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Analysis Validation of Quantum Physics Learning Devices using Blended Learning Models to Improve Critical Thinking and Generic Science Skills of Students

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Abstract: This study aims to develop a quantum physics learning device with a blended learning model to improve the critical thinking and generic science skills of students. The learning device is made with a 4D development model which includes four steps, namely: define, design, develop, and disseminate. The learning tools developed to consist of semester program plans (SPP), student activity sheets (SAS), quantum physics teaching materials, instruments to measure critical thinking skills, and generic science skills of students. The validity results show that the quantum physics learning device with the blended learning model has an average value of more than 4.20. This shows that the learning tools are very feasible to improve the critical thinking and generic science skills of students.

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

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Introduction

The current COVID-19 pandemic has an impact on many countries, including Indonesia. This virus spreads very quickly. The World Health Organization (WHO) urges that activities that have the potential to cause crowds are temporarily stopped so that the spread of COVID-19 can be prevented. This makes various countries have to implement a lockdown system to suppress the spread of the coronavirus more widely. However, the Indonesian government implemented a large-scale social restriction system to anticipate and suppress the spread of the virus. Since the implementation of these restrictions, the education system which was initially applied face-to-face in schools has shifted to a distance learning system, where students study and carry out activities at home (Septeanawati et al, 2021). This also occurs in the lecture process at the University of Mataram, especially among physics education students who take Quantum Physics courses (Doyan et al, 2022).

The teaching and learning process during the pandemic, especially in the Quantum Physics course, is carried out using an online system. Online learning can be done with applications such as whatsapp, google meeting, google classroom, and other learning applications (Rahayu et al, 2019). Online learning that is carried out has advantages and disadvantages for lecturers and students. The advantages of online learning are reducing costs, the flexibility of time, place, and speed of learning, standardization, and effectiveness of learning. Meanwhile, the disadvantage of online learning is that face-to-face interactions between students and lecturers or between students and students are minimal. This has an impact on student learning outcomes, especially critical thinking skills and

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generic science students are not optimal, because during online learning students are less able to analyze a case given by the lecturer (Doyan et al., 2022).

These problems can be overcome by the way educators or lecturers must choose the right online learning model. One of the appropriate online learning models used to achieve learning objectives in quantum physics courses is the blended learning model (Hamka et al, 2019; Rizaldi et al, 2021). The blended learning model can combine synchronous and asynchronous processes to make it easier to achieve learning objectives (Kurniawati et al, 2019; Anggraeni et al., 2020). The blended learning model mixes theory, methods, and technology so that it can maximize the learning process in a certain context (Idris, 2018). Therefore, there are elements in blended learning that will help make it easier to achieve learning objectives (Lestari et al, 2016; Putra et al, 2021). These elements include conventional, self-study, application, procedures, collaboration, and assessment (Doyan et al, 2022). By applying the blended learning model in quantum physics learning, it is expected 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, have also increased (Doyan et al, 2019; Susilawati et al, 2019).

Method

The quantum physics learning device uses a blended learning model of development with a 4D model. The development with this model consists of four stages, namely: (1) the defining stage, (2) the design stage (¬design), (3) the development stage, (4) the dissemination stage (Sugiyono, 2007). 2017). The tools developed in this study consisted of four types, namely: Semester Program Plans (SPP), Student Activity Sheets (SAS), quantum physics teaching materials, and instruments to measure critical thinking skills and generic science skills of students (Susilawati et al, 2022). The finished quantum physics learning device is then tested for validity to determine the level of feasibility. The data from the validity test results were analyzed using equation 1 (Susilawati et al, 2022), while for the level of validity the device refers to several criteria, namely: very solid ($4.2 \geq SV \leq 5.0$), valid ($3.4 \geq SV \leq 4.2$), quite valid ($2.6 \geq SV \leq 3.4$), less valid ($1.8 \geq SV \leq 2.6$), and very less valid ($1.0 \geq SV \leq 1.8$) (Arikunto, 2010).

$$SV = \frac{n}{N} \tag{1}$$

Where SV is the average value of validity, n is the average value of expert validity, and N is the maximum score.

Result and Discussion

Quantum physics learning tools are developed using a 4-D model which has four steps, namely define, design, develop, and disseminate. The define stage is carried out through several analyzes, namely: curriculum analysis, analysis of student needs, analysis of learning materials, and analysis of objectives which are components of content in compiling learning tools in connection with the subject matter and task analysis to analyze what tasks must be given to students, so that students achieve the competencies that have been determined (Susilawati et al, 2020). As for curriculum analysis, obtained in quantum physics lectures, the material to be discussed consists of seven chapters which include: Introduction to Quantum Physics, Fundamentals of Quantum Physics, Simple Potential, Electrons in a Magnetic Field, Single-Electron Angular Momentum, Atoms with One Electron, Electron Spin (Doyan et al, 2022). The time needed by students in studying this material is 16 meetings. In addition, quantum physics lectures can be attended by students who have taken Basic Physics I, Basic Physics II, Mathematical Physics I, Mathematical Physics II, and Modern Physics courses (Susilawati et al, 2022).

