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THE APPLICATION OF A MULTIMEDIA-ASSISTED PROBLEM-BASED LEARNING MODEL BASED ON ANDROID TO ENHANCE STUDENTS' CRITICAL THINKING SKILLS

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Abstract

The study's goals are to find out how the students in class IX-A at MTsN 11 Tasikmalaya's critical thinking skills and activities improved after using the problem-based learning (PBL) model with the help of multimedia apps on their Android phones and to see how they felt about the model. We conducted this classroom action research in three cycles, utilizing the Kurt Lewin design, which included stages of planning, implementation, observation, and reflection. Multiple-choice tests with reasons were used to measure critical thinking skills, while student activity sheets and questionnaires were used to assess student activity and responses. The results showed an increase in student activity, from 60.2% (poor) in cycle I to 78.5% (good) in cycle II and 80.6% (good) in cycle III. An increase in critical thinking skills also occurred, with an N-Gain value of 0.43 (low) in cycle I, increasing to 0.68 (moderate) in cycle II and 0.69 (moderate) in cycle III. There was no significant difference between male and female students. In general, the students' response to the Android-based multimedia-assisted PBL model was positive, with a score of 80.1%.

Keywords: PBL, AABTLT, Android, Critical Thinking

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INTRODUCTION

Global education continues to evolve to meet the demands of the 21st century, focusing on developing the skills needed to face global challenges due to the industrial revolution 4.0 and globalization. Due to rapid technological, economic, and social advances, the younger generation needs more than just academic knowledge (Anwar, 2022). Therefore, students need to broaden their horizons and master important skills in order to adapt to change and succeed in life. 21st-century skills, such as problem solving, creativity, critical thinking, metacognition, and communication, are essential in learning.

To face the challenges and changes in the era of globalization, education plays a crucial role. We expect education to shape a generation that is creative, innovative, and talented. Education must prepare students to be able to adapt to new developments and continue to learn throughout life. In addition to providing knowledge, education must also encourage continuous learning and foster 21st-century skills (Hairani, 2018).

Teachers have an important role in developing 21st-century skills, such as improving the quality of learning, encouraging student participation, adjusting learning to suit individual needs, and developing creativity, collaboration, communication, and problem solving. Implementing contextual learning that prioritizes students and enhances their critical thinking skills can fulfill this role (Haryati & Wangid, 2023).

Critical thinking skills themselves are an important component in the learning process to foster student creativity (Rosba et al., 2021). Through critical thinking skills, students are able to use their minds to solve everyday problems and train their thinking and self-reflection (Halimah et al., 2023)

We expect students to practice their critical thinking skills and solve everyday life problems through problem-based learning. The principles of constructivism align with problem-solving-based learning, which builds knowledge from personal experience rather than transferring it between individuals (Hendry et al., 1999). This method is effective in guiding students' learning experiences, helping them understand new things through direct interaction with real problems.

The observations at MTsN 11 Tasikmalaya revealed that 71.3% of class IX-A students had not achieved KKM in science lessons. Students' inability to solve problems requiring critical thinking skills contributed to the low learning outcomes. Additionally, findings indicate a low degree of student participation in the learning process, which results from a presentational shortcoming of the science content that lowers motivation to learn. According to early observations, most students prefer when science is presented through interesting media like films, interactive quizzes, and audiovisuals.

Students' low critical thinking skills and lack of learning activities need attention. The development of critical thinking skills is important in learning to facilitate the achievement of educational goals. Teachers at every level of education must help students hone these skills because they are important intellectual assets. We need innovation in learning methods and media to enhance students' comprehension and skills in science lessons.

One alternative problem solving tool that might help students with their learning activities and critical thinking skills is problem-based learning (PBL), which is supported by interactive multimedia based on Android, which motivates students to engage in active learning, critical thinking, and solve real problems that are relevant to the subject matter (Amalia & Radiansyah, 2023). According to Diana et al.'s (2022) research, the use of PBL assisted by interactive multimedia such as virtual laboratories can improve students' problem-solving abilities. Lestari & Sunarso's research (2024) also states that learning using interactive media can improve students' critical thinking skills.

