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Integrating Lampung Local Wisdom into Science Education: Development and Validation of a Culturally Responsive Textbook to Enhance Physics Learning Outcomes

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Abstract – *The consistently low national performance in science, particularly at the junior high level, highlights the urgent need for innovative approaches in Indonesian science education. Despite policy reforms such as the Indonesian Merdeka Curriculum, many science learning experiences remain abstract and disconnected from students' daily lives, leading to low motivation and achievement. To address this gap, this study aimed to develop a science textbook model grounded in Lampung local wisdom to create more meaningful, contextualized, and engaging learning experiences. Employing a Research and Development (R&D) design, the study followed the ADDIE framework, which consists of the steps analyze, design, develop, implement, and evaluate. 30 eight-grade students at SMP Negeri 3 Batanghari, East Lampung, participated in a one-group pretest–posttest design. Validation by two science education experts rated the textbook as "very good," confirming the product's quality and curricular relevance. Statistical analysis revealed a significant improvement in learning outcomes, with a mean gain of 10.46 points and a significance value of 0.000, while classroom observations indicated increased engagement, enthusiasm, and cultural pride. The novelty of this study lies in the systematic mapping of Lampung's cultural practices directly onto science concepts, such as tapis weaving, traditional games, and piil pesenggiri values, thereby bridging the gap between scientific knowledge and cultural identity. In conclusion, the research demonstrates that integrating local wisdom into science education enhances both learning achievement and cultural relevance. This study contributes to the field of physics education by providing empirical evidence and a replicable framework for a culturally responsive science curriculum, and offers significant implications for teachers, curriculum developers, and policymakers.*

Keywords: *contextual physics learning; culturally responsive science education; Lampung culture; local wisdom; science textbook development*

I. INTRODUCTION

Science education has long been recognized as one of the central pillars in national education systems, playing a critical role in equipping learners with the necessary knowledge, skills, and

scientific attitudes to understand natural phenomena and address real-world problems. In Indonesia, science education has been emphasized within the curriculum as a means of preparing students to meet the challenges of modern society, fostering inquiry, problem-solving, and scientific literacy (Rosa & Widiawati, 2022; Rosa & Aththibby, 2021). The importance of science learning extends beyond conceptual understanding, as it provides opportunities for students to connect theoretical knowledge with daily experiences, develop rational decision-making abilities, and cultivate awareness of global challenges such as climate change, health, and sustainability (Ali et al., 2023; Haris et al., 2024). Effective science education should therefore not only transmit factual knowledge but also foster curiosity, creativity, and critical thinking skills that empower students to make meaningful contributions to society.

In this context, innovations in science education have become increasingly urgent and necessary. Traditional approaches that rely heavily on rote memorization and teacher-centered instruction often fail to engage students meaningfully, resulting in low motivation and suboptimal learning outcomes (Suryaningsih & Nurlita, 2021). The demand for innovation is particularly acute in Indonesia, where national science achievement remains below international standards. According to data from the Ministry of Education's Assessment Center, the average national score for junior high school science subjects in 2019 was only 48.79, with Islamic junior secondary schools achieving an even lower average of 44.61. These figures placed science as the third-lowest performing subject after Indonesian language and English. Such statistics highlight the urgent need for transformative approaches that make science learning more meaningful, contextual, and motivating for students (Agato et al., 2025; Puspasari et al., 2019; Wati et al., 2024). Against this backdrop, the Merdeka Curriculum was introduced as a policy reform aimed at restoring students' enthusiasm for learning following the COVID-19 pandemic. By granting schools, teachers, and students greater autonomy, the curriculum encourages creativity and exploration, with the ultimate goal of fostering contextual and enjoyable learning experiences.

Despite these policy innovations, several persistent challenges remain in science education, particularly concerning the disconnection between learning materials and students' daily lives. One of the most prominent problems is that science content is often presented abstractly, with little relevance to students' cultural or local contexts. This lack of contextualization diminishes engagement, reduces the perceived usefulness of scientific knowledge, and limits students' ability to transfer what they learn to practical situations (Kadi & Awwaliyah, 2017). Research has consistently shown that learning experiences grounded in students' immediate environment, such as cultural traditions, local practices, and community knowledge enhance understanding and retention (Utari et al., 2016). Culture, as a repository of values, practices, and ways of knowing, serves not only as a medium for transmitting heritage across generations but also as a powerful

resource for constructing meaningful learning experiences (Tanu, 2016). However, globalization and the increasing dominance of Western scientific paradigms have contributed to the marginalization of local knowledge systems, creating a perception among younger generations that local culture is irrelevant to modern science (Ilhami et al., 2021; Sarini & Selamet, 2019; Ufie, 2016).

