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Implementation of Android-Based Interactive Learning Media on Students' Critical Thinking Skills in Physics Learning

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Abstract

This study aims to determine the average improvement in high school students' critical thinking skills in physics learning by using Android-based interactive learning media. This research is quantitative in nature and employs a quasi-experimental pretest-posttest control group design. The research population consisted of all grade XI students at one school in the Garut District during the even semester of the 2024/2025 academic year. The study involved two classes: XI-J (the experimental group, n = 34 students) using Android-based learning media, and XI-I (the control group, n = 34 students) using Google Sites. The research instruments included student response questionnaires and pretest-posttest questions based on the critical thinking aspects defined by Ennis. Data were analyzed using tests for homogeneity, normality, a t-test, and the N-gain test, with the aid of SPSS. The questionnaire results showed an 81.24% acceptance level for the Android-based media, categorized as very good, while observations indicated that the implementation of the learning process reached an average of 90%. Pretest-posttest analysis revealed a significant improvement in students' critical thinking skills. The experimental group's average score increased to 77.74 (categorized as good), while the control group achieved 65.59 (categorized as sufficient). The t-test yielded a significance value of 0.01 < 0.05; hence, H_0 was rejected and H_a was accepted, confirming a significant difference between the two groups. Based on these results, it can be concluded that the use of Android-based interactive media is proven to be more effective in improving students' critical thinking skills in the topic of static fluids compared to the use of Google Sites.

Keywords: Android; Critical thinking; Interactive learning media; Physics learning

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INTRODUCTION

The curriculum plays a fundamental role in the education sector. In accordance with Law No. 20 of 2003 concerning the National Education System (Sisdiknas), the curriculum is a design and arrangement that encompasses objectives, content, instructional materials, and the methods implemented as a guide for learning activities to achieve specific educational goals (Nurholis et al., 2022). Currently, the curriculum in use is the Merdeka Curriculum, which focuses on both character and skill development, as reflected in the six aspects of the Pancasila student profile. This statement is included in the decision by the Director General of the Ministry of Education, Culture, Research, and Technology Regulation No. 009/H/KR/2022 concerning the Aspects, Elements, and Sub-elements of Pancasila. The Pancasila student profile is based on: (1) Faith, Devotion to Almighty God, and Noble Morals, (2) Global Multicultural Awareness, (3) The Spirit of Mutual Cooperation, (4) Independence, (5) Critical Thinking, and (6) Creativity (Budayani & Meitriana, 2023).

The development of critical thinking skills is one of the crucial factors in education and must be prioritized (Maryani et al., 2022). Critical thinking skills have extensive benefits that are not limited to students' academic years but also provide advantages later in life. The ability to think critically is an essential skill required to solve problems (Sundari & Sarkity, 2021). Critical thinking is the capacity to think wisely, where an individual utilizes their intellect to analyze a problem from various perspectives and conducts an investigation to arrive at the most appropriate conclusions, evaluations, and decisions. This skill is especially important for students to master across various subjects, particularly in physics learning.

Physics is one of the branches of science that deals with scientific concepts (Haspen et al., 2021). The process of learning physics also plays a significant role in developing students' critical thinking abilities. However, many students feel less interested in physics because it involves many calculations, formulas, deep thought processes, as well as abstract and complex concepts. A common obstacle in learning physics is the lack of critical thinking skills among students (Suharyani & Siswanto, 2022). Previous studies have reinforced this finding by revealing that the level of critical thinking among secondary school students is still relatively low. A study conducted at one public high school in Jatibarang in 2023 revealed that 73% of students tend to quickly forget the physics material they have learned, while 34% of students encounter difficulties when identifying events based on scientific concepts. Consequently, 73.8% of students are unable to apply the physics concepts they have learned in solving problems.

The low level of critical thinking skills is caused by various factors, one of which is that students tend to memorize formulas and material rather than understand the underlying concepts. This hinders their ability to comprehend and solve problems that require analysis (Minarti et al., 2023). As a solution, the researchers utilized audio-visual educational media developed using Kinemaster, which incorporated STEM material. This improvement was demonstrated by a significant change: 47% of the data showed an increase in the low-level critical thinking category, while 76.90% experienced an improvement in the high-level critical thinking category. In other words, the audiovisual learning media with Kinemaster containing STEM content contributed to the development of students' critical thinking abilities (Permatasari et al., 2023). The primary difference in this study lies in the type of media and material used by the researchers.

