



# The Effectiveness of Android Based Interactive Learning Media in Improving Students Computational Thinking on Heat Material

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**Abstract:** Learning using Android-based interactive learning media can actively engage students in the learning process. This study aims to improve students' computational thinking on heat material at SMAN 3 Kotabumi. The research method used in this study is experimentation. Experimental research is used to find the effect of a particular treatment on another under controlled conditions. The design used in this study was a pretest-posttest control group design. Data collection in this study was conducted during the use of Android-based interactive learning media to improve students' computational thinking on heat material in the learning process. The research subjects were 72 high school students, 36 in the experimental class and 36 in the control class. The results showed that this interactive learning media was quite effective in improving computational thinking skills, as seen from the significant difference between the average posttest scores in the experimental class and the control class based on the results of the Independent Samples Test, Sig. (2-tailed) = 0.00, with a significance level below 0.05. Based on the pretest and posttest data, the average N-Gain score was 0.61, categorized as moderate. Based on the research results and data analysis, the developed product can be used in mathematics learning.

**Keywords:** Android; Computational thinking; Heat; Interactive; Learning media

## Introduction

Physics is one of the natural sciences that most students often find difficult to learn. The complexity of the concepts, the many abstract mathematical formulas, and their connection to natural phenomena that are sometimes difficult to imagine are the reasons why this subject is difficult to understand. Although the natural phenomena studied in physics are found in the surrounding environment, students still find it difficult to apply physics in their daily lives. Students find it difficult to relate the formulas they learn in class to real-life events or to solve application problems. The main objective of physics education is to help students achieve the main goal, which is to master the concepts (Marsuki et al., 2020). Therefore, it is important to explore the understanding of physics concepts in their application to everyday life. To that end, teachers must use appropriate

learning media to help students better understand physics learning as a whole. The use of technology-based interactive learning media is one potential solution to overcome this challenge (Permana et al., 2024). Based on the analysis of student learning outcomes conducted during preliminary research on computational thinking indicators in 2023, 2024, and 2025 on the topics of heat and sound waves, the results are as follows:

**Table 1.** Results of Computational Thinking Analysis of Students on Heat Material

CT indicators	Heat material		
	2023	2024	2025
Decomposition	41.18 %	32.35 %	38.89 %
Pattern recognition	27.94 %	23.53 %	33.33 %
Abstraction	50.00 %	44.12 %	47.22 %
Algorithm	16.17 %	14.71 %	16.67 %

## How to Cite:

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**Table 2.** Results of Computational Thinking Analysis of Students on Sound Wave Material

CT indicators	Sound wave material		
	2023	2024	2025
Decomposition	79.41 %	80.88 %	82.64 %
Pattern recognition	74.51 %	72.79 %	77.08 %
Abstraction	71.57 %	75.00 %	72.92 %
Algorithm	60.78 %	69.85 %	69.44 %

Based on the analysis of the table above, the computational thinking skills of students in 2023, 2024, and 2025 are lower in heat material than in sound wave material. This is because most students only study the material and memorize formulas. Their learning only seeks to impart knowledge without any process of discovery, thus failing to develop problem-solving skills and optimize the use of ICT, such as Android, as an interactive learning medium. This is in line with the results of interviews with teachers and students regarding the use of learning media in the learning process at SMAN 3 Kotabumi. The problems that arise for students are also influenced by the limitations of the learning media used, which can affect students' computational thinking. Learning media that utilize technology not only help students understand the material more easily, but also encourage their active involvement in the learning process (Melati et al., 2023). Based on the results of research by Ridwan et al. (2021), students are interested in using interactive media during the learning process. Another study by Melati et al. (2023) also shows that interactive media can increase student engagement in the learning process, making them more active in exploring difficult concepts. Digital learning media is an important alternative in overcoming facility limitations in schools (Awila et al., 2025).

The existence of Android applications in the context of learning also provides opportunities to create a more personalized and engaging learning experience for students. The use of mobile applications in education is expected to increase student engagement, facilitate access to materials, and help manage learning time more efficiently. Through the use of this technology, students can access learning without being constrained by space and time, which is a very important added value for today's education (Bernacki et al., 2020). According to St Mulyono et al. (2025), the use of interactive learning media has been proven to be effective in improving conceptual understanding, attracting interest in learning, and overcoming the abstraction of material.

