KnE Social Sciences
ICMScE
International Conference On Mathematics And Science Education
Volume 2024

Research Article

Analysis of Critical Thinking Skills Improvement Through App Inventor-based Learning Media on Sound Wave Topic

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Abstract.
This study aims to analyze the improvement of critical thinking skills using learning media development based on App Inventor on sound wave topics. The research was quasi-experimental with a non-equivalent control group design. The research population were students of class XI MIPA in one of the senior high schools in West Java Province. The sampling technique used was random sampling. Class XI MIPA 5 as the experimental class, used App Inventor-based media, and class XI MIPA 2 as the control class used Google Classroom media. The number of students in both categories were 35 each. The research instrument used a critical thinking skill test. The analysis technique uses n-gain and t-independent sample tests. The results showed an increase in students' critical thinking skills in the experimental class by 0.67 in the moderate category and the control class by 0.46 in the medium type. The results of the t-independent sample test shows the value of t_{count} ?? $> t_{table}$??. Thus, there is a difference in improving students' critical thinking skills between learning using App Inventor-based media and using Google Classroom media on sound wave topics.

Keywords: critical thinking skills, app inventor-based learning, sound wave.

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Published: 3 April 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICMScE Conference Committee.

1. INTRODUCTION

The government issued a circular letter from the Minister of Education and Culture No. 4 of 2020 regarding the implementation of education policies in emergency mass distribution [1]. The government creates an online learning from home program [2]. Online learning follows technological developments in the use of media [3, 4]. Learning media can be via Zoom, Google Meet, WhatsApp, and Youtube [5, 6] using the internet connection and smartphone [7].

Based on a preliminary study through interviews with the vice-principal of the curriculum section, teachers, students and tests of critical thinking skills to students. The results of interviews with the vice-principal of the curriculum for preparing lesson

plans and learning activities must practice critical thinking skills and application in everyday life. The results of interviews with physics teachers in online learning are difficult for practical activities to train critical thinking skills. The teacher only provides practice questions. The results of interviews with students have difficulty answering questions about critical thinking skills because it is difficult to understand the material independently. The test results of critical thinking skills on learning media A using e-books through Google Classroom, which teachers usually do, get an average score of 23.15%. Learning media B uses e-books, animated learning videos, simulations, and virtual practicums through Google Classroom, with an average of 54.5%. The preliminary study results require an increase in critical thinking skills using the development of learning media, especially in the sound wave material.

Based on Rahayu's research literature study, 40% of students have difficulty understanding sound wave material [8]. The sound wave material in Puspitasari's research, through conventional learning, got a post-test score of 29.92 and a pretest value of 39.73. The sound wave material with scientific learning got a post-test value of 43.71 and a pretest of 52.92 [9]. Difficulties in understanding sound wave material can use an App Inventor-based learning application. App Inventor-based learning media has been widely used by previous research on temperature and heat materials [10], acceleration [11], Newton's Law and parabolic motion [12], elasticity [7], optic [13] and fundamental physics experimental [14].

This study aimed to determine the difference between increasing critical thinking skills between learning using App Inventor and using Google Classroom media. The difference between the researchers and previous research is a novelty in media development. Development of learning media made of games, discussions, groups, and contact with teachers can be used for sound wave material.

The benefits of research on sound wave material to improve critical thinking skills according to the indicators developed by Facione using the development of learning media based on App Inventor can be used as material for further research studies. Useful for teachers, it can be used to develop learning media in the teaching and learning process in the classroom remotely or face to face. So that teachers in the learning process can increase creativity, and professionalism, make learning fun, increase motivation, and be active and easily understood by students. Benefits for students can improve critical thinking skills using learning media based on App Inventor, motivated to learn independently in physics subjects quickly. Benefits for academics can improve critical thinking skills in physics lessons, especially sound wave material, by applying problems in everyday life. Learning activities are trained according to indicators

of critical thinking skills developed by Facione. Learning can be done anywhere and anytime through App Inventor-based learning media to improve critical thinking skills. Learning to train critical thinking skills, teacher can apply phenomena information in everyday life using physics concepts, giving students new experiences [15]. This can overcome the problem of having difficulty understanding the physics lesson of sound wave material [10, 16, 17].

