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Physics Multimedia Learning (PsML) to Improve Critical Thinking Skills in Distance Learning

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ABSTRACT

The Covid-19 pandemic has caused changes in various sectors, including the education sector. These changes are found in implementing learning that previously took place in the classroom offline and must now be carried out online/blended learning. This study aims to develop a Physics Multimedia Learning (PsML), to test the product's validity and effectiveness in improving pre-service physics teachers' critical thinking skills on the subject of Static Electricity. This study uses a 4D development model. Data collection methods used are questionnaires, tests, and documentation. Validity testing is carried out through an assessment by two experts. The product that has been made is tested on pre-service physics teachers. The sample was taken using a purposive sampling technique by taking pre-service physics teachers who have taken the Basic Physics 1 course. The final product of Physics Multimedia Learning (PsML) contains covers, instructions for use, lists of materials and manuals, apperceptions, material content consisting of videos and pdf materials, activities, questions to make pre-service physics teachers think critically in finding concepts, Quiz, and the final project. The validator's assessment results show that the product is feasible in the excellent category. The experimental class's improvement of critical thinking skills is in the medium type, with a coefficient of 0.6. This increase was higher than the control class, which experienced an expansion with a coefficient of 0.32. Based on the results of data analysis, it can be concluded that PsML is effective for improving critical thinking skills in Static Electricity material.

Introduction

The Covid-19 pandemic that has hit the world since early 2020 has affected various sectors, including education. Learning initially done face-to-face in the classroom was forced to switch to online distance learning. This is a challenge for educators and students because they have to adapt quickly to new schemes without compromising the quality of education. However, various limitations arise when implementing online learning, such as mastery of IT by educators and students, facilities and infrastructure, and signals and internet access (Aji, 2020). As a result, the implementation of learning is only task-based, so student activities are not monitored, and learning outcomes decrease (Herliandry et al., 2020). This problem does not only occur in Indonesia; it has even become a global problem. Basilaia & Kvavadze (2020) stated that currently, there is no quality assurance method for online teaching. The learning is limited to saving the educational process and continuing in any possible format.

The research results of Sun et al. (2020) stated that students were less enthusiastic about online learning, so an increase in discipline was needed in following lessons. The results of a survey of 40 Physics Education students at UIN Walisongo Semarang regarding the implementation of online learning, 90% said lecturers gave assignments, 55% said lecturers occasionally held virtual meetings, 30% said lecturers used google classroom, 45% used e-learning walisongo, 47.5 % uploaded teaching video recordings to youtube, and all survey samples stated that lecturers used WhatsApp Groups to coordinate during learning. Through WhatsApp Groups, lecturers share material in photos, pdf, ppt files, or teaching videos. However, it is common for lecturers to only open classes and assigns substitute for lectures. Monotonous learning without media variations also makes students bored and pay less attention to lessons. This kind of learning system causes low critical thinking skills in students (Priyadi et al., 2018).

Critical thinking skills demand learning outcomes in the 21st century, which are part of higher-order thinking skills (Yanti et al., 2019). Each learning process is expected to emphasize critical thinking skills to make it more meaningful, and students can understand the material more deeply (Chukwuyenum, 2013; Duron et al., 2006; Švecová et al., 2014). Physics learning requires students to think critically, creatively, innovatively, and collaboratively to achieve learning objectives (Rahayu et al., 2018).

Applying critical thinking skills will get students used to thinking profoundly and intelligently in denying, analyzing, distinguishing, and being able to take responsibility for what has been decided. Critical thinking allows one to find the truth of various events and information.

Critical thinking skills make students able to analyze ideas or ideas that are more specific, classify, select, identify, and develop them in a perfect direction so that they can develop themselves to make decisions and solve problems. Critical thinking skills can be trained by honing an understanding of the mind and the ability to solve problems that lead students to think logically and rationally.

