IMPLEMENTING THE PROBLEM BASED LEARNING MODEL BASED ON THE LOCAL WISDOM OF HOMBO BATU TO ENHANCE STUDENTS' PHYSICS PROBLEM-SOLVING SKILLS AT SMA NEGERI 1 FANAYAMA

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Abstract

This study aims to examine the effectiveness of the implementation of the Problem Based Learning (PBL) model based on the local wisdom of Hombo Batu in improving students' physics problem-solving abilities at SMA Negeri 1 Fanayama. The research employed a quasi-experimental method with a pretest–posttest control group design. The participants consisted of tenth-grade students who were divided into an experimental class and a control class. The experimental class received instruction using the Problem Based Learning model integrated with the cultural context of Hombo Batu, while the control class was taught using conventional learning methods. Data were collected through a physics problem-solving test administered before and after the learning process. The results showed that students in the experimental class experienced a significant improvement in their problem-solving abilities compared to those in the control class. The normalized gain score of the experimental group was higher than that of the control group, indicating that the implementation of the PBL model provided a more effective learning experience. In addition, integrating the Hombo Batu cultural context helped students understand physics concepts more meaningfully because the learning materials were related to real-life cultural practices familiar to the students. Therefore, the integration of Problem Based Learning with local wisdom can create contextual and meaningful physics learning while also fostering students' appreciation of local cultural heritage.

Keywords: *Problem Based Learning, local wisdom, Hombo Batu, physics education, problem-solving ability.*

Abstrak

Penelitian ini bertujuan untuk mengkaji efektivitas penerapan model Problem Based Learning (PBL) berbasis kearifan lokal Hombo Batu dalam meningkatkan kemampuan pemecahan masalah fisika siswa di SMA Negeri 1 Fanayama. Penelitian ini menggunakan metode kuasi eksperimen dengan desain pretest–posttest control group. Subjek penelitian adalah siswa kelas X yang dibagi menjadi kelas eksperimen dan kelas kontrol. Kelas eksperimen memperoleh pembelajaran menggunakan model Problem Based Learning yang diintegrasikan dengan konteks budaya Hombo Batu, sedangkan kelas kontrol menggunakan pembelajaran konvensional. Data penelitian dikumpulkan melalui tes kemampuan pemecahan masalah fisika yang diberikan sebelum dan sesudah pembelajaran. Hasil penelitian menunjukkan bahwa siswa pada kelas eksperimen mengalami peningkatan kemampuan pemecahan masalah yang lebih tinggi dibandingkan dengan kelas kontrol. Nilai normalized gain pada

kelas eksperimen berada pada kategori lebih tinggi, yang menunjukkan bahwa penerapan model PBL memberikan pengalaman belajar yang lebih efektif. Selain itu, integrasi konteks budaya Hombo Batu membantu siswa memahami konsep fisika secara lebih bermakna karena materi pembelajaran dikaitkan dengan praktik budaya yang dekat dengan kehidupan mereka. Oleh karena itu, integrasi Problem Based Learning dengan kearifan lokal dapat menciptakan pembelajaran fisika yang kontekstual sekaligus menumbuhkan apresiasi terhadap budaya lokal.

Kata Kunci: *Problem Based Learning, kearifan lokal, Hombo Batu, pendidikan fisika, kemampuan pemecahan masalah.*

A. Introduction

Education in the 21st century emphasizes the development of higher-order thinking skills, particularly problem-solving abilities, critical thinking, and creativity. In science education, especially physics, problem-solving skills are essential because physics concepts are closely related to natural phenomena and real-life situations. Students are required not only to understand theoretical concepts but also to apply these concepts in solving contextual problems Harefa, D. (2025. Therefore, physics learning should encourage students to actively engage in exploring, analyzing, and solving problems encountered in daily life. Problem-solving skills enable students to develop analytical thinking, reasoning abilities, and scientific understanding necessary to face the challenges of modern society (Prahani et al., 2022).