Analysis of student needs is carried out to find out the needs of students in expediting and simplifying the quantum physics learning process during the COVID-19 pandemic (Khasanah et al, 2019). The results of this analysis indicate that quantum physics learning tools are needed that are following the needs of students. The need is in the form of a quantum physics learning device using a blended learning model so that it can improve students' critical thinking skills and generic science skills (Doyan et al, 2019; Doyan et al, 2020).

Material analysis is carried out to adjust the material to the demands of the curriculum, especially during this pandemic. Analysis of learning objectives aims to determine learning objectives that are following the Learning Outcomes of Graduates of the Study Program and Learning Outcomes of Subjects that will be achieved by students during learning.

After the definition stage has been carried out, the next step is to design the learning device to be developed which is called the design stage. The purpose of this stage is to produce a developed learning device, namely a quantum physics learning device (Kartini et al, 2019). As for the learning tools that developed in the form of SPP, SAS, quantum physics teaching materials, and instruments to measure critical thinking skills and generic science skills of students (Susilawati et al, 2022).

The next stage is development. The quantum physics learning tools developed to consist of SPP, SAS, quantum physics teaching materials, and instruments to measure critical thinking skills and generic science skills of students. Before being used in learning, the quantum physics learning device is tested for validity to determine its feasibility level. The validity test of the learning device was assessed by five experts. In this study, the validation carried out emphasizes the validation of content, constructs, and language so that the learning tools used are following the appropriate criteria and the arrangement of the devices made is appropriate and meets the requirements for the preparation of learning tools. The data from the assessment results from five experts were then analyzed to determine the level of validity. The results of the validation of quantum physics learning devices can be seen in Figure 1.

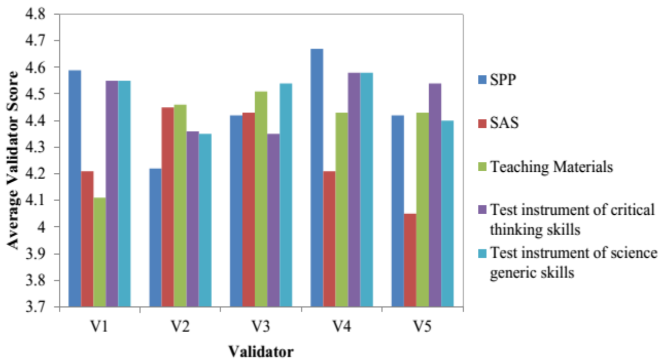

Figure 1. The results of the validity of the quantum physics learning device.

The validity of the quantum physics learning device is shown in Figure 1. The results of the SPP validity of each validator are 4.59, 4.22, 4.42, 4.67, and 4.42. Overall the value of the validity of the SPP is 4.46. This shows that the value of the validity of the SPP is categorized as very valid because the value is more than 4.20. This means that the SPP is very suitable to be used in improving critical thinking skills and generic science of students in learning quantum physics.

The next validity is the SAS. The results of the validity of the SAS for each validator are 4.21, 4.45, 4.43, 4.21, and 4.05 (Figure 1). Overall, the validity of the SAS is 4.27. This shows that the validity value of the SAS is categorized as very valid because the value is more than 4.20. This means that the SAS is very suitable to be used in improving critical thinking skills and generic science of students in learning quantum physics.

The next validity is the quantum physics teaching materials. The results of the validity of quantum physics teaching materials for each validator are 4.11, 4.46, 4.51, 4.43, and 4.43 (Figure 1). Overall the value of the validity of teaching materials is 4.39. This shows that the value of the validity of teaching materials is categorized as very valid because the value is more than 4.20. This means that the teaching materials are very suitable to be used in improving critical thinking skills and generic science of students in learning quantum physics.

The next validity is the critical thinking skill instrument. The results of the validity of the critical thinking skills instrument of each validator are 4.55, 4.36, 4.35, 4.58, and 4.54 (Figure 1). Overall the value of the validity of the instrument is 4.48. This shows that the instrument validity value is categorized as very valid because the value is more than 4.20. This means that the instrument is very suitable to be used in improving the critical thinking skills of students in learning quantum physics.

The last validity is the generic science skill instrument. The results of the validity of the generic science skills instrument of each validator are 4.55, 4.35, 4.54, 4.58, and 4.40 (Figure 1). Overall the value of the validity of the instrument is 4.48. This shows that the instrument validity value is categorized as very valid because the value is more than 4.20. This means that the instrument is very suitable to be used in improving the generic science of students in learning quantum physics.

Conclusion

The development of quantum physics learning tools with blended learning models to improve critical thinking and science generic skills has been successfully carried out. The validity results show that the quantum physics learning device with the blended learning model has an average value of more than 4.2 and is categorized as very valid. This shows that the learning tools are very feasible to improve the critical thinking and generic science skills of students.

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