Learning physics requires critical thinking skills because physics requires logical thinking, reflection analysis, interpretation, interference, explanation, and evaluation (Giri & Paily, 2020). The material studied in physics is also related to everyday life, so students need to analyze problems and relate them to concepts to make learning more meaningful. However, the online learning system implemented so far has not honed students' critical thinking skills.

This research is essential because online learning is more demanding than independent learning, and critical thinking skills are not paid attention to during online learning. Interactive and communicative learning media are needed and can help students learn independently and hone critical thinking skills. Physics Multimedia Learning (PsML) is a physics learning application that will help students to learn independently, increase learning motivation with an attractive and interactive display, and train critical thinking skills because it contains various stimuli in the form of teaching videos, questions, and quizzes whose results can be directly obtained (Manurung & Panggabean, 2020; Warsono et al., 2020). Indicators of critical thinking skills that can be achieved in learning physics using Physics Multimedia Learning (PsML) include:

a) Ability to solve problems

Critical thinking skills on this indicator are seen from the ability to solve problems in everyday life related to Static Electricity material.

b) Ability to decipher answers

Students' skills are seen from the description of the answers given when answering the questions in the application. Students with good critical thinking skills will be able to describe answers coherently and in detail according to the concept.

c) Create original ideas/ideas

The success of this indicator is marked by the uniqueness and authenticity of students in deciphering the answers, which can be seen in the difference between the answers of other friends or from book sources or other learning resources.

d) Looking for alternative problem solving

Students' skills are shown by the ability to study, analyze, and find solutions to the questions given in the PsML application.

Physics Multimedia Learning (PsML) is a physics learning application that can help students to learn independently, especially during distance learning. PsML contains a list of learning materials, apperceptions, material content, explanatory videos and animations, guidebooks, activities, and various questions to provoke students to think critically. PsML was developed with user-friendly characteristics (making it easy for users to respond, using clear, simple, easy-to-understand language, and using standard terms), flexible (can be used to learn Static Electricity material at any time), and contains questions that can be used to hone critical thinking skills. The advantages of PsML include the following:

a) An attractive and interactive display that can increase students' learning motivation

b) Presentation of coherent content to make it easier for students to learn the material

c) Students can learn independently by following the flow contained in the application

d) Improve critical thinking skills

e) Improve learning outcomes

f) Facilitate educators in delivering material

g) Efficiency of learning time, especially in online learning

h) Easy to use the app

i) PsML size is small, so it doesn't take up too much space to install applications

j) Can be used anytime and anywhere offline after the application is installed

PsML prioritizes learning stimuli for students so they can be actively involved independently to get results according to learning outcomes. The answers given on the quiz menu are responded to directly by the application so that students can determine which parts are answered correctly and incorrectly. This can make students know the ability to master the material in each sub-chapter of material (Manurung & Panggabean, 2020; Roysa & Hartani, 2020). Through the development of PsML, it is hoped that students will be more motivated to learn independently and have critical thinking skills, especially in Static Electricity.

Literature Review

Critical Thinking

Critical thinking is an ability that is essentially needed by students in the context of higher education (Tathahira, 2020). Critical thinking skills require mental processes to differentiate, analyze and evaluate to achieve logical understanding in order to obtain valid and reliable conclusions (Chukwuyenum, 2013; George et al., 2012). Critical thinking can be seen from a person's ability to act rationally in facing problems, being able to analyze, organize, and dig up information based on facts, and draw conclusions to solve problems (Kurniawati, 2020).

The application of critical thinking skills will get you used to thinking deeply, being intelligent in denying, analyzing, distinguishing, and being able to take responsibility for what you have decided. Critical thinking allows someone to find the truth from various events and information.

Critical thinking skills enable students to analyze more specific ideas, classify, select, identify and develop them in a more perfect direction, so that they can develop themselves to make decisions and solve problems. Critical thinking skills can be trained by honing understanding of the mind and ability to solve problems which leads students to think logically and rationally.