However, many studies report that students' problem-solving abilities in physics remain relatively low Harefa, D. (2025. One of the main causes is the dominance of teacher-centered learning methods, where teachers mainly deliver information while students act as passive recipients. Such learning environments often limit students' opportunities to explore concepts independently and develop problem-solving strategies. As a result, students tend to rely on memorization rather than conceptual understanding when dealing with physics problems. Previous research indicates that conventional instruction does not effectively support the development of students' analytical and problem-solving skills in physics learning (Wilujeng & Suliyanah, 2022).

To overcome this issue, innovative learning models that actively involve students in the learning process are needed. One of the learning approaches widely recommended in science education is the Problem Based Learning (PBL) model. Problem Based Learning is a student-centered instructional model that uses real-world problems as the starting point for learning activities Harefa, D. (2025. Through this approach, students work collaboratively to identify problems, collect relevant information, propose possible solutions, and evaluate the results. The PBL model encourages students to develop critical thinking, collaboration, and independent learning skills. Several studies have demonstrated that the implementation of PBL significantly improves students' understanding of physics concepts and enhances their ability to solve problems (Dewi et al., 2023).

Furthermore, integrating local wisdom into learning activities can make physics

E-ISSN : 2828-626X
Universitas Nias Raya

learning more contextual and meaningful. Local wisdom reflects the cultural values, traditions, and knowledge systems that develop within a community and are closely related to daily life. When local wisdom is incorporated into classroom learning, students can connect scientific concepts with familiar cultural practices, thereby improving their engagement and conceptual understanding. Contextual learning based on local culture also contributes to preserving cultural heritage while promoting meaningful learning experiences for students.

One example of local wisdom that can be integrated into physics learning is the cultural tradition of Hombo Batu from Nias Island, Indonesia. Hombo Batu, also known as the stone-jumping tradition, requires participants to jump over a high stone structure, demonstrating physical strength, agility, and courage. From a physics perspective, this cultural practice involves several concepts such as motion, force, energy, and projectile motion. Therefore, integrating Hombo Batu into physics learning activities can provide authentic contexts for students to explore physics concepts and apply problem-solving strategies in real-life situations.

In addition, research indicates that the use of the Problem Based Learning model can significantly improve students' physics learning outcomes and problem-solving abilities because it encourages active participation and inquiry-based learning processes (Naenggolan, 2023). A meta-analysis study also revealed that the application of the PBL model has a positive effect on improving students' physics problem-solving skills across various learning contexts (Putri et al., 2024).

Based on these considerations, integrating the Problem Based Learning model with local wisdom such as Hombo Batu is expected to create a meaningful and contextual learning environment that enhances students' problem-solving abilities in physics. This approach not only promotes scientific understanding but also strengthens students' appreciation of local culture. Therefore, this study aims to investigate the implementation of a Problem Based Learning model based on the local wisdom of Hombo Batu to improve students' physics problem-solving skills at SMA Negeri 1 Fanayama.

B. Research Method

This study employed a quasi-experimental research design to investigate the effectiveness of implementing the Problem Based Learning model based on the local wisdom of Hombo Batu in improving students' physics problem-solving abilities. Quasi-experimental designs are widely used in educational research because they allow researchers to examine causal relationships in natural classroom settings where random assignment of participants is often not feasible (Creswell & Creswell, 2021). This research utilized a pretest–posttest control group design, which involves two groups: an experimental group receiving the treatment and a control group receiving conventional instruction.

The research was conducted at SMA Negeri 1 Fanayama, located in Nias Selatan, Indonesia. The participants consisted of tenth-grade students during the 2024/2025 academic year. Two classes were selected as research samples using a purposive

sampling technique. One class was designated as the experimental group, where the learning process was carried out using the Problem Based Learning model integrated with the cultural context of Hombo Batu. The other class served as the control group, where learning was conducted using conventional teacher-centered methods. Purposive sampling is often used in educational research when researchers select participants based on specific characteristics relevant to the research objectives (Etikan & Bala, 2020).

The implementation of the Problem Based Learning model in the experimental group followed several stages. These stages included: (1) presenting contextual problems related to physics concepts through the cultural practice of Hombo Batu, (2) organizing students into collaborative groups, (3) guiding students to investigate and collect relevant information, (4) developing and presenting solutions to the problems, and (5) evaluating the problem-solving process and reflecting on learning outcomes. The integration of local wisdom into learning activities was intended to provide meaningful and contextual learning experiences that connect scientific concepts with students' cultural environment.

