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Effectiveness of Quantum Physics Learning Tools Using Blended Learning Models to Improve Critical Thinking and Generic Science Skills of Students

Aris Doyan[1,3]*, Susilawati[1,3], Saprizal Hadisaputra[2,3], Lalu Muliyadi[3]

[1]Physics Education, Faculty of Teacher Training and Education, University of Mataram, Lombok, West Nusa Tenggara, Indonesia.
[2]Chemistry Education, Faculty of Teacher Training and Education, University of Mataram, Lombok, West Nusa Tenggara, Indonesia.
[3]Master of Science Education Program, University of Mataram, Lombok, West Nusa Tenggara, Indonesia.

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Abstract: This study aims to determine the effectiveness of quantum physics learning tools using blended learning models to improve critical thinking and generic science skills of students. The learning device was developed using a 4-D model which includes the stages of define, design, develop and disseminate. Learning devices that have been declared valid, then conducted a limited-scale trial in the Physics education undergraduate program at the University of Mataram, which consisted of thirty students. Analysis of increasing critical thinking and science generic skills using the n-gain (g) test. The results of the n-gain analysis for all aspects indicate that the students' critical thinking and generic science skills are in the medium and high categories. These results indicate that the use of quantum physics learning using a blended learning model is effective in improving students' critical thinking and generic science skills.

Keywords: Blended learning model; Critical thinking skills; Science generic skills.

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Introduction

The spread of the Covid-19 outbreak that continues to increase has caused a worrying impact in the education sector. Advances in science and technology in the global era require teachers to be able to master and utilize technology in carrying out learning, especially during the Covid-19 pandemic where learning activities are carried out online or called distance learning (Septeanawati et al, 2021).

Along with the circular from the Ministry of Education and Culture regarding distance learning, education actors must adapt to carry out learning habits that were originally carried out face-to-face and must carry out online learning processes as a result of the spread of the COVID-19 virus outbreak. Higher education leaders are forced by circumstances to immediately make decisions or study-from-home rules in response to a circular issued by the Ministry of Education and Culture. This is no exception in the lecture process at the University of Mataram. This situation causes the learning process carried out by Mataram University students to be constrained, especially physics education students who take Quantum Physics courses.

The quantum physics lecture process with the application of a distance learning system requires the competence of educators, especially lecturers to choose the use of models in suitable learning so that students also adapt to the distance learning process while still paying attention to the independence of students in learning. This learning model is expected to help lecturers convey material to students even without meeting face to face. One of them is the Blended Learning model which can improve students' ability to study independently (Hamka et al, 2019; Rizaldi et al,

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* Corresponding Author: aris_doyan@unram.ac.id

2021). Blended Learning is a combination of offline and online learning delivery by utilizing technology (Kurniawati et al, 2019). This learning model combines learning based on the use of technology (Anggraeni et al., 2020) where advances in information technology have affected aspects of life, including education (Faozi et al., 2020).

The blended learning model allows students to interact with each other in the form of discussions and information obtained from various sources on an ongoing basis so that higher-order thinking skills, especially students' critical thinking skills, can be developed. The blended learning model provides opportunities for students to develop individual abilities without leaving social interaction in the classroom, so that with this system students play an active role in learning while teachers or lecturers act as facilitators. With the active role of students in learning, it is hoped that students' critical thinking skills will increase (Handriani et al, 2015; Kartini et al, 2019; Aminah et al, 2020). In addition, students' generic science skills, especially in quantum physics courses, will also increase (Doyan et al, 2019).

Method

This research is a type of development with a 4D model which has 4 stages, namely define, design, develop and disseminate (Sugiyono, 2017). In this study, the 4D model was simplified to the develop stage, namely a limited-scale test which aims to determine the effectiveness of the learning device (Doyan et al, 2020). The limited-scale test was carried out in the S1 Physics Education study program at the University of Mataram, which consisted of 30 students. The data collection technique is done by means of tests. The data collection instrument in this study was a test of learning outcomes, namely the results of students' critical thinking and generic science skills. The data obtained from the results of the study were then analyzed using the N-gain test (equation 1) to determine the effectiveness of the learning device (Doyan et al, 2020). The n-gain value consists of three categories, namely high (n-gain>0.7), moderate (0.70>n-gain 0.30), and low (n-gain <0.3).

$$\mathrm{N-gain} = \frac{S_{post}-S_{pre}}{S_{max}-S_{min}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Result and Discussion

The product of this research is a quantum physics learning device using a blended learning model. The development of the tool aims to improve critical thinking and generic science skills of students. In this study, the learning tools made discussed 4 chapters consisting of: introduction to quantum physics (chapter 1), basics of quantum physics (chapter 2), simple potential (chapter 3), electrons in a magnetic field (chapter 4).