Multimedia Learning

Multimedia is the use of computers to present or combine text, graphics, audio, video and animation (simulation) with connections (links) and tools so as to enable students to navigate, be creative, interact and communicate (Suyanto, 2007). Multimedia is often used in the world of informatics, the world of games, the world of education and business, even to create websites. Multimedia in the world of education is usually used as a teaching medium, both in class and self-taught (individually).

According to Nopriyanti & Sudira (2015), multimedia is divided into two types, namely interactive multimedia and linear multimedia. Interactive Multimedia is an

instrument equipped with control devices so that it can be operated by the user to select what they want. Examples of interactive multimedia are learning multimedia (multimedia-based learning), game applications and others.

Multimedia learning according to Prinz et al. (2021) is a teaching method to channel messages (knowledge, skills and attitudes) that can stimulate students' thoughts, feelings, attention and willingness to learn, so that a purposeful and controlled learning process occurs. Multimedia-based learning is computer-assisted learning (multimedia applications) that utilizes Android (Fauyan, 2019).

Multimedia provides opportunities for educators to develop learning techniques so that maximum results are obtained. The use of multimedia for students in learning is expected to facilitate the absorption of information quickly and efficiently. Information sources are no longer focused on text from textbooks alone, but are broader than that. The increasingly better and developing capabilities of multimedia technology will make it easier for students to gain a lot of knowledge.

Festiyed et al. (2019) argues that multimedia-based learning can support a learning process that:

a) Active, which allows students to be actively involved because the learning process is interesting and meaningful.
b) Constructive, which allows students to combine new concepts/ideas into previously held knowledge to understand the meaning that has always been in their minds.
c) Collaborative, which allows students in a group or community to work together, share ideas, suggestions and experiences.
d) Intentional, namely enabling students to be active and enthusiastic in trying to achieve the desired goals.
e) Conversational, namely enabling students to carry out social and dialogical processes that enable students to benefit from the communication process, both inside and outside the educational environment.
f) Contextualized, namely enabling students to carry out the learning process in meaningful (real-world) situations.
g) Reflective, allows students to be aware of what they have learned and explain it again as part of the learning process itself.

Based on this description, multimedia allows students to practice high-level thinking skills (such as problem solving, decision making and others) and indirectly improves their skills in using ICT or Information and Communication Technology Literacy (Widada, 2017).

Research Method

This study uses the 4D method. The sample was taken using a purposive sampling technique by taking 63 prospective physics teacher students at UIN Walisongo Semarang who had taken the Basic Physics 1 course. Each stage of development carried out was explained as follows:

1. Define

The define step begins with identifying the problems found in online learning at the Physics Education Study Program of UIN Walisongo Semarang. Information was

collected through a survey of 40 students randomly to find out the teaching and learning process, the platforms used by lecturers, and the obstacles experienced during online learning. A survey was also conducted to analyze needs, especially in Distance Learning. In addition, at this step, an analysis of learning content is also carried out following the curriculum, material content, critical thinking indicators, and the form of multimedia developed.

2. Design

Design is a product prototype planning step based on analyzing the problems and needs found. At this step, material preparation, simulation video creation, and preparation of questions/questions are included in the developed learning application.

3. Develop

Develop is a product development stage, namely Physics Multimedia Learning (PsML). Media and material experts then validate the application developed to determine the feasibility of the product. After being declared feasible, the product was applied in learning with a sample of Physics Education students at UIN Walisongo Semarang to test the product's effectiveness in improving critical thinking skills on Static Electricity material. This effectiveness test was conducted by comparing the improvement of critical thinking skills of experimental class students using PsML and control classes using conventional methods during online learning.

4. Disseminate

Suppose it has been tested for feasibility and declared effective for improving critical thinking skills. In that case, the product can be disseminated to the public, lecturers, students, teachers, and all parties who need physics learning applications to improve critical thinking skills in Static Electricity material. The dissemination process can be done through various social networking platforms, such as WhatsApp Group, Instagram, and Youtube.