To address these challenges, scholars and educators have turned to the integration of local wisdom into science education as a potential solution. Local wisdom encompasses the values, norms, and practices that have been transmitted across generations and remain embedded in the everyday lives of communities. When utilized as a learning resource, local wisdom offers a unique opportunity to contextualize science education, making it more engaging and relevant while simultaneously fostering cultural pride. For instance, agricultural practices, health traditions, and local technologies can all serve as entry points to explore concepts in biology, chemistry, and physics, respectively. Integrating local wisdom into science education has been shown to improve students' motivation, enhance conceptual understanding, and reinforce their connection to cultural identity (Pamungkas et al., 2017; Damayanti et al., 2017; Umamah et al., 2024). Importantly, such approaches also contribute to character education by cultivating values such as cooperation, respect, and responsibility, which are deeply embedded in local cultural traditions (Mamu et al., 2023).

A growing body of research demonstrates the effectiveness of science learning based on local wisdom. For example, Rosa et al. (2020, 2023) found that integrating Lampung's cultural values, such as *Piil Pesenggiri*, into collaborative problem-solving models strengthened students' scientific attitudes and teamwork abilities. Similarly, Widyaningtyas et al. (2024) reported that contextualizing physics problem-solving within local cultural practices improved both creative thinking and problem-solving skills. In Madura, Umamah et al. (2024) identified how pigeon racing traditions can be leveraged to teach physics concepts such as force and motion. These examples demonstrate the untapped potential of diverse cultural traditions across Indonesia to enrich science education. However, while such efforts are promising, they have often been limited to small-scale interventions or specific local contexts, and systematic efforts to develop comprehensive, curriculum-aligned teaching materials rooted in local wisdom remain scarce.

The literature also highlights persistent research gaps. Despite increasing recognition of the importance of integrating culture into science education, few studies have developed structured teaching resources such as textbooks or modules that systematically embed local wisdom within science curricula. In Lampung specifically, initial observations revealed a lack of science teaching materials authentically grounded in local culture. Although contextual and inquiry-based learning models have been implemented to some extent, they rarely incorporate cultural elements

meaningfully (Chomsun et al., 2024, 2025). As a result, students often perceive science as abstract and disconnected from their lived experiences, which hinders both conceptual understanding and engagement. Moreover, while the Indonesian Merdeka Curriculum emphasizes contextualization and creativity, teachers often lack the necessary resources, training, or examples to effectively operationalize these principles in classroom practice. This disconnect underscores the need for systematic innovation that bridges cultural heritage with modern scientific education.

In response to these challenges, this study proposes the development of a science textbook model explicitly grounded in Lampung's local wisdom. The integration of cultural elements such as traditional games, musical instruments, crafts, and philosophies into science materials provides multiple avenues for contextualization. For example, the traditional weaving art of Tapis Lampung can be used to explain concepts of fiber properties, solutions, and material changes; the game *Kebabeng* embodies principles of force and motion aligned with Newton's Laws; and the *Piil Pesenggiri* philosophy provides a foundation for cultivating scientific attitudes. By mapping these cultural practices directly onto curriculum content, the proposed textbook seeks to create learning experiences that are both scientifically rigorous and culturally meaningful (Rosa et al., 2024; Ufie, 2016).

The novelty of this research lies in its systematic approach to integrating Lampung's local wisdom into a structured science textbook for junior high school students, aligning cultural elements with curriculum standards under the Indonesian Merdeka Curriculum. Unlike previous studies that have focused on isolated practices or small-scale interventions, this study aims to develop a comprehensive, validated, and empirically tested teaching resource. By doing so, it addresses a critical research gap in science education: the lack of culturally contextualized, curriculum-aligned materials that can be readily adopted by teachers in diverse settings. The outcomes of this study are expected to contribute not only to the theoretical advancement of science learning models but also to practical improvements in teaching and learning processes. Furthermore, the research provides a replicable framework that can be adapted in other regions of Indonesia, each with its unique cultural heritage, thereby promoting a broader movement towards culturally responsive science education.

II. METHODS

This study employed a Research and Development (R&D) design aimed at producing and validating a science textbook model that integrates Lampung local wisdom with junior high school science content. The R&D method is widely recognized in educational research as an appropriate approach for generating instructional products while simultaneously testing their

feasibility and effectiveness in authentic learning environments (Damayanti et al., 2017; Pamungkas et al., 2017). This study specifically adopted the ADDIE model, which comprises the steps of analysis, design, development, implementation, and evaluation, considered one of the most systematic and flexible frameworks for instructional design (Puspasari et al., 2019; Wati et al., 2024).