The instrument used in this study was a physics problem-solving test consisting of essay questions designed based on indicators of problem-solving ability, including understanding the problem, planning a solution strategy, implementing the solution, and evaluating the results. These indicators were adapted from the problem-solving framework commonly used in physics education research. Before being administered to the students, the instrument was validated by experts in physics education and tested for reliability. Instrument validation is essential to ensure that the test accurately measures the intended constructs and provides reliable data for analysis (Taherdoost, 2021).

Data collection was carried out in several stages. First, a pretest was administered to both the experimental and control groups to determine the initial level of students' problem-solving abilities Abdul Mutolib., Dkk. (2025). Afterward, the experimental group received learning treatment using the Problem Based Learning model integrated with Hombo Batu for several instructional sessions, while the control group received conventional learning instruction. At the end of the treatment period, a posttest was conducted to measure students' problem-solving abilities after the learning process.

The collected data were analyzed using both descriptive and inferential statistical techniques. Descriptive statistics were used to describe the mean, standard deviation, and distribution of students' scores. Meanwhile, inferential statistical analysis was conducted to determine whether there was a significant difference between the experimental and control groups. The independent sample t-test was used to test the research hypothesis after the data met the assumptions of normality and homogeneity. Statistical analysis is commonly used in experimental educational studies to determine whether the applied instructional strategy significantly influences learning outcomes (Field, 2020).

Through this research method, the study aimed to provide empirical evidence regarding the effectiveness of integrating the Problem Based Learning model with the local cultural context of Hombo Batu in improving students' physics problem-solving skills. The results of this study are expected to contribute to the development of contextual physics learning strategies that integrate cultural heritage with modern educational approaches.

C. Research Results

The results of this study describe the effectiveness of implementing the Problem Based Learning (PBL) model based on the local wisdom of Hombo Batu in improving students' physics problem-solving abilities at SMA Negeri 1 Fanayama. The analysis was conducted by comparing the pretest and posttest scores of students in the experimental and control groups.

1. Descriptive Analysis of Students' Problem-Solving Ability

Before the learning treatment was implemented, a pretest was administered to determine the initial level of students' physics problem-solving abilities. The results showed that the average pretest scores of both groups were relatively similar. The experimental group obtained a mean score of 45.32, while the control group achieved an average score of 44.87. These results indicate that the initial abilities of the two groups were relatively equivalent before the implementation of the learning treatment.

After the learning process was completed, a posttest was conducted to evaluate students' problem-solving abilities. The results revealed a significant improvement in both groups; however, the experimental group demonstrated a higher increase compared to the control group. The experimental group obtained an average posttest score of 81.46, whereas the control group achieved an average score of 69.28. The results suggest that the implementation of the Problem Based Learning model integrated with the Hombo Batu cultural context had a positive effect on improving students' physics problem-solving skills.

The improvement in students' problem-solving abilities was also analyzed using the normalized gain (N-gain) score. The experimental group achieved an N-gain score of 0.67, which falls into the medium-to-high improvement category, while the control group obtained an N-gain score of 0.43, categorized as moderate improvement. These results indicate that the Problem Based Learning model provided a more effective learning experience in enhancing students' ability to analyze and solve physics problems.

2. Inferential Statistical Analysis

To determine whether the observed differences between the experimental and control groups were statistically significant, an independent sample t-test was conducted. Before performing the hypothesis test, the data were analyzed using normality and homogeneity tests. The results of the normality test indicated that the data were normally distributed, while the homogeneity test confirmed that the variance of the two groups was homogeneous.

The results of the independent sample t-test showed that the significance value (p-value) was 0.000, which is lower than the significance level of 0.05. Therefore, the null hypothesis was rejected, indicating that there

was a significant difference in students' physics problem-solving abilities between the experimental group and the control group. These findings demonstrate that the implementation of the Problem Based Learning model based on the local wisdom of Hombo Batu significantly improved students' problem-solving skills in physics learning.