The 21st century has widely accepted Problem-Based Learning (PBL) as an effective method to meet its learning needs. PBL places students in real-life situations that require them to solve problems, thereby encouraging the development of critical thinking, creativity, collaboration, and communication skills. Oderinu et al. (2020) conducted research indicating that the PBL model application yielded the highest average scores in critical thinking skills, communication, effectiveness as a learning method, organization, and interaction between teachers and students.

Furthermore, the implementation of the PBL model requires students to think critically in problem-solving, allowing them to become accustomed to addressing the problems they encounter in their daily lives (Kusumawardani & Aminatun, 2024; Suciyati & Hardiansyah, 2020). Hidayana et al. (2022) say that PBL can also help students learn better by improving their conceptual understanding (B. Kurniawan et al., 2023), science process skills (Pozuelo-Muñoz et al., 2023), and their scientific thinking skills (Haulia et al., 2022).

Other studies have shown that the application of the PBL model can be combined with various learning media. For example, the application of PBL assisted by PhET simulations not only improves student learning outcomes but also increases student activity (Rumansara et al., 2024)

and student interest (Agusmin et al., 2018). PBL assisted by spin wheel media has an effect on students' conceptual understanding abilities (Triyadi & Utami, 2024). PBL combined with audiovisual media can improve conceptual understanding (K. Kurniawan et al., 2020) and student achievement (Syafira, 2022).

On the other hand, PBL in conjunction with interactive materials like Articulate Storyline or edPuzzle successfully raises students' critical thinking skills (Mayang et al., 2021). Liana et al. (2020) found that internet of things-based experimental media can enhance students' HOTS skills through problem-based learning. Thus, the PBL model, whether used independently or in combination with various learning media, is effective in enhancing activity, motivation and interest in learning, process skills, problem-solving skills, learning achievement or outcomes, and 21st-century skills among students.

Previous studies have explored the benefits of PBL supported by various media, such as PhET simulations, audiovisual media, and other interactive materials. However, research that combines PBL with Android-based multimedia in science education, especially on the topic of static electricity, is still limited. Android-based multimedia is a learning medium that integrates various features, including learning materials in text and audiovisual formats, virtual laboratories, quizzes, and interactive assessments. This combination offers an innovative approach that not only enhances critical thinking skills but also encourages student engagement through interesting, interactive, and technologically relevant media.

Furthermore, this study also measures the improvement in student activity at each stage of the PBL model through authentic assessment using student activity sheets—an aspect that has been rarely addressed in previous literature. The student activity sheets used are based on the teaching and learning trajectory (AABTLT), which effectively and comprehensively assesses student learning activities within the PBL framework (Amiruddin et al., 2024).

Given the aforementioned context, we formulate the following problem: can the implementation of an Android-based multimedia-assisted problem-based learning (PBL) model enhance students' critical thinking skills regarding static electricity? The purpose of this study was to determine the increase in critical thinking skills of class IX-A students of MTsN 11 Tasikmalaya after using the problem-based learning (PBL) model assisted by android-based multimedia seen from the average score and gender. In addition, this study aims to measure the increase in student activity at each stage of the PBL model, as well as student responses to the application of the PBL model assisted by android-based multimedia on static electricity material.

METHOD

This kind of study is called three-cycle classroom action research using Kurt Lewin's design. There are phases for planning, implementing, observing, and reflecting in each cycle.

Each cycle comprises a single meeting, during which students receive a pretest and a posttest. Each learning cycle applies a treatment of science learning on static electricity material, utilizing a problem-based learning model and android-based multimedia. The subjects of this classroom action research were class IX-A students at MTsN 11 Tasikmalaya in the odd semester of the 2023/2024 academic year, consisting of 28 students. We conducted this research in October 2023.

This study used a multiple-choice test with reasons as the instrument to measure the improvement of students' critical thinking skills. The number of questions used in this study was 15, with alternative answer choices a, b, c, and d accompanied by reasons.