Data collection methods used include questionnaires, tests, and documentation. The questionnaire is used as a product validation instrument that has been developed. The test method is used in the test questions that will be used for pre-test and post-test, as well as to test the critical thinking skills of prospective physics teacher students. Documentation was conducted to collect research data, including validation and tests of higher-order thinking skills.

Product feasibility analysis is carried out by calculating the average assessment of the two validators and interpreting the calculation results into the eligibility criteria. Analysis of higher-order thinking skills was carried out using the N-gain equation. The results of the N-gain calculation of the experimental class were compared with the control class to determine the effectiveness of PsML in improving the critical thinking skills of prospective physics teacher students.

Result and Discussion

Product Description

The product produced in this study is a Physics Multimedia Learning (PsML) application to improve the critical thinking skills of prospective physics teacher

students. The resulting products are described in Table 1.

Table 1.
Description of Physics Multimedia Learning

Design	Information
Product Specification	Application size 86.28 MB; consists of 15 slides; next and back and home navigation icons are available on each slide; illustrations and covers adapted to the material; available manuals, pdf materials, and PhET simulations that can be accessed directly without having to leave the application; available video, audio, and quiz; and applications run offline.
Material	Static electricity
Content	The introductory section includes: cover, instructions for use, application menu, list of learning materials, manuals, and apperception The content section includes: material submitted in pdf/image/video files, investigated questions, and quizzes. The closing section contains a final project consisting of worksheets, PhET simulation, and an open-ended practicum designed by the students.

Physics Multimedia Learning (PsML) improves students' critical thinking skills, especially in distance learning. PsML can be used offline after the application is installed to be used easily anytime and anywhere as needed. Students can also reopen the material they have learned quickly and easily (Sulisworo et al., 2017). In addition, mobile-based physics learning can improve divergent and higher-order thinking skills (Mardiana & Kuswanto, 2017; Saputra et al., 2019; Yulianci et al., 2021). PsML can also make students learn more independently by following the learning flow contained in the application. This follows the research results of Tuada et al. (2020), which shows that students' learning independence through mobile-based physics learning is in the high and very high categories.

Physics Multimedia Learning is a product of the development of learning applications that can be used by students to study independently and applied in online and offline learning. This learning application product is designed in the form of mobile learning. According to Chiang et al. (2014), learning through mobile learning technology has been identified as one of the strategies that can improve higher order thinking skills. Mobile learning technology is able to improve HOTS (Higher Order Thinking Skills), and one of the skills in HOTS is critical thinking skills (Muilenburg & Berge, 2005; Nurhalimah et al., 2017).

Product Eligibility

The feasibility of the product is seen based on the results of the assessment of the two validators. The feasibility assessment was carried out based on content, design, and critical thinking with a score range of 1 to

4 for each evaluation component. The results of the validator's assessment show that Physics Multimedia Learning (PsML) is suitable for use in physics learning. Aspects of critical thinking skills got the maximum score from both validators. This shows that PsML is an application that attracts learning motivation and focuses on critical thinking skills. PsML contains various stimulants that can improve students' thinking skills in videos, activities, questions to find concepts, quizzes, and independent assignments that make students receive concepts instantly. These various features can improve the quality of student understanding so that using PsML makes learning more efficient (Čubrilo et al., 2014).

Analysis of Critical Thinking Skills for Pre-service Physics Teachers

The analysis of the effectiveness of Physics Multimedia Learning (PsML) is carried out through again test to determine prospective physics teacher students' improvement in critical thinking skills. The analysis results of increasing the critical thinking skills of pre-service physics teachers are presented in Table 2.