Improvement of critical thinking skills in education needs to be improved to allow students to develop knowledge skills, evaluate problems and decide on information with critical thinking skills [18]. Critical thinking skills are the ability to solve complex problems in the application of everyday life, for example, when making decisions about a problem using physics concepts [19–22]. Critical thinking skills are the ability to analyze, evaluate and provide conclusions in deciding something to have an opinion. The improvement of critical thinking skills in learning is measured according to the indicators developed by Facione, namely (1) interpretation, namely giving opinions, (2) analysis, namely investigating something; and (3) evaluating the process of identifying the results of an activity, (4) conclusion, namely giving conclusions to problem solvers. , (5) explanation, namely the relationship between science and the phenomenon of giving reasons and (6) self-regulation, namely self-regulation in following the ability to think with knowledge [23]. Train critical thinking skills using App Inventor-based media development [10, 24]. App inventor provides research projects in the field of education to meet the needs of students [25].

App Inventor-based media is a visual programming interface with various components that can be edited by drag and drop using a block-based programming language [26]. The development of learning media based on App Inventor is made of games, discussions, groups and contacting teachers in online learning on sound wave material. Virtual learning can use animated learning videos, quizzes, games, and virtual practicums to practice critical thinking skills. Learning media facilities based on App Inventor include electronic books, animated learning videos, virtual practicums, quizzes, games, discussion rooms, groups, contact teachers, calendars and teacher profiles. The development of learning media in the form of games, discussions, groups, and contact with teachers can be used for sound wave material animated video facilities, quizzes and games trains students for critical thinking skills using learning media [7, 16, 27].

The concept of physics, especially the material of sound waves. Sound waves have longitudinal and mechanical waves that can propagate through solids, liquids, and gases—forming the properties of sound waves in the form of refraction, reflection,

diffraction, and interference—the nature of sound waves on the Doppler effect, superposition and resonance phenomenon. Sound waves are helpful in everyday life, such as communication and calculating ocean depth using sonar [28].

2. RESEARCH METHOD

The research method used was quasi-experimental with a non-equivalent control group design study because the experimental class and the control class were not chosen randomly, and the use of learning media was carried out in two classes [29]. The research location is at the senior high schools in West Java Province. The study population was all students of class XI MIPA with a sample of two homogeneous classes, namely class XI MIPA 5 as an experimental class consisting of 25 women and ten men and class XI MIPA 2 as a control class consisting of 24 women and 11 men, so the total 35 people in each class and the average age is 17 years. The research instrument for the critical thinking skills test refers to the indicators developed by Facione, consisting of 6 indicators and 15 sub-indicators [23]. The Facione indicator is in Table 1.

TABLE 1: Critical thinking skill indicator.

Indicator		**Sub-Indicator**
Interpretation	1.	The Facione indicator is in the table below:
	2.	Write down the meaning of the problem clearly and precisely
	3.	Describe the problems that occur clearly
Analysis	4.	Identify physics concepts through reference sources carefully
	5.	Explain the relationship between the concepts of physics used in solving critical problems
	6.	Make a mathematical equation from the given problem correctly
	7.	Write down what must be done in solving problems carefully.
Evaluation	8.	Explain the solution to the problem in the problem correctly
	9.	Using the strategy of doing calculations/explanations in solving problems completely
Inference	10.	Draw conclusions from the questions asked logically
	11.	Suggest other alternatives to solve the problem critically
Explanation	12.	Write the final result in solving the problem on the problem correctly
	13.	Give reasons for logical conclusions
Self-regulation	14	Evaluate the advantages and disadvantages in deciding the problem given appropriately
	15.	Repeating the answer given correctly

Table 1 shows the indicators of critical thinking skills according to Facione [19, 23, 30–32]. The critical thinking skills test was made into a description of 15 pretest and post-test questions according to the sub-indicators. Technical analysis using n-gain for all experimental and control classes, each indicator of critical thinking skills and each sub-material of sound waves. N-gain to analyze the increase in critical thinking skills [30] using the following equation:

$$< g >= \%\frac{\langle G \rangle}{\%\langle G \rangle} = \left(\frac{\%\left\langle S_f \right\rangle - \%\langle S_i \rangle}{(100 - \%\langle S_i \rangle)} \right) \quad (1)$$

where $< g >$ is the gain number $\langle G \rangle$ is posttest score minuse pretest score and $\%\langle G \rangle$ is maximum score minus the pretest score. Hypothesis testing uses the t-independent sample test to determine whether there is a significant increase in students' critical thinking skills [29] after using learning media based on App Inventor and Google Classroom.