Learning media are tools for efficiently presenting information to students (Firdha & Zulyusri, 2022). Interactive learning media are needed to ensure that students remain interested in and comprehend the learning material (Handayani & Rahayu, 2020). Interactive learning media are support devices assembled using various media elements such as illustrations, animations, videos, and texts, accompanied by control features that allow users to interact, exchange messages, organize, and obtain information (Nur, 2018). Interactive learning allows students to engage directly with the learning media. Moreover, the Android platform is easily accessible by students since almost all students own smartphones. Therefore, the use of interactive learning platforms is necessary to enhance the quality of the learning process. Applications that facilitate interactive learning include those based on Android media.

Interactive learning media developed on the Android platform are educational tools that use Android devices (tablets, smartphones) to deliver learning materials to students in an interactive and engaging manner (Kartini & Putra, 2020). This media enables students to interact directly with the subject matter, thereby helping them better understand the material and boost their learning motivation (Nurhayati & Langlang Handayani, 2020). An interactive learning process based on the Android platform can be developed through various applications and platforms, one of which involves the use of interactive media supported by Android platforms such as PowerPoint, iSpring, and web applications. The combination of these three tools allows for the creation of interactive, engaging, and easily accessible learning media for students. Microsoft PowerPoint can be used to design engaging and informative presentations; iSpring can add various interactive features to the presentation such as animations, videos, and quizzes; and web applications can convert learning videos into downloadable and mobile-accessible application formats (Budiman et al., 2021).

Other research has demonstrated that the use of interactive media supported by the Android platform can significantly develop the critical thinking skills of secondary school students when studying topics such as temperature and heat. This study revealed that the use of interactive learning media based on the Android platform holds potential as a solution, especially for physics material that is considered abstract and difficult to understand. Thus, the author further explores the implementation of interactive learning platforms based on Android in other physics topics to observe the extent to which these media optimally function.

This research is necessary because Android-based interactive learning media have a high potential to improve students' critical thinking skills. With enhanced critical thinking, students can comprehend information, analyze problems deeply, and make appropriate decisions. Android-based interactive media have the ability to transform the learning process into a more engaging and enjoyable experience, thereby boosting students' enthusiasm to delve into and understand the material more easily, particularly in physics—a subject often considered challenging. The utilization of this technology is expected to result in a highly effective learning experience.

METHODS

This study adopts a quantitative approach using a quasi-experimental pretest-posttest control group design. The study was conducted during the even semester of the 2024/2025 academic year, from January to early February, focusing on the topic of static fluids. The target group for this study comprised all grade XI students at a school in Garut District, spanning 5 classes. Two classes were then selected as samples: XI-J (n = 34 students) served as the experimental class using Android-based interactive media, and XI-I (n = 34 students) served as the control class using Google Sites.

Tabel 1. Pretest-posttest control grup design

Group	Pretest	Treatment	Posttest
Experimental	O_1	X_1	O_2
Control	O_1	X_2	O_2

Table 1 explains that at the beginning of the lesson, both classes were given a pretest to determine the level of critical thinking skills for each class regarding the topic of static fluids before the approach was applied. Subsequently, in the experimental class, treatment X_1 was administered, which involved the implementation of Android-based interactive learning media, while the control class received treatment X_2 by utilizing Google Sites. After these strategies were provided to both classes, a final test (posttest) was administered at the end of the lesson to examine the improvement in critical thinking skills in each class.

Data for this study were obtained using an initial test (pretest) and a final test (posttest) designed to assess the students' critical thinking abilities. The test comprised 6 essay questions that have been validated by several experts and deemed valid and feasible for use. In addition, this study also employed various supporting instruments, such as teaching modules for learning materials, questionnaires to collect students' responses to the media used, as well as an observation sheet to assess whether the learning process proceeded in accordance with the research design.

The data collection instruments included indicators of critical thinking skills according to Ennis. These indicators served as a reference for analyzing student responses and evaluating the development of their critical thinking abilities throughout the lessons. Table 2 below presents these indicators.

