

Implementation of E-learning based-STEM on Quantum Physics Subject to Student HOTS Ability

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ABSTRACT

E-learning media is one effective solution as a learning tool that could be implemented anytime and anywhere. Science, Technology, Engineering, and Mathematics (STEM) approach through the use of e-learning is expected to develop students Higher Order Thinking Skills (HOTS). This study aimed to measure students HOTS abilities through the use of e-learning based-STEM media in quantum physics courses. Through purposive sampling technique set sample research that is students who are in the program of quantum physics courses for ten people in the even semester 2017-2018 in Jurusan Pendidikan Fisika Universitas Papua. The instruments used are eight numbers of HOTS questions in the form of essays and questionnaires of student responses given after the lesson. The data analysis technique used was gain test to see if there was the improvement of HOTS student ability and hypothesis test through SPSS to know the difference of HOTS ability before and after learning, while student response questionnaire analysis is done through Rasch modeling using the Winstep program. The results showed that the value of N-gain (0.7) high category and Wilcoxon test significance value (0.004) indicating that learning of quantum physics through e-learning based on the STEM can improve students HOTS capability. Rasch modeling showed that in general the students strongly agree on the learning done. Therefore, the implementation of e-learning based on the STEM in quantum physics course could be used as one of the references to develop students HOTS capability.

Keywords: e-learning, HOTS, response, STEM

INTRODUCTION

The development of science and technology has penetrated in various aspects of life including education. Science and technology today have an essential role in education, in particular, to equip learners with challenges in the future. Science, Technology, Engineering, and Mathematics (STEM) is one alternative that can be applied in science learning to build a generation capable of facing various challenges in the 21st century. Science and technology cannot be separated from the concept of the STEM. Science can be found from the advent of



technological products and the opposite, the development of science supports for the emergence of various cutting-edge technologies. The life skills of learners must meet the

needs of today's world that they must be able to work with IT and develop their thinking skills (Wahyuni and Zainnuri, 2017).

The ability to think or known as HOTS is very important to train to learners who are able to develop their abilities in problem solving. The ability HOTS of students is still relatively low in Department of Physics Education, Faculty of Teaching and Education, University of Papua. The low ability of HOTS is affected by lack of student learning motivation (Yusuf and Widyaningsih, 2018). Innovation in learning is essential to be done by educators to improve the motivation to learn that affects the HOTS ability of students. The use of technology can be one of the innovations in learning that can foster the motivation of learners (Suryani, 2017). The use of technology in learning can help learners to understand the material and encourage their perception and motivation to learn (Yusuf and Subaer, 2013; Yusuf, et al., 2015; Iksan and Saufian, 2017).

One of the uses of technology in learning is through the use of e-learning. Learning through e-learning is one of the means of transforming conventional learning into digital form. Utilization of e-learning can eliminate the limits of space and time that happened in education (Gunga and Ricketts, 2007). Learning through the use of e-learning can affect the ability of STEM learners and their interest in science lessons (Proudfoot and Kebritchi, 2017; Popovici and Mironov, 2015). Learning through e-learning can also create learning independence for learners and contribute positively to their learning experiences (Tubaishat and Lansari, 2011).

Therefore, it is necessary to apply e-learning based on the STEM in the quantum physics course to examine HOTS capability of students. The purpose of this study is to measure students HOTS capabilities through the use of e-learning based on STEM-media in quantum physics courses.

METHODOLOGY

This research was quasi-experiment research of one group pretest-posttest design. The purposive sampling technique was used to determine the sample of research which was the student of quantum physic program courses of 10 people in the even semester of 2017-2018 Department of Physics Education, Faculty of Teaching and Education, University of Papua. The instruments used were eight of HOTS questions in essays and questionnaires of student responses given after the lesson. Data analysis technique used was the N-gain test ($\langle g \rangle$) to measure whether there was an improvement of HOTS student ability. The N-gain test equation according to Hake (1998) as in equation (1).

$$\langle g \rangle = \frac{\% \langle S_f \rangle - \% \langle S_i \rangle}{100 - \% \langle S_i \rangle}$$

Where, $\langle g \rangle$ was a normalized gain, $\langle S_i \rangle$ was the average score of the pretest, and $\langle S_f \rangle$ is the posttest average score. N-gain improvement criteria are categorized according to Table 1.

