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Enhancing Student-centered Learning through Introducing Module for STEM Development and Assessment

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Abstract

During Covid-19 pandemic, virtual learning has a significant role in conducting learning process in almost all educational institutions around the world. This study introduces new module of e-learning and examines recent known evaluation methods through virtual learning. Science, Technology, Engineering and Mathematics (STEM) are the most subjects facing several challenges during virtual learning based on the nature of these courses and using mathematics and related practices. Mixed method of quantitative and qualitative data analysis was adopted to conduct this study. Six expertise in pedagogical Science were chosen for interviews to investigate and develop e-learning module and a sample of 623 students were chosen to evaluate the learning module. This study developed PADA module through conducting online assessment for educators and students in selected universities in Yogyakarta, Indonesia. The module has many benefits to conduct successful virtual learning during Covid-19 pandemic and similar issues. More instructions about re-using this module have been represented as part of this study.

Keywords: Virtual learning**,** e-learning module, STEM, e-evaluation, Covid-19

INTRODUCTION

During covid-19, the importance of social media and educational platforms have increased significantly (Al-Ansi & Garad, 2021). Developing countries have more challenges than developed countries due to availability of e-learning infrastructure, access to internet, human competencies and educational skills (Al-Ansi, 2017). Furthermore, learning environment has been changed due to the outbreak of Covid-19 and this changes have caused anxiety among educators and learners. These issues forced many educational institutions to re-think again about using online learning effectively and invest more in online learning environment (Al-Ansi, 2021). In addition to some difficulties in using social media and online applications, personality and individual attitudes were rated as the biggest dilemmas and obstacles faced by some researchers in teaching STEM (Al-Ansi & Suprayogo, 2019). They feel anxious if the teaching does not conform to standards, and this feeling drags down to the performance because learning consuming a lot of their own time. Conducting learning in different environment (online) including preparing e-materials with different style and formats, ability to involve all students and enable them to be active during the class and finally assessment through certain process to make sure the evaluation process is attained

effectively lead to anxiousness of academic and educators. According to Kara (2013) stated that many of the academics and educators feel devastated and emotions during their work. Kara (2013) also stated that educators have to learn more how to control their emotions during their teaching and better present their task and problem solving when they give STEM courses. Furthermore, Sword et al. (2018) confirmed that educators are frustrated in ICT-based learning materials because they often face many difficult and lack of required skills.

On the other hand, the evaluation process of students' performance remains one of the main challenges during virtual learning. There more effective approaches during assessment process of virtual learning could be considered as follows: True-False (TF), Short Answer and Multiple-choice format. Some previous studies investigated the comparability of assessment determination and approaches (Esomonu et al., 2020). The usual used format in e-assessment is consisted of true-false. Short answers and multiple choice (Eleje, et al., 2017).

Therefore, e-assessment by using these three formats have been discussed in different studies and which one is more effective to conduct class assessment. Comparison of these three formats some of these studies conducted in students perception of these assessment tools revealed that true-false answer is preferred (Javid, 2014). Thus, the importance of this study comes from the significance of testing these three formats as the main tools for e-assessment during the covid-19 pandemic. This study investigates these three format and highlight the needed competences to be present in postgraduate students and academics in university level. Among the skills that need to be possessed are educator's skills, students' skills and well preparation of university infrastructure and learning management systems.

METHOD

A mixed method was used to conduct this study (Cresswell & Cresswell, 2017). To develop e-learning and e-assessment module, both interviews and questionnaires approaches were employed to build and test the outcomes of the two stages. Developing module for STEM e-learning was conducted through three different stages namely: design stage, developing stage and evaluation stage. On the other hand, participants of assessment questionnaire were randomly selected among students and educators including 623 participants from different universities in Yogyakarta province Indonesia. The questionnaire and interviews were conducted online regarding the Covid-19 pandemic. Google drive was the tool used to design and organize questions while interviews were conducted through Zoom and Microsoft team's platforms. Furthermore, collected quantitative data analyzed by using SPSS including mean and standard deviation in addition to analysis of variance among three different formats of assessments.