Table 2. Indicators of critical thinking skills (Sternberg, 2016)

Indicator	Sub-Indicator
Elementary Description	• Emphasizes the formulation of questions. • Evaluates and examines arguments. • Poses and responds to questions
Basic Skills	• Aligns with the references used. • Conducts observations and considers the findings obtained from them
Inference	• Drawing conclusions based on the results of observations and critically reviewing them. • Formulating generalizations from observed patterns and evaluating the outcomes. • Making decisions and carefully assessing their impacts.
Advances Clarification	• Explains the meaning of a term and critically examines it. • Identifies and analyzes an action
Strategies and Tactics	• Making a decision in taking action. • Communicating and interacting with others.

Based on Table 2, these indicators encompass various aspects of critical thinking, ranging from providing simple explanations to determining strategies and tactics. However, in the study conducted, not all sub-indicators of critical thinking were used; rather, only a few were selected to represent each indicator category. The selection of these indicators was based on their relevance to the topic of static fluids as well as their suitability for the research objectives, thus expected to efficiently measure students' critical thinking skills. The chosen indicators also took into account the complexity of the questions and the time constraints during the learning process and testing.

Data processing for the information obtained in the study utilized SPSS statistical software, which involved conducting tests for normality, homogeneity, and a t-test to identify differences between pretest and posttest outputs. N-Gain was used to assess the level of critical thinking, and effect size was determined to identify the impact of the Android-based interactive learning platform.

RESULTS AND DISCUSSION

A normality test was conducted to determine whether the data were normally distributed prior to further analysis. The data are considered normally distributed if the p-value > 0.05. Conversely, if the p-value < 0.05, the data are categorized as not following a normal distribution. Below is the output of the normality test for the pretest and posttest information.

Table 3. Results of the normality test for pretest-posttest data

Group	Statistic	df	sig
Pretest-Experimental	.958	34	0.21
Posttest- Experimental	.949	34	0.11
Pretest-Control	.969	34	0.41
Posttest-Control	.960	34	0.24

Based on Table 3, the results of the normality test for the pretest and posttest data using the Shapiro-Wilk technique indicate that all p-values exceed 0.05, confirming a normal distribution. Therefore, the normality assumption is met, which permits further analysis using a t-test to compare the critical thinking abilities between the two groups. Table 4 below presents the results of the homogeneity test.

Table 4. Results of the homogeneity test for pretest-posttest data

Variable		Levene Stat.	df1	df2	Sig.
Critical thinking test results	Based on Mean	0.079	1	68	.780

Based on the data in Table 4, the significance value is 0.780, which exceeds the threshold of 0.05 (0.780 > 0.05). Therefore, since the data are normally distributed and homogeneous, the t-test can be used for hypothesis testing.

Table 5. Pretest-posttest data results

Variable	t	df	Sig.
Critical thinking test results	4.742	68	0.01

Based on Table 5, the Asymp. Sig. value of 0.01 < 0.05 indicates that Ha is accepted and H_0 is rejected. The Android-based interactive media in the experimental class yielded a different effect compared to the control class using Google Sites. Furthermore, the N-Gain test was used to evaluate the differences between students' pretest and posttest scores in order to determine the improvement in their critical thinking skills during the physics learning process. The analysis was carried out using SPSS statistics to determine the effectiveness of the learning methods applied. The data were then categorized based on the N-Gain interpretation. The analysis results are shown in the table below.

Table 6. N-gain results

Group	N-gain	Criteria
Experimental	77.74	High
Control	65.59	Moderate

According to the N-Gain results shown in Table 6, the experimental class (with an average score of 77.74), which falls into the high category, indicates that students in the experimental class experienced a considerable improvement in critical thinking after the learning process. Meanwhile, the control class achieved an N-Gain score of 65.59 (categorized as moderate), indicating that although there was an improvement in critical thinking skills, the rate of improvement was not as high as that of the experimental class. Another study also revealed that the Android-based approach was able to significantly enhance students' cognitive achievement (Elisabeth, 2024). Furthermore, as an additional measure, the effect size was calculated using the following formula.

$$d = \frac{m1 - m2}{\sqrt{\frac{SD1^2 + SD2^2}{2}}}$$

$$d = \frac{77{,}74 - 65{,}59}{\sqrt{\frac{9{,}41^2 + 9{,}90^2}{2}}}$$

$$d = \frac{12{,}15}{\sqrt{\frac{186.55}{2}}}$$

$$d = \frac{12{,}15}{9{,}65}$$

$$d = 1{,}25$$

The effect size analysis resulted in a value of 1.25. Its influence is considered high, indicating a significant impact in enhancing critical thinking skills in physics learning.