3. Improvement of Students' Problem-Solving Indicators

Further analysis was conducted to examine improvements in each indicator of problem-solving ability. The results showed that the most significant improvement occurred in the indicators of understanding the problem and developing solution strategies. Students in the experimental group demonstrated better abilities in identifying known and unknown variables, constructing problem-solving plans, and applying relevant physics concepts.

The integration of the Hombo Batu cultural context in the learning process provided meaningful real-life examples related to physics concepts such as motion, energy, and force. This contextual approach helped students understand abstract physics concepts more easily because they could relate them to familiar cultural practices.

These findings are consistent with previous studies indicating that the Problem Based Learning model can significantly improve students' critical thinking and problem-solving abilities in science education (Prahani et al., 2022). Moreover, contextual learning that integrates local culture into science education has been proven to increase students' motivation, engagement, and conceptual understanding (Dewi et al., 2023). Therefore, the results of this study support the idea that integrating local wisdom with modern learning models can create a more meaningful and effective learning environment.

Overall, the findings indicate that the implementation of the Problem Based Learning model based on the local wisdom of Hombo Batu is effective in improving students' physics problem-solving abilities. This approach not only enhances students' academic performance but also promotes cultural awareness and appreciation of local traditions.

The results of this study indicate that the implementation of the Problem Based Learning (PBL) model based on the local wisdom of Hombo Batu significantly improved students' physics problem-solving abilities at SMA Negeri 1 Fanayama. The improvement can be observed from the increase in students' posttest scores and the higher normalized gain scores in the experimental group compared to the control group. These findings suggest that integrating contextual cultural elements into a problem-based learning framework can provide meaningful learning experiences and enhance students' understanding of physics concepts.

One important factor contributing to the effectiveness of the PBL model is its student-centered learning approach. In the PBL process, students are actively involved in identifying problems, discussing possible solutions, and evaluating their results. This learning process encourages students to develop higher-order thinking skills, particularly problem-solving and critical thinking abilities. According to Prahani et al.

(2022), problem-based learning allows students to construct knowledge independently through investigation and collaboration, which significantly improves their ability to analyze and solve scientific problems.

In addition, the integration of local wisdom such as Hombo Batu into physics learning activities plays an important role in creating contextual learning environments. Hombo Batu, a traditional stone-jumping practice from Nias culture, provides real-life contexts related to physics concepts such as motion, energy, and force. By connecting these cultural practices with physics learning materials, students can better understand abstract scientific concepts. Contextual learning that integrates local cultural elements has been shown to increase students' motivation and engagement because the learning materials are closely related to their social and cultural environment (Dewi et al., 2023).

The findings of this study also support previous research indicating that the Problem Based Learning model has a positive impact on students' problem-solving skills in science education. Putri et al. (2024) conducted a meta-analysis and found that the PBL model significantly improves students' ability to solve physics problems across different educational contexts. The study highlights that the use of real-world problems encourages students to apply conceptual knowledge in practical situations, thereby strengthening their analytical and reasoning abilities.

Furthermore, the collaborative learning process in the PBL model also contributes to the improvement of students' problem-solving abilities. During group discussions, students exchange ideas, debate possible solutions, and refine their understanding of physics concepts. This collaborative learning environment enables students to develop communication skills and encourages deeper conceptual understanding. Research by Naenggolan (2023) also confirms that students who learn through the PBL model demonstrate better conceptual understanding and higher learning outcomes compared to those who learn through traditional instructional methods.

Another important finding of this study is that contextual learning based on local culture helps students bridge the gap between theoretical knowledge and real-life applications. In traditional classroom instruction, physics concepts are often presented abstractly, making it difficult for students to relate them to real-world phenomena. However, by incorporating examples from the Hombo Batu tradition, students are able to visualize how physics principles operate in real-life situations. This contextualization enhances students' conceptual understanding and encourages them to apply scientific reasoning when solving problems.

Moreover, integrating cultural elements into learning activities also contributes to the preservation of local heritage. Education that incorporates local wisdom not only improves academic outcomes but also strengthens students' appreciation of cultural traditions. This approach aligns with modern educational perspectives that emphasize culturally responsive teaching and contextual learning environments.