In the meantime, we utilize Student Activity Sheets used based on the teaching and learning trajectory (AABTLT) to understand student learning activities. Student activity sheets contain questions that students must answer in each PBL learning syntax. Student answers are then analyzed to determine the implementation of student activities for each PBL syntax.

Meanwhile, we used a questionnaire with five alternative answers to gather the students' responses to the implementation of the Android-based multimedia-assisted PBL model. If the questionnaire item is positive, we assign a value of 5, 4, 3, 2, and 1 to each alternative answer. If the response is negative, we will obtain values of 1, 2, 3, 4, and 5 for each alternative answer.

After applying the Android-based multimedia-assisted PBL model, we used the Normal Gain (NG) value (see Table 1) and the following equation to measure the increase in students' critical thinking skills in statistical electricity material:

$$NG = \frac{posttest\ score - pretest\ score}{\max score - pretest\ score}$$

Table 1. Normalized N-gain values and their classification based on Hake (1998)

Number	N-Gain Values	Criteria
1	Ngain < 0.30	Low
2	0,70 > Ngain ≥ 0.30	Medium
3	Ngain ≥ 0.70	High

We use a straightforward display of the observation sheet analysis results for each cycle to identify the teacher's activities. Meanwhile, to determine students' activities and student responses in the learning process using PBL models assisted by multimedia based on Android, the percentage (%) of the results of the student activity sheet analysis is calculated using the following formula.

$$NP = \frac{R}{SM} x100\%$$

Description:
NP = % of desired or anticipated value
R = raw result attained
SM = the desired highest mark possible on the given exam
This percentage is then interpreted in categories as in Table 2.

Table 2. Categories of student activities and responses adapted from (Rochman et al., 2018)

Percentage (%)	Categories
<55	Bad
55-70	Not Good
71-85	Good
>85	Very Good

RESULT AND DISCUSSION

Android-based multimedia used to support the problem-based learning model has previously been tested for feasibility. The feasibility test is seen from the aspects of media design, content quality, practicality, attractiveness, and technological suitability. The results of the learning media feasibility test showed an average score of 79.5, which is considered feasible to use. The media display is shown in Figure 1.

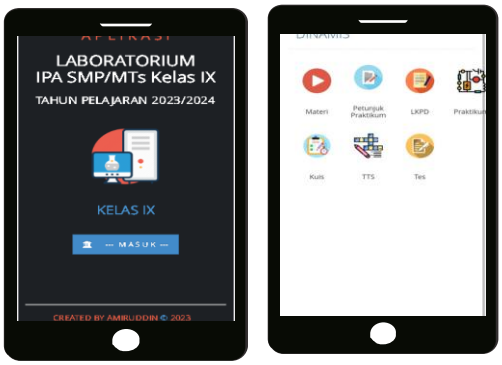

Figure 1. Android-based multimedia display

The percentage data of student activity was 60.2% with a less than good category in cycle I, 78.5% with a good category in cycle II, and 80.6% with a good category in cycle III, based on the results of observations of student activities in learning with the PBL paradigm assisted by interactive media based on Android as seen in Figure 2.

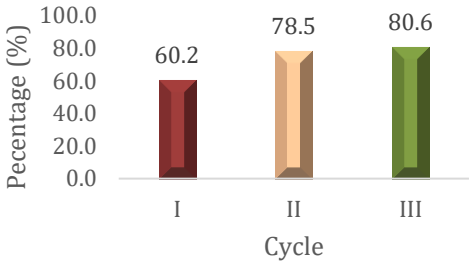

Figure 2. Percentage of student activities using the PBL model

In the first cycle, student learning activities were recorded at only 60.2% with a poor category. This low figure is due to the initial adaptation process of students to the PBL learning model (Marlita et al., 2023). All student activities for each stage of learning showed a percentage below 70%, except for stage 2 which reached 78.1%, as shown in Table 3.