Computational thinking is an approach in the learning process that is used to support problem solving in all disciplines (Yuntawati et al., 2021). Computational thinking is the ability to think in order to solve problems comprehensively, logically, and structurally (Wing,

2006). According to Liem (2017), the four foundations of computational thinking are decomposition, pattern recognition, pattern generalization or abstraction, and algorithms. Decomposition is the ability to break down complex tasks (problems) into smaller, more detailed tasks. Pattern recognition is the ability to recognize commonalities or differences that will later help in making predictions. Pattern generalization or abstraction is the ability to filter out unnecessary information and draw generalizations from the necessary information so that one can use that information to solve similar problems. Finally, algorithm design is the ability to organize the steps to solve a problem in a structured, logical, and critical manner.

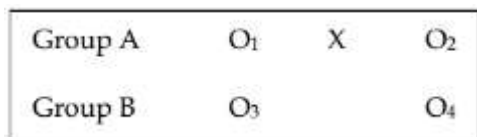
Thus, computational thinking influences a person's thinking ability, one of which is to improve problem-solving skills (Dewi et al., 2021). Maulina et al. (2019) in their research results showed that teaching basic concepts of computational thinking, such as problem decomposition, pattern recognition, abstraction, and algorithms, can improve problem-solving skills. Fatma et al. (2019) found in their research that the use of Android-based interactive media can improve students' computational thinking skills. The integration of computational thinking in physics learning has been proven to be feasible and effective based on Rasch analysis. This approach not only improves understanding of physics concepts but also develops essential 21st-century skills (Yusup et al., 2025). This study shows that Android applications can help students understand complex concepts through a more visual and interactive approach, which in turn improves their understanding and problem-solving skills.

Many students consider heat material in physics lessons Many students consider heat material in physics lessons to be a difficult topic. Android-based interactive media allows students to interact directly with the material, visualize abstract ideas, and engage in in-depth technological problem-solving activities. Sari et al. (2019) in their research showed that Android-based applications can improve students' understanding of abstract physics concepts, one of which is heat material. Based on the above description, the author attempted to apply Android-based interactive learning media to determine its effectiveness in improving students' computational thinking on heat material at SMAN 3 Kotabumi.

**Method**

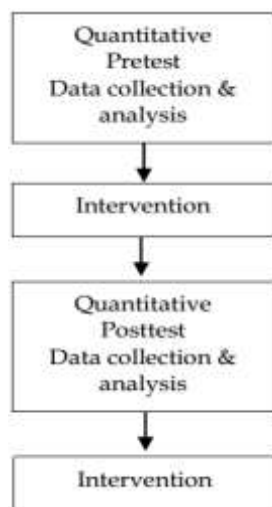
The method used in this study is the experimental method, in which treatment is applied to the independent variable and the results are observed in the dependent variable. According to Sugiyono (2018),

experimental research is a research method used to find the effect of a particular treatment on another under controlled conditions. The design used in this study is a pretest-posttest control group design (Creswell, 2017).



**Figure 1.** Pretest-posttest control group design. Group A: experiment group; Group B: Control group; O<sub>1</sub> = O<sub>3</sub>: Pretest; O<sub>2</sub> = O<sub>4</sub>: Posttest; X: treatment in the experiment group (learning using android-based interactive learning media)

The target or subject of this study, the population in this study, was 12 eleventh-grade classes consisting of 408 students. The sample was determined by taking two classes using purposive sampling, namely selecting classes with the same/equivalent academic profiles. The research sample consisted of 36 students from class XI 1 as the control class and 36 students from class XI 2 as the experimental class. The experimental class used the developed model, namely Android-based interactive learning media, while the control class used learning media in the form of PowerPoint (PPT). In the process of implementing the model in the classroom, the researcher used the problem-based learning model because this model is suitable for implementing Android-based interactive learning media to improve students' computational thinking. The testing method through experimentation was carried out by comparing the learning outcomes of the group using the model (experimental class) and the group not using the model (control class). If the learning outcomes of the group using the model were better than those of the group not using the model, then the model could be declared effective. The research chart can be seen in the following figure:



**Figure 2.** Research chart

The test instrument used in this study was a test to measure students' computational thinking skills. The test consisted of essay questions that were given to students during the field test evaluation stage. The aim was to assess the effectiveness of the learning media and the success of achieving learning objectives. This instrument was applied to the experimental class and the control class with the same test questions for both groups.