This section should contain the subject, method (including data collection and data analysis techniques), the instruments, and the location of the research. In this section, you are asked to describe your research procedure clearly and make sure your research method is in line with your research problem dan the purpose of the research.

3. RESULTS AND DISCUSSION

The improvement of students' critical thinking skills based on the pretest and post-test questions was given to 2 classes, namely the experimental class using learning media development based on App Inventor and the control class using Google Classroom.

3.1. Classes Analysis

TABLE 2: N-gain data of experimental and control class.

Class	Average Score			Interpretation
	Pretest	Posttest	< g >	
Experiment	41.2	80.3	0.67	Moderate
Control	40.8	66.1	0.46	Moderate

Table 2 shows the average value of pretest, post-test, and n-gain in the experimental and control classes in the medium categories. The n-gain factor is in the medium category because both classes use discovery learning; students are trained to find physics concepts with critical thinking skills. Mastery of physics concepts in learning

can be trained with student activities to encourage critical thinking [30]. The results of the pretest and post-test scores of the experimental and control classes have a 14.2% difference. The difference factor in the experimental class is superior because the learning media development facility can control students online to practice critical thinking skills. Online learning with applications can provide discussion opportunities to solve problems with critical thinking [24]. Improving critical thinking skills through practical activites [20, 31].

3.2. Indicator Analysis

The results of the n-gain for each indicator of critical thinking skills according to Facione in the experimental and control classes are in Figure 1.

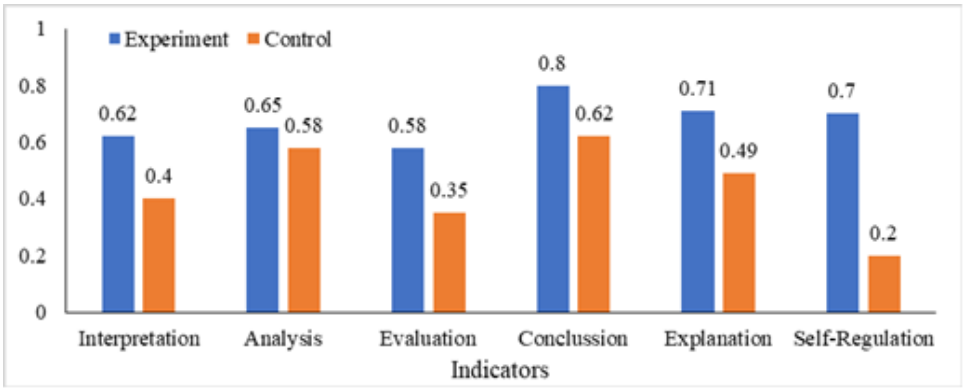

Figure 1: N-gain each indicator of experiment class and control class.

Figure 1. Shows the n-gain for each indicator of critical thinking skills, according to Facione. The experimental class has the highest n-gain of 0.8 in the conclusion indicator because the App Inventor-based development media provides a discussion room facility and asks the teacher. A physics teacher can easily supervise online learning. Solving problems in everyday life [26] through making decisions [24] and conclusions [32] can be quickly done using media development [33]. The experimental class has the lowest n-gain of 0.58 on the evaluation indicator because students have difficulty evaluating statements using physics concepts in solving problems. Evaluation skills are required to distinguish relevant and irrelevant information and solve problems with the right formula [34]. Application in everyday life through the development of questions [35] using physics concepts in learning can improve critical thinking skills [23].

The control class has the highest n-gain at the conclusion indicator of 0.62 because physics learning trains solving problems and finding physics concepts to solve problems.

Evaluating can be trained by solving problems by calculating the concept of sound waves [19, 34]. The control class has the lowest n-gain of 0.2 on the self-regulation indicator because the Google Classroom media is challenging to monitor learning activities in managing students. Lack of Google Classroom, students have difficulty doing their assignments, and teachers have difficulty monitoring students' work in doing assignments [36–38]. Overcoming so that it is not low on self-regulation, assigning tasks to get additional point [34].