Table 3. The mean student input in cycle I of the PBL model syntax

Stage	Learning Steps	Activity (%)	Category
1	Problem Orientation	65.6	Not Good
2	Organizing Students	78.1	Good
3	Guiding investigations/experiments in groups	54.7	Bad
4	Presenting the findings of collaborative work	56.3	Not Good
5	Assessing and analysing the outcomes of problem-solving	46.1	Bad

Classroom action research continues to cycle II, focusing on improving the PBL learning steps, which still need improvement. Improvements are made by providing scaffolding at each less than satisfactory learning step. The teacher provides scaffolding to students during classroom learning activities.

Scaffolding, according to Vygotsky's concept, is a method of gradually providing guidance and support from adults to students during the learning process. This involves providing significant assistance at the beginning of learning which then decreases as students progress until they can learn independently. Scaffolding can be in the form of instructions, encouragement, warnings, breaking down problems into steps to solve them, providing examples, and so on (Fajriani et al., 2021).

The teacher provides scaffolding to students through the following steps: first, giving clear and structured instructions in the LKPD to help students understand the objectives and steps of the lesson. Second, offering guidance in formulating problems through examples and guiding questions. Third, guiding students in group discussions to collaborate effectively and record the discussion results in an organized manner. Fourth, providing guidance on presenting the discussion results with a clear structure. Finally, the teacher gives constructive feedback to improve students' understanding and develop their critical thinking, communication, and collaboration skills.

The Student Worksheet provides students with scaffolding in the form of instructions, particularly during challenging stages. The goal is to help students overcome their learning difficulties according to their respective abilities (Adinda et al., 2024).

In the second cycle, there was a significant increase in student learning activities, reaching 78.5% in the good category. Reflection and evaluation of the results of student activities in cycle II, together with scaffolding and guidance on the difficulties found, significantly increased student learning activities.

The increase in the percentage of student learning activities occurred in all steps of the PBL model learning. Although there was an increase, the learning steps of conducting group investigations and analyzing and evaluating problem-solving results were still not good as seen in Table 4. Therefore, we continued the action research to cycle III, focusing on improvements at these stages. The improvement steps taken were to make group work effective through a clear division of labor and provide direction on how to analyze and evaluate problem-solving results for all students.

Table 4. The average student activity in PBL model syntax cycle II

Stage	Learning Steps	Activity (%)	Category
1	Problem Orientation	89.4	Very Good
2	Organizing Students	86.5	Very Good
3	Guiding investigations/experiments in groups	68.3	Not Good
4	Presenting the findings of collaborative work	81.7	Good
5	Assessing and analysing the outcomes of problem-solving	66.3	Not Good

In the third cycle, student learning activities again increased to 80.6% in the good category. The learning stages of conducting group investigations and analyzing and evaluating the results of problem solving, which are the focus of improvement, increased to 75.9% and 70.4%, respectively, with a good category, as shown in Table 5. The improvement efforts were effective in overcoming problems in cycle II.

Table 5. The mean student input in cycle III of the PBL model syntax

Stage	Learning Steps	Activity (%)	Category
1	Problem Orientation	88.9	Very Good
2	Organizing Students	88.9	Very Good
3	Guiding investigations/experiments in groups	75.9	Good
4	Presenting the findings of collaborative work	78.7	Good
5	Assessing and analysing the outcomes of problem-solving	70.4	Good

According to the results of the pretest and posttest assessment of students, the N-Gain value for improving critical thinking skills was 0.43 with a low category for the first cycle, 0.68 with a medium category for the second cycle, and 0.69 with a medium category for the third cycle, as shown in Figure 3.

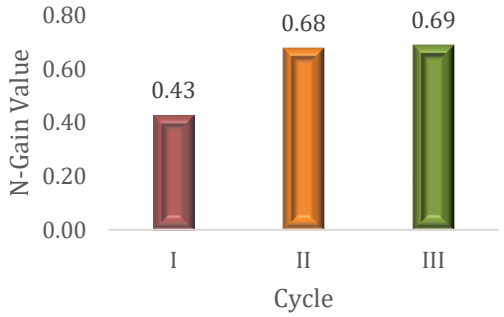

Figure 3. The critical thinking skills of students' N-Gain value

If broken down by gender, the N-Gain value for improving critical thinking skills of male students for three consecutive cycles was 0.44, 0.67, and 0.66, and for female students 0.42, 0.69, and 0.71, as shown in Figure 4.

