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THE EFFECTIVENESS OF USING SOUND WAVE MODULES ON CRITICAL THINKING SKILLS AND SCIENCE PROCESS SKILLS OF STUDENTS AT MUHAMMADIYAH AL-GHIFARI BATANGHARI HIGH SCHOOL

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Abstract. This study aims to determine the effectiveness of using sound wave modules in improving critical thinking skills and science process skills in 11th grade students at Muhammadiyah Al-Ghifari Batanghari High School. The study used a quantitative descriptive method with 21 students as respondents. The results of the critical thinking skills test showed an average score of 77.2 with a standard deviation of 8.6, indicating a good category. Meanwhile, science process skills showed excellent mastery in the indicators of observing (100%), measuring (90%), and concluding (85%), as well as fairly good mastery in predicting (75%) and communicating (80%). These results indicate that the use of sound wave modules is effective in developing students' critical thinking and science process skills.

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Introduction

Education is the primary means of shaping a generation that is intelligent, critical, and capable of scientific thinking. Improvements in education in Indonesia continue to be made, such as developing and updating the curriculum used. The Merdeka Curriculum is the latest curriculum that is now being implemented at all levels in all schools in Indonesia. The Merdeka Curriculum is an improvement on the 2013 curriculum. According to Sherly et al (in Hartoyo & Rahmadayanti, 2022: 7176), the Merdeka curriculum means

giving schools, teachers, and students the freedom to innovate, learn independently, and be creative, where this freedom begins with teachers as the driving force. According to Arifah (2021:15), critical thinking is defined as the way a person answers a question systematically and appropriately, thereby enabling students to think deeply about their surroundings. The basis of critical thinking has three aspects, namely statements, problems, and arguments. According to Susilawati (2020:11), critical thinking is a higher-order thinking skill that has the potential to improve students' critical analytical abilities. Therefore, developing students' critical thinking skills in learning is an effort to improve student learning outcomes. In the context of science learning, especially physics, students are not only required to understand theoretical concepts but are also challenged to develop critical thinking skills and scientific process skills. Critical thinking skills are important to help students analyze information, evaluate arguments, and draw rational conclusions. Arifah et al. (2012:15) state that learning activities in physics require students' critical thinking skills because physics learning covers theories related to natural conditions and life.

Nasution (2018:01) states that in order to develop students' critical thinking skills, a learning process is needed that can maximize students' thinking processes in discovering physics concepts. One solution is to improve science process skills. Science process skills include basic abilities in the scientific method, such as observing, measuring, predicting, concluding, and communicating results. According to Rahma (2023:58), science process skills are students' abilities to apply the scientific method in understanding scientific development and discovering science. Science process skills are very important for every student as they equip them to use the scientific method in developing science to acquire new knowledge or various existing knowledge. Teaching modules are a pedagogical competency of teachers that needs to be developed so that teachers' teaching techniques in the classroom are more effective, efficient, and do not deviate from the achievement indicators (Maulida, 2022:131). Teaching modules must be designed correctly and in accordance with the needs of students so that they can be delivered systematically and make learning interesting. Educators are given the freedom to design and develop these modules to achieve the targeted learning objectives.

According to Ginting et al. (2022:91), science process skills are very important for students to master in order to help improve critical thinking skills. However, many students still have difficulty developing these two skills. This is because physics learning in schools is still dominated by lecture methods and a lack of innovative learning media. As a result, students tend to be passive and less actively involved in the learning process. Initial observations at Muhammadiyah Al-Ghifari Batanghari High School show that most students are not yet able to think critically optimally and are not yet skilled in applying the steps of the scientific process. One solution that can be applied to overcome this problem is through the development of activity-based and scientific learning modules. Learning modules provide space for students to learn independently, in a structured and interactive manner. Therefore, this study aims to determine the effectiveness of using sound wave modules on the critical thinking skills and scientific process skills of 11th grade students at Muhammadiyah Al-Ghifari Batanghari High School. Sound waves are the chosen

material used in the module. In the research by Sepudin & Rusnayati (2019:200), the results of their study show that the obstacles experienced by students are not being able to prove the organ pipe formula (100%), using the Doppler effect concept to solve physics problems (95%), determining sound intensity values (95%), and explaining the relationship between organ pipe length and sound waves (90%). Thus, it can be concluded that, in general, students still experience obstacles in learning sound wave material. The material on vibrations, waves, and sound is one of the abstract materials that students find difficult because it contains calculation formulas that are difficult to understand (Fauziyah, et al., 2019).

Methode

Descriptive research is very important, especially in the early stages of development. This is particularly prominent in the social sciences, where descriptive research presents a detailed picture of a specific situation (Zellatifany & Mudjiyanto 2018:84). This study uses a quantitative descriptive approach, which aims to describe the effectiveness of using sound wave modules in improving students' critical thinking and science process skills. The quantitative descriptive approach was chosen for this study because it is highly relevant and important in objectively describing the effectiveness of using sound wave modules on students' critical thinking and science process skills. Sulistyawati, et al. (2022:69) in their research stated that quantitative descriptive research is research that describes, examines, and explains a phenomenon with data (numbers) as they are without intending to test a specific hypothesis. With this method, researchers will discover what makes two or more variables similar and what is new about the measurement of these variables. Quantitative descriptive research is a type of research that aims to describe or characterize a phenomenon or the characteristics of a particular population or sample quantitatively (Warawu, et al. 2025: 924).