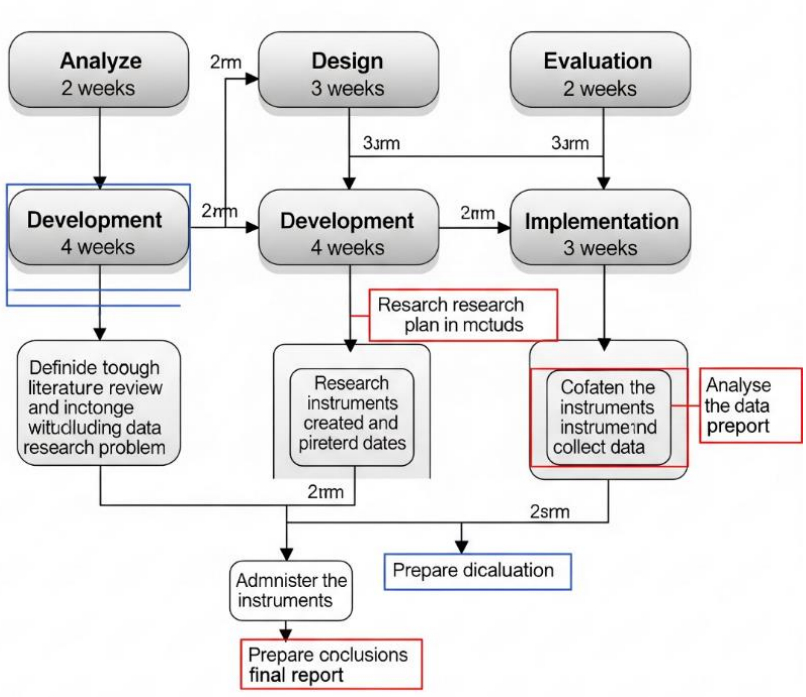

Figure 1. Flowchart of ADDIE stages in research

The Analyze stage was conducted over two weeks and involved gathering data through interviews with cultural experts, document reviews, and analysis of scientific literature. This stage sought to identify cultural practices in Lampung that could be meaningfully connected with science concepts and to examine the need for innovative teaching resources. The findings confirmed that most existing science learning materials lacked contextualization, and that local wisdom had not yet been systematically integrated into science education, thereby justifying the development of the textbook.

The design stage was carried out over three weeks, focusing on the construction of the structure, content, and layout of the textbook. In this phase, the researchers aligned Lampung cultural elements with science concepts specified in the Indonesian Merdeka Curriculum. The design emphasized contextual learning principles, where abstract scientific content was explained through examples derived from students' cultural environments (Utari et al., 2016; Rosa et al., 2024). By incorporating weaving traditions, indigenous games, and philosophical values into the design, the textbook was envisioned as both a scientific and cultural resource.

During the development stage, which lasted four weeks, the textbook prototype was produced based on the design specifications. At this point, draft content was created, illustrations were prepared, and exercises were developed to encourage students' active participation. To ensure quality, the prototype underwent expert validation by two lecturers in science education with more than a decade of experience in curriculum and material development. The experts evaluated the completeness of local wisdom integration, the adequacy of science content, and the relevance of cultural examples to scientific explanations. Their assessments provided constructive feedback, leading to refinements in the content and structure of the textbook.

The Implementation stage was conducted over three weeks in the form of a limited field trial at SMP Negeri 3 Batanghari, East Lampung, involving 30 eighth-grade students. The study employed a one-group pretest–posttest design, a design frequently used in development research to evaluate the effectiveness of educational interventions when experimental control groups are not feasible (Chomsun et al., 2024, 2025). In this stage, students were taught using the developed textbook under the guidance of their science teacher. Data were collected through multiple instruments, including tests of learning outcomes, student questionnaires, teacher feedback forms, and classroom observations. The tests were used to capture both pre-intervention and post-intervention performance. The questionnaires gauged students' responses to the textbook, and the observation sheets documented engagement and participation during classroom activities.

The final stage, evaluation, was conducted over two weeks and involved synthesizing findings from validation, classroom trials, and statistical analysis. Data analysis was carried out using both descriptive and inferential methods. Normality testing was performed with the Kolmogorov–Smirnov test to ensure that pretest and posttest scores followed a normal distribution, a prerequisite for parametric testing. After normality was confirmed, a paired sample t-test was used to determine whether significant differences existed between pretest and posttest results. The significance level was set at 0.05, in accordance with common practice in educational research (Ali et al., 2023; Rosa et al., 2023). In addition to statistical measures, qualitative data from observations and teacher interviews were analyzed to capture students' engagement, enthusiasm, and perceptions of the cultural relevance of the material.

Through the systematic application of the ADDIE model, the methodology ensured that each development stage was rigorously implemented and connected to both theory and practice. The analyze and design stages grounded the textbook in cultural and curricular realities; the development stage produced a validated prototype; the implementation stage tested the product in an authentic classroom setting; and the evaluation stage confirmed its pedagogical effectiveness. By integrating Lampung cultural wisdom into science learning materials, this methodological design provides a robust framework for developing innovative and contextually

relevant resources. It also establishes a foundation for future replications in other regions of Indonesia, each with its distinct cultural heritage, thereby advancing broader goals of culturally responsive science education.