Table 1. Normalized average score criteria

| Value $\langle g \rangle$ | Criteria |
|------------------------------------|----------|
| $\langle g \rangle > 0,7$ | High |
| $0,3 < \langle g \rangle \leq 0,7$ | Medium |
| $\langle g \rangle \leq 0,3$ | Low |

FINDINGS

a) The characteristics of interviewees

There were 40 interviewees at the age of 47 and 48. 47% of the interviewees were men while 53% were women. In terms of education, 45% of the interviewees graduated with Bachelor degree while 55% graduated with Master degree. In terms of experience in following scientific activities, 48% of the interviewees have followed the scientific activities 1-3 times, while 52% of the interviewees claimed that they have followed the scientific activities 4-5 times. The characteristics of the interviewees can be illustrated in Table 2.

Table 2. *The characteristics of respondents*

| No | Sex | Total | Percentage (%) | Education | | Scientific activities | |
|--------------|--------|-------|----------------|--------------------------|--------------------|-----------------------|----------|
| | | | | Undergraduate (Bachelor) | Graduate (Masters) | 1-3 time | 4-5 time |
| 1 | Female | 21 | 53 | 18 | 22 | 19 | 21 |
| 2 | Male | 19 | 47 | (45%) | (55%) | (48%) | (52%) |
| Total | | 40 | 100 | 100 | | 100 | |

From the Table 2, 55% of the teachers had certificate of master's degree in education and had attended in the training of scientific activities as much as 4-5 times. The above teacher profile is an important capital in improving the quality of education.

b) Teachers' Ability and Performance

Almost half of the teachers (45%) stated that they were teaching social sciences for the purpose of developing knowledge and sensitivity to social reality, enabling students to become aware of the reality of a multicultural society. Around 40% of the teachers purposed to improve students' social skills. And only, 15% of the teachers who had a goal just to give knowledge about the facts of social studies to students.

All teachers understand that they have a responsibility to improve student's social skills and instill students' solidarity with nationality. This cannot be separated from the current reality that social skills and national solidarity are fade. Though, social skills are important because it determines the success of student learning while the attitude of national solidarity to form the identity of the student personality. The cultivation of national solidarity is very important to form the knowledge and character of the soul of nationalism, the attitude of patriotism and loyalty to the homeland.

Teachers assess that the process of improving social skills and strengthening national solidarity in social science teaching activities can be performed through the formation of heterogeneous/discussion groups, applying learning models which prioritize cooperation, developing and learning social science materials based on the diversity of local culture.

Teachers also considered that the development of social science teaching materials on the diversity of local cultures would be more interesting, if they are in digital form rather than regular textbooks.

c) The Use of Digital Teaching Materials

The use of digital teaching materials can be seen in the stages of planning, problems, innovation and learning application with digital teaching materials.

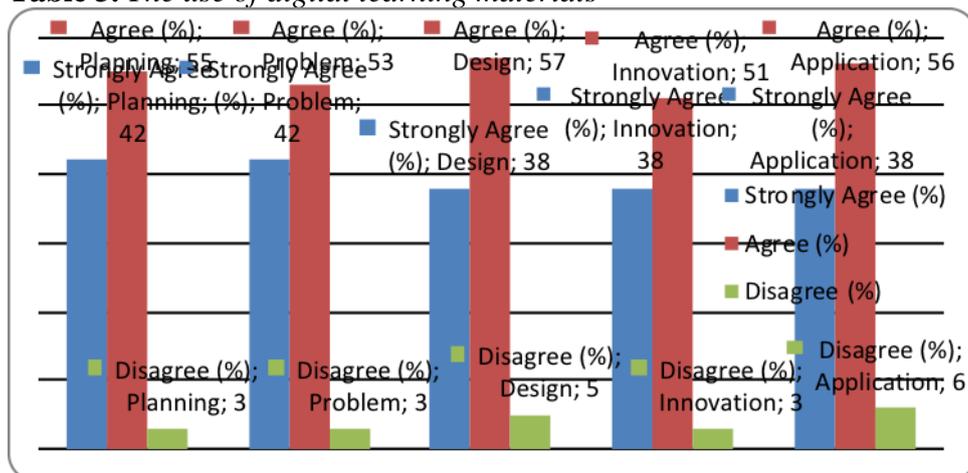
Lesson planning: In this aspect, the teachers stated that they (42%) were strongly agree with digital teaching materials are making classes easy to organize, designing and learning will be more structured while as many as 55% agreed, and the remaining 3% were neutral.