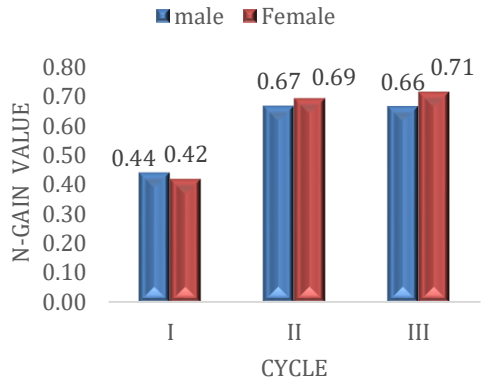

Figure 4. The gender-based N-gain value of students' critical thinking capabilities

Students' low learning activities in science classes that use the multimedia-assisted PBL model supported by Android also result in a low growth in their critical thinking skills. Male students began learning with the PBL paradigm with an average gain in critical thinking skills (N-Gain) of 0.44, whereas female students had a lower average increase of 0.42. This is due to students' efficacy and self-motivation at the start of learning static electricity material. Female students' efficacy and self-motivation in dealing with science learning, particularly physics material, is lower than that of male students. This is in accordance with the results of a study by Li & Singh (2021) which stated that female students have much lower academic motivation and self-efficacy compared to male students in the field of physics. Academic self-efficacy is a student's belief in their ability to complete study tasks according to the specified target results and time. This belief is important to achieve optimal performance (Salim & Muhammad Fakhrurrozi, 2020).

In the second cycle, there was a significant increase in students' critical thinking skills, as evidenced by the N-Gain value, which increased to 0.68 overall, with a significant increase in the male (0.67) and female (0.69) groups. Female students even exceeded the achievements of the male group. High academic resilience, the dynamic ability of students to recover from negative emotional experiences in difficult learning situations, explains this increase (Wahidah, 2018).

Academic resilience is a key component of students' learning readiness and aids in overcoming a variety of learning challenges, claim Kumalasari & Akmal (2020), students' academic resilience plays a major role in their learning readiness and helps overcome various learning difficulties. Although there is no significant difference between the levels of academic resilience in the male and female groups, on average, the level of academic resilience in the female group is higher than that of the male group (Utada et al., 2023).

Reflection and evaluation after the first cycle, as well as scaffolding focused on student difficulties, play an important role in increasing

learning activities and improving thinking skills. This intervention, which includes improving learning steps and student activities in the second cycle, helps improve student activities and learning outcomes, and strengthens their academic resilience (Erna Muliastrini et al., 2019).

In the third cycle, overall, the N-Gain value of students' improved critical thinking skills rose to 0.69, with specific values for the male and female groups being 0.67 and 0.71, respectively. This shows that students are increasingly accustomed to the PBL method, and their understanding of the material is getting deeper.

This finding is consistent with previous research, such as that by Kusumawardani & Aminatun (2024), which highlights the effectiveness of the PBL method in enhancing students' critical thinking skills through active problem-solving and inquiry-based learning. Similarly, a study by Liana et al. (2020) found that PBL not only deepens students' understanding of the subject matter but also fosters higher-order thinking skills by encouraging them to analyze, evaluate, and synthesize information collaboratively. The results of this study reaffirm the idea that sustained exposure to PBL enables students to develop critical thinking skills regardless of gender, aligning with broader evidence that PBL is a robust approach to improving cognitive skills in diverse learning contexts.

This improvement is highly consistent with the principles of constructivist learning theory, which emphasizes that knowledge is actively constructed by learners through experiences and interactions with their environment (Jumaah, 2024; Perkowska-Klejman & Górka-Strzałkowska, 2023). In the context of PBL, students engage in authentic problem-solving activities that require them to utilize prior knowledge, collaborate with peers, and reflect on their learning process. Constructivism argues that such active involvement promotes deeper understanding and the development of critical thinking skills (Ranjana, 2022). The increasing N-Gain values for both male and female groups indicate that iterative PBL cycles create a supportive learning environment where students can internalize concepts more effectively, validating the constructivist notion that meaningful learning occurs when learners actively engage in constructing their own knowledge.