3.3. Sub Topic Analysis

The sub-material of sound waves is divided into four: sound wave propagation, Doppler effect, interference and sound intensity level, which has an n-gain value in Table 3.

TABLE 3: N-gain data for each sub-material.

Sub-Topic	Average Score							
	Experiment Class				Control Class			
	Pretest	Posttest	< g >	Category	Pretest	Posttest	< g >	Category
Sound wave propagation	1.9	3.5	0.72	High	1.7	3.0	0.54	Moderate
Doppler effect	1.3	3.0	0.60	Moderate	1.5	2.7	0.47	Moderate
Interferency	1.6	3.0	0.57	Moderate	1.6	2.9	0.39	Moderate
Level of Intensity	1.6	3.2	0.66	Moderate	1.9	2.6	0.25	Low
Average	1.6	3.1	0.62	Moderate	1.7	2.8	0.40	Moderate

Table 3 shows an increase in critical thinking skills in the sound wave sub material. The sound wave propagation material has the highest n-gain of 0.72 in the experimental class and 0.54 in the control class because both classes use virtual practicum learning activities. Practical activities can improve critical thinking skills [19] and increase motivation [39] from experiential learning through technological developments [40] and virtual learning [41]. Sound wave material to make it easier to understand the concept with the help of multimedia combining text, audio, graphics, images, into an animated learning video [42] to provide a learning experience [43]. The interference material has the lowest n-gain of 0.57 in the experimental class because learning activities evaluating practicum videos do not do a practicum. This makes the n-gain low. Students have difficulty analyzing videos to identify problems [34] and finish with physics concepts [40]. The intensity level material has the lowest n-gain of 0.25 in the control class because learning activities are carried out through practicum video analysis. Students do assignments carelessly, and teachers find it difficult to supervise students using Google Classroom [38].

Test the hypotheses for the hypothesis accepted or rejected using the independent sample t test equation. Independent test to see the difference in the mean of two unpaired samples. Based on the results of hypothesis testing using the t-independent sample test, it shows $t_{count} > t_{table}$ of $4.884 > 1.995$ where H_a is accepted and H_o Is rejected. The calculations using SPSS obtain a Sig (2-tailed) value of $0.000 < 0.05$, so H_a is accepted, and H_o is rejected. So it can be concluded that there are differences in improving students' critical thinking skills between learning using App Inventor-based media and using Google Classroom media on sound wave material. Increasing critical thinking skills is due to the development of learning media based on App Inventor, which provides supporting facilities for independent learning and makes it easier to understand physics material. The development of learning media based on App Inventor is very supportive for education in research in meeting the needs of students to understand physics material [26, 44]. The results of the preliminary study require increasing critical thinking skills. The solution can use learning media development based on App Inventor to improve critical thinking skills [19, 34, 45–47]. App Inventor-based learning media facilities to practice critical thinking skills in e-book menus, virtual practicums, games, discussions and groups. The e-book menu and animated learning video menu are given the application to problems in everyday life [44] which virtual practicum activities can solve to find physics concepts. After finding the physics concept, data processing, analysis, evaluation and concluding are carried out in the discussion menu. Thus, you can make a decision [24, 32], provide explanations and set strategies by training students' critical thinking skills [23].

4. CONCLUSION

Based on the results of data processing and analysis of research that has been carried out at the senior high schools in West Java Province regarding improving critical thinking skills, the effect of developing learning media based on App Inventor on sound wave material. The results of the n-gain data processing showed that students' critical thinking skills were increased after using App Inventor-based media development, getting 0.67 with moderate interpretation, while Google Classroom learning media obtained 0.46 with moderate interpretation. Based on the hypothesis test using the t-independent test, the value of the hypothesis test results with the value of $t_{count} > t_{table}\ is\ 4.884 > 1.995$. H_a is accepted, and H_o is rejected. Thus, it can be concluded that there are differences in the improvement of students' critical thinking skills between learning using App Inventor-based media and using Google Classroom media on sound wave material.

Acknowledgments

The author would like to thank the students who have participated in this research. Special thanks are also conveyed to the principal of the senior high schools in West Java Province who has assisted and granted permission to conduct research.

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