Learning problems: In this aspect, teachers stated that they (42%) were strongly agree with the technology in learning while 53% of the teachers were agreed. While 3% of the teachers disagree with the reason that the use of teaching material is difficult to implemented and takes a lot of time.

Learning innovation: In this aspect, teachers stated that they are strongly agree (38%), agree (51%) and disagree (3%). While the disagreed teachers explained that the use of digital teaching materials is less efficient in learning and need more adaptation in learning process, method or and learning model to use it.

Learning application: In this aspect, teachers stated that they were strongly agree (38%), agree (56%), and disagree (6%). The teachers agreed that digital teaching materials take time to be developed, but in use they will be more efficient, easier on teaching. In addition, the development of teaching materials is once completed that can be used more than once. But for the teachers who do not agree with the use of technology, they believed that learning innovation and technology application requires professional teachers and a drastic change on understanding, perception, trust and attitude to technology. For more, details are presented in Table 3.

Table 3. The use of digital learning materials



d) Pedagogical and Technical Aspects

The use of digital teaching materials can be considered in the pedagogical aspect of providing new ways to learn, improving the efficiency of learning time, leading to automatic learning, facilitating access to information, and offering collaborative learning. In technical terms, digital teaching materials can be seen as learning tools, information tools and learning content.

Providing a new way to learn: In this aspect, the teachers stated that they were strongly agree (55%) and agree (45%). They agree that the development of digital teaching materials is one of the alternative ways in creating an interesting social science lesson. Using digital-based teaching materials about the diversity of local cultures can create meaningful social science learning for students, provide a wider experience, and can make them more active in learning.

Learning time: In this aspect, the teachers stated that they were strongly agree (50%) and agree (50%). The teachers agreed that the utilization of digital teaching materials in social science learning can improve students' learning efficiency and inspire to learn. In addition, the

manufacture of digital teaching materials can improve the effectiveness in the mastery of social science learning materials. Students are more pleased and curious about the content of the presented digital materials, so that they were interest in doing learning tasks.

Cause automated learning: In this aspect, the teachers stated that they were strongly agree (44%), agree (53%), and disagree (3%). The teachers agree that with the support of digital learning materials for social science learning, it will alert students' skills in the decision-making process to solve problems and useful in supporting student self-reliance. As well as with teaching materials/digital textbooks can encourage students to browse the various references.

Facilitating access to information: In this aspect, the teachers stated that they were strongly agree (44%), agree (54%), and disagree (3%). The teachers agreed that digital teaching materials facilitate teachers in enhancing interactive learning and enable to encourage teachers to apply innovative learning strategies. The digital teaching materials also make students eager to find sources of information. The students easily and more actively access various information as teaching materials.