We asked every student in class IX-A to fill out a questionnaire in order to get their feedback on the use of the multimedia-assisted PBL model based on Android. The questionnaire consisted of 15 statement items with positive and negative orientations. The number of positive-oriented statements was 10, and the number of negative-oriented statements was 5, developed from five indicators: learning motivation, activity and creativity, understanding of the material, critical thinking, and independent learning. Table 6 displays the student responses based on the five indicators.

Table 6 shows that, on the whole, student reactions to the use of the multimedia-assisted PBL model based on Android fell into the good category, scoring 80.1%. Students responded well and agreed that the implementation of the Android-based multimedia-assisted PBL model could increase motivation, activity, and creativity, help understand the material, assist with improve critical thinking skills, and develop the ability to learn independently with percentages of 81.5%, 84.0%, 79.8%, 76.7%, and 78.5%, respectively.

These results are in line with research conducted by Setiyawan et al. (2024). The results of the study showed that the average motivation score of students after using the PBL model was 83%. These results are also in line with the results of research Yesmita et al. (2023) which states that student learning activities continue to increase at each meeting when using the PBL model.

This finding aligns with the principles of constructivist learning theory, which emphasizes that students actively construct their knowledge through meaningful experiences (Fosnot, 1996). The Problem-Based Learning (PBL) model fosters this process by encouraging students to engage in collaborative problem-solving, critical thinking, and inquiry-based activities (Hastuti et al., 2024). According to Vygotsky's theory of social constructivism, the interaction among peers and guided facilitation by instructors in PBL creates a zone of proximal development (ZPD), enabling students to achieve higher levels of understanding and motivation (Mudi & Samanta, 2024; Salsabila & Muqowim, 2024; Wibowo et al., 2025). Thus, the increased motivation and active participation observed in these studies reflect the core tenets of constructivism, where learners become active participants in their own knowledge construction.

Table 6. Student responses to the android-based multimedia-assisted PBL model

Number	Response Indicator	%	Category
1	Increase motivation	81.5	Good
2	Increase activity and creativity	84.0	Good
3	Help understanding of the material	79.8	Good
4	Help improve critical thinking skills	76.7	Good
5	Develop the ability to learn independently	78.5	Good
	Average	80.1	Good

CONCLUSIONS AND SUGGESTIONS

Conclusion

The results of the study show that the multimedia-assisted PBL model based on Android is successful in enhancing critical thinking skills and the activity of class IX-A MTsN 11 Tasikmalaya students on statistical electricity material. Students believe that this method motivates them to learn, increases activity and creativity, helps them understand the material, and develops critical thinking and independent learning abilities. Descriptively, following the learning process utilising the Android-based multimedia-assisted PBL approach, there is no discernible difference in the improvement of critical thinking skills between male and female students. The research implications suggest that the Android-based multimedia-assisted PBL model effectively enhances critical thinking skills, student engagement, and independent learning. By utilizing technology, this approach creates an interactive learning environment that motivates students and promotes equality in skill development, regardless of gender. Teachers can integrate this model across various subjects to foster 21st-century skills, such as critical thinking and active participation.

Suggestion

Based on the results of the research that has been carried out, there are several suggestions provided by the researcher. The validator did not validate the use of Android-based multimedia as a learning medium in this study, potentially compromising its validity. This study is also based on classroom action, which only covers problems in the class where the researcher educates. Further research is required to evaluate the impact of implementing the Android-based multimedia-assisted PBL model on enhancing critical thinking skills and students' overall learning activities, by assessing the significance of its influence. Furthermore, we need to conduct additional research to examine the relationship between learning activities and the enhancement of students' critical thinking skills, as well as investigate the impact of implementing the Android-based multimedia-assisted PBL model on gender differences.

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