The pretest and posttest data were tested for effectiveness using normalized gain scores (N-Gain). The test instrument used in this study was an essay test using questions about heat. This instrument was used to obtain data on the effectiveness of Android-based learning applications. The pretest was given at the beginning of the learning process before the learning treatment using Android-based interactive learning media. The posttest was given after the treatment or learning process using the learning application. This test was conducted using a written test sheet. The results of the pretest and posttest were then tested using normalized gain (N-Gain) to determine the effectiveness of the Android-based learning application. Normalized gain, abbreviated as N-Gain, is the ratio of the actual gain score to the maximum gain score (Hake, 1999).

The calculation of the normalized gain score (N-Gain) can be expressed in the following formula:

$$N - Gain = \frac{Posttest\ Score - pretest\ Score}{Ideal\ Score - Pretest\ Score} \tag{1}$$

**Table 3.** N-Gain Score Categories N-gain

Score N-Gain	Category
$g > 0.7$	High
$0.3 \leq g \leq 0.7$	Moderate
$g < 0.3$	Low

**Table 4.** N-Gain Score Effectiveness Interpretation Categories

Percentage (%)	Category
$< 40$	Ineffective
$40 - 55$	Less effective
$56 - 75$	Moderately effective
$> 76$	Effective

In hypothesis testing, researchers use the t-test formula to determine whether there is a difference between the pretest score (before using Android-based Interactive Learning Media on Students' Computational Thinking Skills) and the posttest score (Android-based Interactive Learning Media on Students' Computational Thinking Skills). The t-test is conducted to test the research hypothesis regarding the partial influence of each independent variable on the dependent variable. The t-test is a statistical test used to test the truth or falsehood of a hypothesis stating that there is no

significant difference between two sample means taken randomly from the same population (Sudjiono, 2010). T-statistics is a value used to see the level of significance in hypothesis testing by finding the T-statistics value through the bootstrapping procedure. Decisions are made by looking at the significance value in the Coefficients table. Usually, regression results are tested with a confidence level of 95% or a significance level of 5% ( $\alpha = 0.05$ ). The criteria for the t-statistic test are as follows (Ghozali, 2016).

If the significance value of the t-test  $> 0.05$ , then  $H_0$  is accepted and  $H_1$  is rejected. This means that there is no effect between the independent variable and the dependent variable; If the significance value of the t-test  $< 0.05$ , then  $H_0$  is rejected and  $H_1$  is accepted. This means that there is an effect between.

### Result and Discussion

The results of the study were conducted at SMAN 3 Kotabumi, North Lampung. It involved 72 eleventh-grade students consisting of 36 students in the experimental class and 36 students in the control class. The product implementation was carried out in five meetings. In the process of implementing the product in the classroom, the researcher used the problem-based learning model because this model is suitable for implementing Android-based interactive learning media to improve students' computational thinking. According to this interpretation, the problem-based learning stages can challenge students to define a problem, break the problem down into smaller parts to find solutions, and design algorithms to obtain usable solutions so that students can explore their computational thinking abilities. Thus, the problem-based learning model significantly improves students' computational thinking abilities (Manullang et al., 2023). In line with the results of the study by Rahmadita et al. (2021), the PBL syntax provides an interactive and visual learning environment, thereby helping students investigate problems, analyze data, and ultimately improve their critical thinking skills in dynamic electricity material.

The pretest and posttest questions consist of five different essay questions with the same level of difficulty to measure computational thinking skills with computational thinking indicators, namely: Decomposition, Pattern recognition, Abstraction, and Algorithms. Each question consists of four computational thinking indicators, namely Decomposition, Pattern recognition, Abstraction, and Algorithms. Based on the pretest and posttest results, the following is the N Gain data for each computational thinking indicator in the experimental class and control

class, calculated based on the pretest and posttest data results.

**Table 5.** N-Gain Indicators of Computational Thinking in the Experimental Class

Indicator	Pretest	Posttest	N Gain score	Category
Decomposition	66	91	0.78	High
Pattern recognition	68	88	0.33	Medium
Abstraction	39	82	0.72	High
Algorithms	40	71	0.31	Medium

**Table 6.** N-Gain Indicators of Computational Thinking in the Control Class

Indicator	Pretest	Posttest	N Gain score	Category
Decomposition	60	70	0,21	Low
Pattern recognition	53	64	0,15	Low
Abstraction	29	41	0,16	Low
Algorithms	27	31	0,04	Low

Based on the table above, in the experimental class, the Computational Thinking decomposition indicator achieved an N-Gain of 0.78, which is in the high category. The Pattern recognition indicator achieved an N-Gain of 0.33, which is in the medium category. The Abstraction indicator achieved an N-Gain percentage of 0.72, which is in the high category. The Algorithms indicator achieved an N-Gain percentage of 0.31, which is in the medium category. Meanwhile, in the control class, the Computational Thinking decomposition indicator achieved an N-Gain of 0.21, which is in the low category. The Pattern recognition indicator achieved an N-Gain of 0.15, which is in the low category. The Abstraction indicator had an N-Gain percentage of 0.16, which is in the low category. The Algorithms indicator had an N-Gain percentage of 0.04, which is in the low category. Of the four computational thinking indicators, the decomposition and abstraction indicators obtained high scores, while the pattern recognition and algorithms indicators obtained moderate scores in the experimental class.