A descriptive analysis compared the experimental class using Android-based interactive media with the control class using Google Sites. Data were obtained through pretest and posttest. The statistics on students' critical thinking skills are presented in Table 7.

Table 7. Pretest-posttest data results

Group	n	Average	Standard Deviation	Highest Score	Lowest Score
Pretest-Experimental	34	38.88	9.75	50	15
Posttest-Experimental	34	77.74	9.41	90	60
Pretest-Control	34	39.15	11.86	55	25
Posttest-Control	34	65.59	9.90	80	45

Based on Table 7, the descriptive results show that the experimental class had an initial average pretest score for critical thinking abilities of 38.88 (categorized as low), which increased to 77.74 (categorized as good) on the posttest. Meanwhile, the control class had an average pretest score of 39 (categorized as low) and increased to 65.59 (categorized as moderate) on the posttest. The improvement in the experimental class was more prominent than in the control class, due to the different learning media used.

The main objective of implementing Android-based interactive media was to determine the improvement in students' critical thinking abilities. To assess the success of this implementation, the learning process in both classes was monitored. Observational results indicated that the execution of the learning process in the experimental class reached 90%, demonstrating that the use of Android-based media is generally more effective in maintaining teacher and student engagement compared to

Google Sites, which requires additional strategies to enhance interaction. These findings align with other research (Cahyani et al., 2022). However, other studies have indicated that the use of Google Sites can optimize students' analytical abilities and digital understanding (Setianingsih et al., 2024). Nonetheless, to achieve an optimal level of engagement, its application requires supplementary strategies.

In addition to the effectiveness in the implementation of the learning process, the effectiveness of this media was also reflected in the questionnaire data completed by the students. The questionnaire analysis revealed that the effectiveness of using Android-based interactive learning media reached 81.24%, which is classified as very good. This indicates that students responded positively to this media. These findings are consistent with previous studies that mentioned Android interactive media facilitate mastery of material and promote more engaging and interactive teaching (Aulia et al., 2022).

The advantages of Android-based interactive media lie in its features, such as simulations, interactive quizzes, and visual materials designed for active learning. In contrast, Google Sites presents content in the form of text, images, and videos organized on web-based pages. The differences between the two media are evident in the interfaces used in the experimental and control classes, as illustrated in Figures 1 and 2.

