and multimedia can be improved to increase engagement.

A well-liked method for removing regional restrictions and expanding access to medical education is the MOOC. Rural and underserved people in low- and middle-income nations stand to gain the most from this, as these groups frequently lack access to quality education.

ETHICAL CONSIDERATION

The procedure follows the principles of the Declaration of Helsinki, and its use has been approved by the Ethics Committee of Faculty of Medicine, Public Health, and Nursing Universitas Gadjah Mada (registration no. KE/FK/0373/EC/2020).

CONFLICT OF INTEREST

The authors declare that there are no competing interests related to the study.

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Figure 1. User satisfaction evaluation of ECG learning using MOOC.

AUTHORS’ CONTRIBUTION
PPRG responsible for coordinating the research process, developing research proposal, publication manuscript. RAG responsible for developing research proposal and data analysis. SH responsible for collecting data and data analysis. VANF responsible for developing research proposal, funding management, and publication manuscript. OK responsible for data analysis and publication manuscript. KS assisted in collecting data. HMS responsible for data analysis and publication manuscript.

REFERENCES