**Table 7.** N-Gain Test

Class group	Pretest average	Posttest average	N Gain	Category
Experimental	54	83	0.61	Moderate
Control	42	52	0.15	Low

Based on the data above, the average percentage of N-Gain scores in the experimental class was 0.61, which is in the moderate category. The average percentage of N-Gain scores in the control class was 0.15, which is in the low category. The average N-Gain score for the experimental class was higher than that of the control class, indicating that the computational thinking skills of the experimental class after using the problem-based

learning model and interactive learning media were greater than those of the control class, which used conventional learning (lectures) and PPT media. Maximum effectiveness is achieved when learning media is integrated with problem-based learning (Mahmud et al., 2025). Problem-based learning provides

a scientific framework (problem identification, analysis, solution) for understanding the complexity of learning material (Perayanti et al., 2025). From these results, it can be concluded that problem-based learning using interactive learning media is quite effective in improving students' computational thinking.

**Table 8.** T-test

		Independent samples Test									
		Levene's test for equality of variances				t-test for equality of means					
		F	Sig.	T	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence interval of the difference		
										lower	upper
Value	Equal variances assumed	1.42	0.238	10.37	70	0.00	31.53	3.041	25.46	37.59	

Based on the results of the Independent Samples Test, the Sig. value (2-tailed) = 0.00, the significance value is below 0.05 ( $p < 0.05$ ). This indicates that there is a significant difference between the average learning outcomes of students in the two groups, namely the experimental class using Android-based interactive learning media and the control class using conventional learning (lectures) using PowerPoint (PPT) learning media. The significance value of the t-test is  $< 0.05$ , so  $H_0$  is rejected and  $H_1$  is accepted. This means that there is an effect between the independent variable and the dependent variable.

The results of the analysis conducted in this study indicate that SMAN 3 Kotabumi needs to implement interactive Android-based learning media on heat material, supported by the availability of facilities and infrastructure to improve computational thinking. To achieve good learning outcomes, it is necessary to have facilities that can help encourage students to achieve maximum performance. The use of technology in learning can increase student engagement and provide a more interesting learning experience. The use of Android applications as learning media can enrich the learning process, especially to increase motivation and learning outcomes (Damayanti et al., 2022). Because there are virtual laboratory simulations in Android applications, they can support the students' understanding of the material. Because learning aided by virtual simulations provides space for students to experiment safely and repeatedly, it strengthens their procedural and conceptual understanding (Rahmatina et al., 2024). The use of smartphone-based media can address learning challenges in the digital era, including for abstract material (Restyayulita et al., 2023). This helps students understand the material better because understanding heat requires repeated practice. Moreover, the material is delivered through interactive Android-based learning media.

Through learning using interactive Android-based learning media on heat, students begin to build their knowledge individually. Melati et al. (2023) also showed that interactive media can increase student engagement in the learning process so that they are more active in exploring difficult concepts. The learning experience using Android-based interactive learning media applications has an impact on improving students' computational thinking skills. The use of this media significantly improves students' computational thinking skills compared to conventional methods (Khaulah et al., 2025). Nurwahidah et al. (2025) state that problem-based science applications have proven to be an effective innovative strategy for integrating the development of students' thinking skills. The use of interactive Android-based learning media applications is effective in improving students' computational thinking based on student learning outcomes. This improvement in students' computational thinking skills is seen based on the pretest and posttest scores of students in the experimental class and control class.