The research subjects were 21 students in grade XI at Muhammadiyah Al-Ghifari Batanghari High School. The instruments used in this study included two types, namely critical thinking skills tests and science process skills observation sheets. Critical thinking skills were assessed based on the completion of summative assessment questions contained in the module. The summative assessment consisted of 10 essay questions. Meanwhile, the science process skills observation sheet covered the aspects of observing, measuring, predicting, concluding, and communicating. These instruments underwent validity and reliability testing before being used in data collection.

The research procedure began with the development of modules, validation by experts, and limited trials. Next, the module is used in learning activities over several sessions. After implementation, students are given critical thinking tests and observed using science process skill sheets. The data obtained is analyzed descriptively and quantitatively by calculating the average score, achievement percentage, and learning outcome categories. The results of the analysis are then used to assess the extent to which the module is effective in improving both aspects of student ability.

Table 1. Aspects and Indicators in Process Skills Instruments

Number	Aspect	Indicator
1.	Observe	Students are able to identify physical phenomena through direct observation of sound phenomena.
2.	Classify	Students are able to group data or phenomena based on specific criteria.
3.	Measure	Students ar e able to use measuring instruments (stopwatches, measuring tapes, frequency applications) appropriately and accurately.
4.	Predict	Students are able to estimate experimental results based on scientific concepts.
5.	Communicate	Students are able to convey observation results and data analysis in writing and orally.
6.	Conclude	Students are able to draw conclusions based on observation results and data analysis.

Result and Discussion

This study aims to determine the effectiveness of sound wave modules in improving students' critical thinking and science process skills. The assessment was conducted on 21 students in grade XI at Muhammadiyah Al-Ghifari Batanghari High School using two main instruments, namely a critical thinking test and a science process skills observation sheet. Based on the data analysis, the average score for students' critical thinking skills was 77.2 with a standard deviation of 8.6. This result falls into the good category, indicating that students are able to meet critical thinking indicators, such as: giving reasons, evaluating arguments, identifying problems, and drawing conclusions from the information presented. These results show that the developed module not only helps students understand the concept of sound waves theoretically, but also encourages them to think more deeply and actively question information.

Table 2. Summary of Critical Thinking Test Instrument Trials

Test Results	Scores
Highest Scores	92
Lowest Scores	60
Average	77,2
Mode	75 dan 85
Median	77
Standard Deviation	8,6

The activity- and exploration-based learning model in the module allows students to build understanding through the process of analysis and evaluation, which is at the core of critical thinking skills. Measurement of science process skills is carried out through

observation of five main indicators: observing, measuring, predicting, concluding, and communicating. The percentage of achievement for each indicator is as follows:

Tabel 3. Recapitulation of Science Process Skills Test Results

Science Process Skills Indicators	Mastery Percentage	Brief Description
Observing	100%	Participants actively observe and record phenomena.
Classifying	85%	Classification based on variables needs reinforcement.
Measuring	90%	Already quite accurate, some need initial practice.
Predicting	75%	Predictions still need to be linked to concepts.
Communicating	80%	Needs practice in presentations and scientific reports.
Concluding	85%	Already quite good, needs practice in constructing sentences.

From this data, it can be seen that students were very active in conducting observations and measurements during learning activities. This shows that the experimental activities in the module greatly supported students in understanding physics concepts directly. Meanwhile, prediction and communication skills are in the fair to good category. This evaluation shows that more emphasis needs to be placed on reflecting on the results of experiments and presenting learning outcomes so that students are more confident in communicating results and dare to make predictions based on data. This is in line with the research by Triandini, et al. (2021:95), which states that the development of physics modules is very feasible to be used in learning to improve critical and effective thinking skills to support learning activities. According to Rikizaputra, et al. (2021:43), learning modules have an effect on student learning outcomes, science process skills, and critical thinking skills.

The effectiveness of using sound wave modules in this study can be attributed to several factors. First, the interactive and activity-based design of the modules allows students to be more involved in the learning process. Second, the integration of theory and practice makes it easier for students to relate abstract concepts to concrete experiences in the field. In addition, module-based learning gives students the flexibility to learn at their own pace and in their own style. Overall, the results of this study reinforce the argument that learning modules are not only learning aids, but also strategic media for instilling critical thinking skills and scientific processes, especially in physics learning, which requires analytical and experimental skills.

Conclusion

Based on the results of the study, it can be concluded that the use of sound wave modules has been proven effective in improving the critical thinking skills and science process skills of 11th grade students at Muhammadiyah Al-Ghifari Batanghari High School. The average results for students' critical thinking skills reached the good category, while science process skills showed high mastery in most indicators. The developed module was able to encourage active student involvement, improve conceptual understanding, and support activity-based and scientific learning approaches. Thus, this module is suitable for use as an alternative physics learning medium in schools.

Recommendations

Based on the results of the study, the author provides the following recommendations:

1. For Teachers
   Physics teachers are advised to use activity-based sound wave modules as an alternative learning medium to improve students' critical thinking and scientific process skills.
2. For Students
   Students are expected to be more active in using learning modules independently to practice logical and analytical thinking skills and scientific process skills.
3. For Schools
   Schools can support the use of interactive learning modules by providing supporting facilities and training for teachers so that learning is more innovative and science-based.
4. For Future Researchers
   This research can be used as a reference for developing modules on other physics materials and conducting effectiveness tests with different methods or populations to expand the scope of the research results.

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May the results of this research be beneficial for the development of education, particularly in physics learning at the secondary school level.

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