Overall, the results of this study demonstrate that the implementation of the Problem Based Learning model integrated with the local wisdom of Hombo Batu provides significant benefits in improving students' physics problem-solving abilities. The findings highlight the importance of combining innovative instructional strategies with culturally relevant learning contexts. Therefore, educators are encouraged to integrate local cultural knowledge into science learning to create more meaningful, engaging, and effective educational experiences.

D. Conclusion and Suggestions

Conclusion

Based on the results of the study, it can be concluded that the implementation of the Problem Based Learning (PBL) model integrated with the local wisdom of Hombo Batu has a significant positive impact on improving students' physics problem-solving abilities at SMA Negeri 1 Fanayama. The findings indicate that students who participated in the learning process using the Problem Based Learning model demonstrated higher levels of improvement in their ability to analyze and solve physics problems compared to students who experienced conventional teacher-centered instruction.

The improvement in students' problem-solving abilities can be observed from several aspects. First, students became more capable of identifying and understanding the problems presented in physics contexts. Through the PBL approach, students were encouraged to examine problem situations critically and identify relevant variables and information needed to solve the problems. This learning process enabled students to develop a deeper conceptual understanding of physics concepts.

Second, the use of contextual problems based on the cultural practice of Hombo Batu helped students connect theoretical physics concepts with real-life experiences. Hombo Batu, as a cultural tradition from Nias, involves physical activities that can be explained through physics principles such as motion, force, and energy. By integrating this local wisdom into the learning process, students were able to visualize the application of physics concepts in real-world situations. As a result, learning became more meaningful and easier for students to understand.

Third, the collaborative learning activities embedded in the Problem Based Learning model also contributed to the improvement of students' problem-solving skills. Students worked together in groups to discuss problems, share ideas, and develop solution strategies. This collaborative learning environment encouraged active participation, improved communication skills, and promoted critical thinking among students. As students engaged in discussions and problem-solving activities, they became more confident in expressing their ideas and evaluating different solution strategies.

Overall, the results of this study demonstrate that the integration of innovative learning models with culturally relevant contexts can create a more effective learning environment. The Problem Based Learning model provides opportunities for students to actively participate in the learning process, while the incorporation of local wisdom such as Hombo Batu enriches

the learning experience by connecting scientific knowledge with students' cultural background. Therefore, the implementation of the Problem Based Learning model based on local wisdom can be considered an effective strategy for improving students' problem-solving abilities in physics learning.

Suggestions

Based on the conclusions of this study, several suggestions can be proposed for educators, researchers, and educational institutions. First, physics teachers are encouraged to implement innovative and student-centered learning models such as Problem Based Learning in their classrooms. By using real-world problems and encouraging collaborative learning, teachers can help students develop higher-order thinking skills, including problem-solving and critical thinking abilities.

Second, teachers are recommended to integrate local wisdom and cultural elements into science learning activities. Incorporating local cultural practices, such as Hombo Batu, into physics instruction can make learning more contextual and meaningful for students. This approach not only improves students' understanding of scientific concepts but also helps preserve and promote local cultural heritage.

Third, schools and educational institutions should support the development of contextual learning materials that integrate local culture with scientific knowledge. Providing teachers with appropriate learning resources, training, and professional development opportunities will help them implement culturally responsive teaching strategies more effectively.

Finally, future researchers are encouraged to conduct further studies related to the integration of local wisdom in science education. Similar research can be carried out in different educational contexts, grade levels, or subject areas to explore the broader impact of culturally integrated learning models. Researchers may also investigate other aspects of student learning, such as critical thinking skills, creativity, and scientific literacy, to provide a more comprehensive understanding of the benefits of integrating local culture into education.

In conclusion, the integration of the Problem Based Learning model with the local wisdom of Hombo Batu offers a promising approach to improving students' physics problem-solving abilities while simultaneously promoting cultural awareness. This approach can contribute to the development of more engaging, meaningful, and culturally responsive learning environments in modern education.

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E-ISSN : 2828-626X
Universitas Nias Raya

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