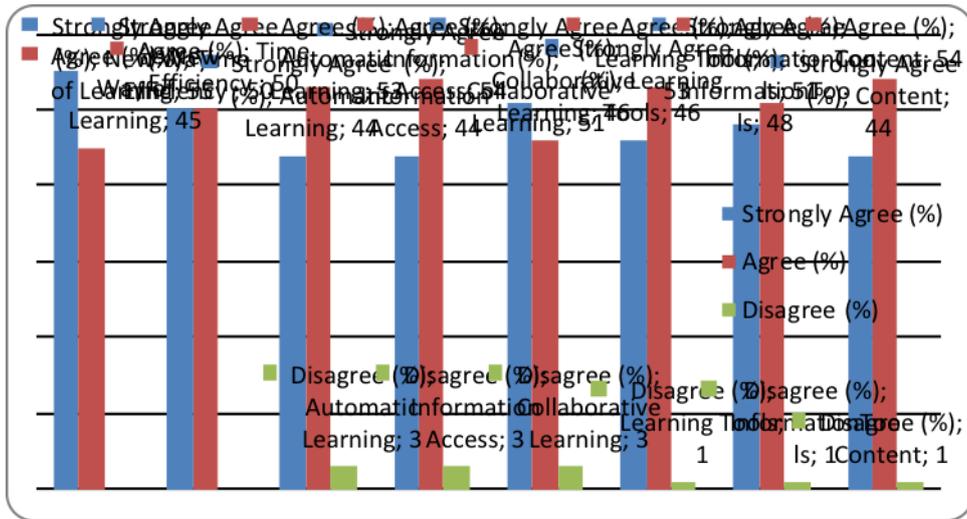
Collaborative learning: In this aspect, the teachers stated that they were strongly agree (51%), agree (46%), and disagree (3%). The teachers agreed that the use of teaching materials/digital books of social science could encourage students to read and learn materials and be social. While teachers who disagreed had reasoned that the use of digital teaching materials of social science only encourage students to be individualistic because the use of digital teaching materials provokes low students' understanding of social attitude. The students were more pleased with their own digital learning tools. As a result, they were anti-social.

Learning tool: In this aspect, the teachers stated that they were strongly agree (46%), agree (53%), and disagree (1%). The teachers agreed that the instructional materials/digital learning social science books based on regional cultural diversity can be used as a medium for discussion. Moreover, it could be used to improve the skills of analyzing, writing and improving skills in social sciences and student's national solidarity. Moreover, the instructional materials/digital learning social science book, which is based on diversity of local culture, could be used to develop learning social sciences.

Information tool: In this aspect, the teachers stated that they were strongly agree (48%), agree (51%), and disagree (1%). The teachers agreed that information would increase with the use of teaching materials/digital books based on regional cultural diversity as a reference for social science learning. And the students' understanding also will increase the ability to synthesize information developed by using digital teaching materials. New information is easier to be obtained with the use of digital teaching materials.

Learning content: In this aspect, the teachers stated that they were strongly agreed (44%), agree (54%), and disagree (1%). They agreed that the use of digital teaching materials made them easier to obtain new information. Applying digital teaching materials required skills and tenacity. It is easy to understand the meaning of social science learning materials in the form of digital books, so easy to be used by students in solving problems. The teachers who did not agree have reason that applying digital teaching materials required complex skills and troublesome, difficult to be applied and understood by students. Age factor becomes the dominant influence. More details presented in Table 4.

Table 4. Pedagogical and Technical Aspects



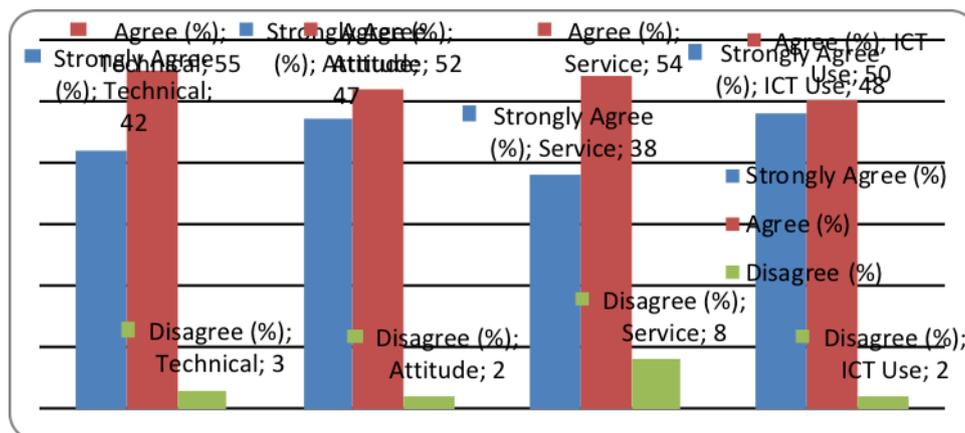
e) The Use of ICT in Social Science Learning Process

In this aspect, the teachers stated that they were strongly agree (42%), agree (55%), and disagree (3%). The teachers recognized that they were familiar with the technology use at planning, downloading materials, timing and classroom setting to the use of digital books in the curriculum. They considered that digital teaching materials as a technology to support teaching and learning activities more quickly.