Table 2.
Results of Analysis of Critical Thinking Skills Improvement

	Experiment	Control
Pre-test Average	41,295	39,45
Post-test Average	76,30	59,10
<g>	0,60	0,32
Criteria	Moderate	Moderate

Physics Multimedia Learning (PsML) is equipped with audio, video, animation, images, and PhET Simulation. Submission of material in PsML is presented by providing brief information and activities that students must carry out, followed by questions to lead critical thinking in finding concepts. Rosnawati (2012) states that providing a simple explanation requires the ability to identify and analyze questions, then remember and understand the information received to form and formulate a concept, including critical thinking activities.

Developing critical thinking is the primary goal of science education (Muilenburg & Berge, 2005). Critical thinking is needed to prepare students to be able to solve problems and make decisions carefully. Critical thinking skills are essential in logical thinking, decision-making, and problem-solving (Tiruneh et al., 2018; Yanti et al., 2019).

Using PsML in learning physics can improve students' critical thinking skills. Animations and various questions in PsML can attract students' interest to complete learning by following the existing flow in the application (Aththibby & Salim, 2015; Hingkua et al., 2014; Purnama et al., 2017). This makes it easier for lecturers to deliver material and achieve learning objectives. The role of the lecturer is as a facilitator who accompanies students during learning. PsML can be used for online, offline, and blended learning. Students can also study independently and explore various things in the application. This can increase curiosity so students think critically in solving questions and cases. The use of IT in physics learning has previously succeeded in improving critical thinking skills through the simulation of physics education technology assisted by the

Scaffolding approach (Ferty et al., 2019).

The current curriculum requires students to learn more independently, causing learning resources to become essential in the world of education. This is under the opinion of Nopriyanti & Sudira (2015) who states that learning resources are one of the essential elements in the learning process because they contain information and learning messages. Interactive learning resources have great potential to stimulate students to respond positively to the learning materials presented and become learning resources that can improve learning performance (Fauyan, 2019; Purnama et al., 2017).

Physics Multimedia Learning (PsML) is an application that can be used as an online learning tool. PsML is easy to apply, can be accessed offline to overcome the problem of limited quota and signal interference, and does not require too much storage space. This shows that PsML can be used as an alternative learning support application. Based on the results of the interviews, students did not experience any difficulties in operating PsML. According to students, the activities and questions in PsML can also practice critical thinking skills. Students stated that to be able to answer the questions provided in PsML required thinking skills, not only based on rote memorization of the material presented by the lecturer or in books. In addition, PsML can be used as an interactive learning resource that is easily accessible anytime and anywhere. Students can reopen the material contained in PsML as needed.

Physics Multimedia Learning (PsML) is welcomed by students as a learning application in an independent learning process. Students become more interested in the learning process assisted by flexible learning applications or mobile learning compared to conventional learning. This is also reinforced by the NCTM (National Council of Teachers of Mathematics) statement which states that using technology in authentic learning is essential because it affects the material being taught and improves the quality of learning (NCTM, 2000).

Conclusion

Physics Multimedia Learning (PsML) is a physics learning application that contains: covers, instructions for use, a list of materials, guidebooks, apperceptions, learning materials that have videos or pdf files of material, activities that students must do to find concepts, questions that must be answered to hone critical thinking skills. In addition, in PsML there is also a Quiz to test students' skills after studying the sub-materials. Quiz is equipped with a review of the results that students have done. So that it can be seen which parts have not been mastered and the correct answers to the questions given. The final part of PsML contains a final project consisting of student worksheets and PhET simulations to increase students' critical thinking skills. Physics Multimedia Learning (PsML) was declared feasible by the two validators with an outstanding category for learning. The results of the gain test analysis show that the use of Physics Multimedia Learning (PsML) can improve the critical thinking skills of prospective physics teacher students at UIN Walisongo Semarang with a coefficient of 0.60, which is included in the medium category. The use of PsML

improved critical thinking skills higher than the control class, which only showed an increase with a coefficient of 0.32.

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