The effectiveness of quantum physics learning tools using the blended learning model is seen from the improvement of students' critical thinking and generic science skills towards learning. The indicators of critical thinking skills that are measured consist of five indicators, namely: providing simple explanations, building basic skills, concluding, providing further explanations, setting strategies and tactics. Meanwhile, the indicators of generic science skills measured in this study include direct observation, indirect observation, the law of cause and effect, a principled logical framework, and logical inference (Doyan et al, 2021).

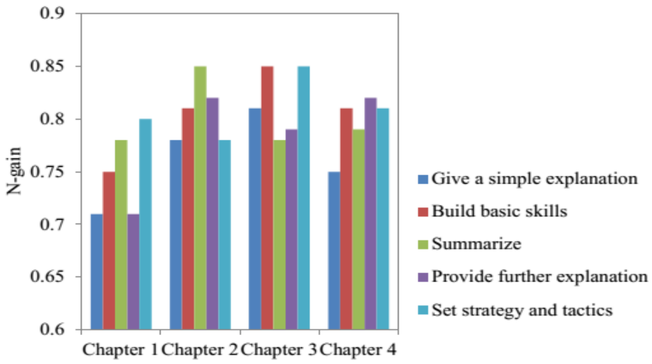

Figure 1. The value of n-gain for each indicator of critical thinking skills.

Student learning outcomes for critical thinking skills are shown in Figure 1. Based on the figure, it is clear that the introductory material for quantum physics (chapter 1) has an n-gain value of 0.70 > n-gain ≥ 0.30. This means that in the material the value of increasing students' critical thinking skills is in the medium category. In contrast to the increase in critical thinking skills that occurs in the basics of quantum physics (chapter 2), simple potential (chapter 3), electrons in a magnetic field (chapter 4), the n-gain value is above 0.70 with a high category or has a significant increase. better than before. This is because students are getting used to practicing critical thinking skills so they prefer to be more active and confident in carrying out learning activities (Rahman et al, 2021). Improvement of critical thinking skills appears as the end result of learning with blended learning strategies (Lestari et al, 2016). This is in accordance with the opinion of Susilawati et al. (2019) which states that the improvement of critical thinking skills can be seen from critical evaluation.

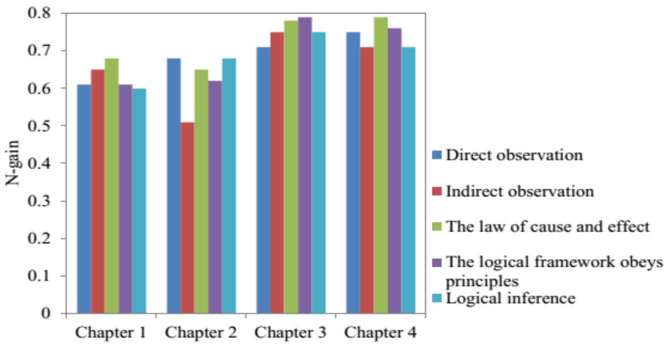

Figure 2. The value of n-gain for each indicator of generic science skills.

Student learning outcomes for generic science skills are shown in Figure 2. Based on this figure, it is clear that the introductory material for quantum physics (chapter 1) and basics of quantum physics (chapter 2) has an n-gain value in the medium category. In contrast to the increase in generic science skills that occurs in simple potential materials (chapter 3) and electrons in a magnetic field (chapter 4), the n-gain value is obtained above 0.70 in the high category or has improved better than before.

Based on these results, it can be seen that the use of quantum physics learning tools using the blended learning model is effective in improving students' critical thinking and generic science skills. This is because the use of blended learning-based learning models expands the range of learning (Idris, 2018). Because through this blended learning model, students can learn from any source (Putra et al, 2021). In addition, students have more opportunities to interact, get direct feedback so that they can improve learning and performance independently (Susilawati et al, 2022).

Conclusion

Quantum physics learning tools using a blended learning model developed with a 4-D model have been successfully carried out. This is indicated by the value of increasing students' critical thinking and generic science skills for each medium and high category material. This shows that quantum physics learning tools using blended learning models are effective in improving students' critical thinking and generic science skills.

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