Attitudes toward digital teaching materials: In this aspect, the teachers stated that they were strongly agree (47%), agree (52%), and disagree (2%). The teachers, who have Master degree, considered that the digital teaching material were very important as teaching materials. They are attracted as digital resources and useful as a tool for changing learning, accelerating students' understanding, helping students to understand learning concepts, making students more active, and making teachers more confident and enjoying the learning process.

Teacher service in teaching and learning process: In this aspect, teachers stated that they were strongly agree (38%), agree (54%), and disagree (8%). The teachers considered that digital teaching materials did not take time at school. On the other hand, the teachers who disagree explained that the digital teaching materials have less technical support, time constrains, limited software and the minimal availability.

Level of ICT use for teaching and learning by teacher: In this aspect, the teachers stated that they were strongly agree (48%), agree (50%), and disagree (2%). The teacher stated that the were accustomed to use technology for many purposes in learning such as making presentation, preparing teaching, supervising and evaluating students' progress, and generating report. More details presented in Table 5.

Table 5. *The Use of ICT in Social Science Learning*

DISCUSSION

The finding of the research has shown that the teachers demands the social science teaching material on the diversity of local culture, particularly in the form of digital books. As Lau (2018) and Osakwe, Dlodlo and Jere's (2017) argumentation, the teachers considered that the digital teaching materials are a technology to support teaching and learning activities more quickly. In line with Ertmer's (2012) finding, the teachers believe that the use of digital technology in learning is the biggest factor for achieving students' learning success.

The teachers agreed that using digital instructional product as an innovation is useful in visualizing themes and making learning more concrete (Mohammadi, Abrizah, Nazari & Attaran, 2015). In addition, the digital teaching materials are also useful in building more intimately and interwoven interaction with students, making the class more interesting, using the time inefficient, and motivating students to study harder (Sampaio & Almeida, 2016). They are attracted as digital resources and useful as a tool for changing learning, accelerating students' understanding, helping students to understand learning concepts, making students more active, and making teachers more confident and enjoying the learning process (Shieh, 2012; Juan, Sánchez, & Alemán, 2011). Because it is interesting, automatically both teachers and students will be more active in the learning process (Louws et al, 2017).

On the other hand, digital teaching materials become an opportunity as well as challenge for teachers in the digital era. The finding of this research has shown that there is an obstacle in utilizing and developing digital technology in learning (Kim, et al, 2013). The obstacle lies in the on the fact that the older teachers prefer textual materials as usual compared to younger teachers (Bannon & Thomas, 2014). It means the Age factor becomes the decisive factor that affects the application of digital teaching material in social science learning.

Based on the discussion, the authors sum up that the teachers perceive that the digital teaching materials will be more interesting, easier to understand, more practical, less expensive, and more diverse and will be more interesting for students in the digital age. It is supporting Joo, Park and Shin (2017) and Bando's (2017) finding about the good expectation, satisfaction, and continuation of digital textbooks. Thus, as Reyes (2017) pointed out that the teachers' perception of the digital teaching materials can be used as an asset to facilitate teachers in enhancing interactive learning and enable to encourage teachers to apply innovative learning strategies.

CONCLUSION

The teachers considered that the development of social science-based teaching materials for regional cultural diversity would be more interesting if it is given in digital form than regular textbooks. It is because digital teaching materials can be more interesting, easier to understand, more practical, less expensive, and more diverse and be more interesting for students in the digital age. Besides, the digital teaching materials are efficient in use. It can also achieve significant learning outcomes with respect to only textbook use. This cannot be separated from the role of the digital teaching materials that are able to visualize the theme and make learning more concrete (real), create meaningful social science learning, able to attract students' attention and interest, and able to improve students' social attitude in digging information and knowledge.

The obstacles faced by most teachers are only about developing the digital teaching materials when the initial planning takes up much of their time. Moreover, most of the teachers are accustomed to use technology for learning, so they have less chance to experience many obstacles. On the other hand, a small number of teachers who are unfamiliar with the technology have more chance to encounter many obstacles in developing it.

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