Characteristics of assessment stage included 275 male (44%) and 348 female (56%). The sampling method was depending on STEM students only. All the participants have experience using virtual learning and educational platforms during Covid-19 pandemic. Based on the objective of the study to test e-assessment tools, the questionnaire included 20 items with True-False format, 15 items with short-answer format and 15 items with multiple choice format. The reliability and validity test indicate that 0.88, 0.85 and 0.89 respectively for true-false format, short-answer format and multiple choice format. These results showed that this tool was quite enough to conduct study using the related items and questionnaire. Every correct answer was scored with 1 weight. The participants in the stages of module development can be seen in Table 1.

Table 1 Stages of Module Development

Stages	Sampling	Participants	Number
Design	Goal-oriented	Educators	10
		Students	10
Development	Goal-oriented	Moduling experties	6
		Assessment experties	6
		Educators	15
		Students	15
Assessment	Random	Educators	15
		Students	15

RESULTS AND DISCUSSION

Module Evaluation

To evaluate the module, descriptive statistics analysis was used including mean and standard deviation of STEM students for three evaluation formats namely: True-False format, Short-Answer format and Multiple Choice format that can be seen in Table 2.

Table 2 Comparison of assessment approaches

Format	Sample	Mean	Standard Deviation
Multiple choice	623	17.09	3.14
Short answer	623	18.34	2.80
True false	623	21.58	2.74

According to Table 2, the mean and standard deviation show that true-false answer was the highest format score related to STEM student's perception while short-answer have the second level format and finally multiple choice format. Furthermore, these results also give educators more understanding about using different formats when it comes to evaluation process during teaching online. In another words, the mix of three formats or more will be better to evaluate students' progress.

Furthermore, analysis of variance among three formats was conducted to understand the significance and difference among three formats including true-false format, short-answer and multiple choice format for STEM students (See Table 3).

Table 3 ANOVA among three assessment styles

Items	Sum of Squares	Degree of freedom	Mean Square	F	P	Result
Formats	3987.401	2.145	1987.324	812.784	<.001	Significant
Error	2987.716	987	2.876			

Based on the results in Table 3, this research proved the significance of differences based on students and educators perceptions among different assessment formats namely: true-false. Short-answer and multiple choice. Results indicate that F(2.145) = 812.784 with p <,001. This result showed the significant deference clearly but it needs more clarification to understand where this difference is. Based on that, further analysis is required. Researchers used pairwise approach to clarify these results as shown in Table 4.

Table 4 Comparison Analysis (pairwise)

Measurement						
Assessment Format	(1) Format	Mean (1-2)	Error	Sig.	95% CI	
					Lower	Upper
A	B	-4.242*	.119	<.001	-4.528	-3.956
	C	-1.486*	.101	<.001	-1.730	-1.242
B	A	4.242*	.119	<.001	3.956	4.528
	C	2.756*	.102	<.001	2.512	3.000
C	A	1.486*	.101	<.001	1.242	1.730
	B	-2.756*	.102	<.001	-3.000	-2.512

Based on Table 4, by giving a to true-false format, b indicate short answer format and c is dedicated to multiple choice format, the result of Table 4 show the differences among each approach with each other. These results were proved also in Table 2 where the mean of true-false format is higher than mean of short answer format and the mean of short answer format is higher than mean of multiple choice format.

The results revealed the significant differences among three formats of STEM evaluation process through true-false, short-answer and multiple choice formats. These results are supported by previous studies including (Javid, 2014; Predeep et al, 2017). These findings

also approved that students' assessment was significant related to their scores that they got in their exams. In addition, the results of every format was different and significant as well.

The results also revealed that the true-false formats has the highest mean related to students performance and perception and short answer is the second favourite format while multiple choice was the third format for assessments. In another words, when educators or academics want to assess class performance, they have to take into consideration these students preferences. This result also approved by Simbak, et al. (2014) which stated that students got better scores in true-false format than multiple choice format.

CONCLUSION

This study introduced new e-learning module called PADA highly used in virtual learning. The results also revealed that, the assessment formats that usually used in virtual learning assessment including that mix of all formats is better to conduct successful assessment process. True-false format was gained the highest score level among other formats as well.

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