The average increase in student scores was higher in the experimental class than in the control class. The increase in scores was seen from the N-Gain of students who learned using this learning media application, which had high criteria, while the students in the control class experienced a low increase in scores. The average N-Gain score in the experimental class was 0.59, which means that the treatment given to the experimental class was effective. The average percentage N-Gain score in the control class was 0.19, indicating that the learning in the control class was ineffective. During the learning process, students in the experimental and control classes were trained in problem solving by working on questions with computational thinking indicators, including Decomposition, Pattern recognition, Abstraction, and Algorithms. An approach that can be applied to train students' problem-solving skills is the

computational thinking approach (Dewi et al., 2021; Yuntawati et al., 2021). This is in line with the results of research by Fuad et al. (2025), which states that Android-based interactive multimedia learning is effective in improving students' computational thinking skills. To train students' computational thinking skills, open the LKPD menu and the exercise questions menu on the Android-based interactive learning media application. Questions with computational thinking indicators can be seen in the following image:

Sebanyak 500 gram air dipanaskan dari suhu 25°C dengan menggunakan pemanas listrik yang mengalirkan kalor sebanyak 42.000 joule. Jika kalor jenis air adalah 4.200 J/kg°C, hitung suhu akhir air tersebut setelah pemanasan !

Figure 3. Student posttest question

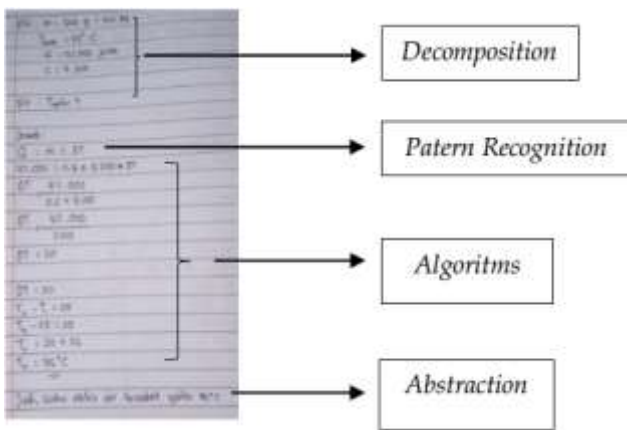


Figure 4. Student's posttest results

The student's answer above shows the good application of Computational Thinking (CT) concepts in solving heat problems. All Computational Thinking indicators are present. The student's answer can be analyzed using Computational Thinking (CT) concepts. In the Decomposition stage, students break down the problem into smaller parts, such as recording known data (mass, initial temperature, heat, and specific heat) and determining what is being asked (final temperature). Next, in Pattern Recognition, students recognize the heat calculation pattern using the formula  $Q = m \times c \times \Delta T$ . This stage involves calculating the change in temperature ( $\Delta T = T_2 - T_1$ ). In the Algorithms stage, students follow systematic steps, namely calculating the final temperature, entering the values into the formula, and completing the calculation to obtain the final temperature ( $T_2 = 45$  oC). Finally, in the Abstraction stage, students demonstrate abstract understanding by identifying factors that affect heating, such as mass, specific heat, and temperature change. Thus, students successfully apply the concept of

Computational Thinking in a structured manner to solve physics problems about heat. From the above discussion, it can be concluded that interactive Android-based learning media is quite effective in improving students' computational thinking skills in heat-related subjects at SMAN 3 Kotabumi.

### Conclusion

Based on the results of research on the effectiveness of Android-based interactive learning media, it can be concluded that interactive learning media applications are quite effective in improving students' computational thinking skills in heat-related subjects at SMAN 3 Kotabumi, as seen from the N Gain results of the four computational thinking indicators, in which the decomposition and abstraction indicators obtained high scores of 0.78 and 0.72, while the pattern recognition and algorithms indicators obtained moderate scores of 0.33 and 0.31 in the experimental class. In addition, there was a significant difference between the average post-test scores in the experimental class and the control class based on the results of the Independent Samples Test, with a Sig. (2-tailed) = 0.00, with a significance value below 0.05 ( $p < 0.05$ ). Based on the pretest and posttest data using the N Gain test, the average N-Gain score was 0.61, categorized as moderate. The suggestion from this study to improve the effectiveness of use in learning is that training is needed for teachers in integrating this media into Android-based learning optimally, so that teachers can manage classes more interactively. For future researchers, it is hoped that there will be further research exploring the effectiveness of this media in the long term, including its impact on other skills such as problem solving, creativity, and student collaboration in technology-based learning.

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### Author Contributions

R. contributed to the creation of learning tools, interactive learning, data collection, article writing, and as a corresponding author; M.N. contributed as a supervisor, in the creation of learning tools, research data analysis, and article writing; H. contributed as a supervisor, in the creation of learning tools, research data analysis, and article writing; D.M.F. contributed as a supervisor in article writing in the creation of instruments and article writing.

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**Conflicts of Interest**

The authors declare no conflict of interest.

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