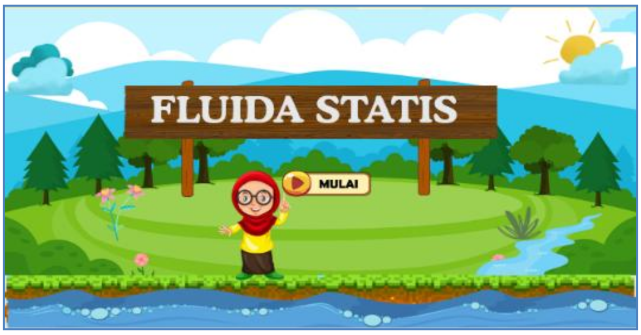

Figure 1. Interface of android-based interactive learning media

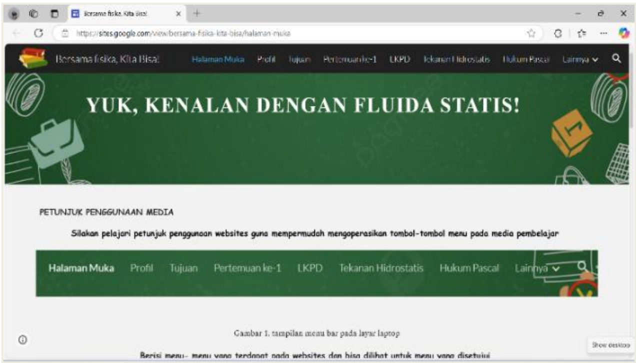

Figure 2. Interface of google sites learning media

The figure shows that both the experimental and control classes have key differences in terms of interface design and the platform used. Figure 1 illustrates the interface of the Android-based educational platform implemented in the experimental class, featuring appealing graphics, illustrations, and interactive buttons that promote active student engagement. In contrast, the Google Sites used in the control class has a simpler design, is text-based, and features structured navigation. Previous research has demonstrated that Android-based learning devices can significantly enhance student engagement, as evidenced by marked improvements in pretest and posttest scores (Nurhamidah et al., 2022).

In addition to the differences in learning media interface design, similar variations are observed in the instructional materials used in the experimental class, particularly in the form of student activity sheets (LKPD). These differences can also be seen in Figures 3 and 4. In the experimental class, the LKPD is developed using an interactive approach that supports simulations and virtual experiments, while the LKPD for the control class is text-based, focusing mainly on reading, analyzing texts and videos, and answering written questions. Moreover, the experimental class's LKPD is enhanced with features such as QR codes and observation tables, which encourage more active participation in the learning process compared to the relatively passive LKPD in the control class.

Figure 3. LKPD in experimental group

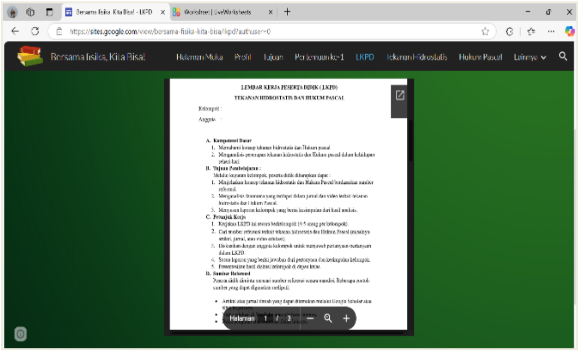

Figure 4. LKPD in control group

This research reinforces previous findings that Android-based interactive media are not only effective in deepening conceptual understanding but also play a crucial role in boosting both learning enthusiasm and analytical thinking skills (Roslina et al., 2024). The experimental class's average score increased from 38.88 to 77.74, while the control class only improved from 39.15 to 65.59. Although both groups showed progress, the experimental class exhibited a more remarkable improvement. Previous research (Putri, 2019) also supports that interactive media enhance posttest results compared to conditions without such media. Thus, the integration of interactive technology in the learning process has proven to have a significantly positive impact.

This study has certain limitations, namely that it did not encompass all sub-indicators of critical thinking. This limitation may affect the comprehensiveness of the analysis regarding the overall improvement in critical thinking skills. Therefore, it is recommended that future research include all sub-indicators so that the interrelationships among the different aspects of critical thinking can be analyzed more comprehensively. Consequently, the research findings could provide a more complete illustration of how each aspect of critical thinking contributes to the problem-solving process.

CONCLUSION

This study aims to determine the average score increase in critical thinking skills among high school students during physics learning using interactive learning media based on the Android system. The results indicate that the media is more effective compared to Google Sites, with the experimental class achieving an average posttest score of 77.74%, while the control class only obtained 65.59%. The t-test results demonstrate a statistical significance of 0.01 < 0.05, indicating a difference in improvement between the two groups. An effect size analysis of 1.25 also indicates that Android-based media have a strong impact. Observations of the learning process showed an effectiveness of 90%, suggesting that this media is more capable of maintaining both teacher and student engagement throughout the learning process. Additionally, questionnaire results showed a positive response with an average score of 81.24% (categorized as good). Thus, this media has proven effective in enhancing critical thinking skills and making learning more interactive.

RECOMMENDATION

Based on the study's findings, it is recommended that educators consider integrating Android-based interactive learning media into physics instruction, as this approach significantly enhances students' critical thinking skills and overall engagement. Future research should aim to include all sub-indicators of critical thinking to provide a more comprehensive analysis of students' cognitive development. Additionally, investigating long-term effects and potential integration with other digital platforms could further optimize the learning process.

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