III. RESULTS AND DISCUSSION

The development of a science textbook model based on Lampung local wisdom was carried out systematically following the ADDIE framework. Each stage of the process generated outputs that provided the foundation for subsequent phases, culminating in the validation and testing of the final product. The initial stage involved gathering information from interviews, literature analysis, and cultural observations. Findings indicated that although contextual and inquiry-based learning models had been previously applied in Indonesian classrooms, there was a notable absence of structured teaching materials rooted in Lampung's cultural heritage.

The design and mapping process resulted in the identification of several Lampung cultural practices that could be directly connected with science concepts. As illustrated in Table 1**,** traditional weaving (*tapis* Lampung) was associated with material properties and chemical changes. At the same time, indigenous games such as *Kebabeng* and *Englek* were linked with principles of motion, force, and balance. In addition, musical instruments such as the *gambus tunggal* were used to illustrate wave and vibration phenomena, and philosophical traditions such as *Piil Pesenggiri* were integrated into the cultivation of scientific attitudes. This mapping demonstrated that Lampung's cultural resources could serve as an authentic foundation for contextualizing junior high school science learning.

Table 1. Mapping Lampung local wisdom in junior high school science materials

Local Wisdom	Description
Tapis Lampung	Concept of types and properties of fibers, solutions, changes in materials, preservation, and diversity of flora and fauna
Traditional game *englek*	Concept of measurement and equilibrium
Traditional game *yeye*	Concept of types of materials and speed
Traditional game *bekel ball*	Concept of momentum
Traditional game of *kebabeng*	Concept of force, motion, energy, and Newton's Laws
Traditional game of *pukan*g	Concept of force and motion, energy & balance
Gambus tunggal musical instrument	Concept of wave; concept of vibration and wave & sound
Siger Lampung	Concept of mechanics, elements and compounds, and chemical reactions
Piil Pesenggiri	Concept of scientific attitude

The prototype textbook underwent expert validation by two senior lecturers specializing in science education. Validation focused on three dimensions: the completeness of local cultural potential identified, the adequacy of the science content, and the coherence between local wisdom

and scientific concepts. The validation results, presented in Table 2, showed that the product achieved a very good category across all dimensions, with average scores ranging from 4.50 to 5.00 on a 5-point scale. The slightly lower score for completeness of local cultural identification reflected the evaluators' view that additional cultural elements from Lampung could potentially be incorporated. Nevertheless, the overall validation results confirmed that the textbook was both feasible and of high quality for classroom implementation.

Table 2. Results of expert validation of the Lampung local culture harmonization book on science learning

Assessment aspects	Average score	Max score	Category
Completeness of identification of local potential	4.50	5.00	Very good
Completeness of science material	5.00	5.00	Very good
Suitability of local potential with science material	5.00	5.00	Very good

The implementation of the validated product was conducted through a limited field trial involving 30 eighth-grade students at SMP Negeri 3 Batanghari, East Lampung. The pre-experimental design employed a one-group pretest-posttest format, allowing direct measurement of learning gains attributable to the intervention. Before conducting the t-test, normality of the data was examined using the Kolmogorov–Smirnov test. As reported in Table 3, the significance values for both pretest and posttest results exceeded 0.05, indicating that the data were normally distributed and thus suitable for parametric analysis.

Table 3. Student learning normality results

Data		Kolmogorv-Smirnov		
		Statistik	N	Sig.
Learning outcome	Initial	0.887	30	0.411
	End	0.786	30	0.567

Subsequently, a paired-sample t-test was conducted to compare the pretest and posttest scores. The results, shown in Table 4, revealed a statistically significant improvement in learning outcomes. The mean gain was 10.46 points, with a standard deviation of 12.33. The significance value of 0.000 ($p < 0.05$) confirmed that the increase in student achievement was not attributable to chance. These results clearly indicate that the use of the Lampung local wisdom-based science textbook had a positive impact on students' learning performance.

Table 4. T-test result of student learning outcomes

Pair mean	Paired differences					t	df	Sig. (2-tailed)
	Mean	Std. deviation	Std. error mean	Lower	Upper			
Posttest - Pretest	10.46	12.33	2.181	6.021	14.917	4.80	31	.000

The quantitative findings were further supported by qualitative observations during classroom implementation. Teachers reported higher levels of student engagement, with learners displaying curiosity and enthusiasm when cultural elements were integrated into science topics. For example, discussions on motion became more interactive when students related Newtonian mechanics to the traditional game *kebabeng*, while lessons on wave properties were made more tangible through the demonstration of the *gambus tunggal* musical instrument. Students were also observed to express pride in their local heritage, suggesting that the integration of culture not only improved conceptual understanding but also contributed to the strengthening of cultural identity.

The findings of this study demonstrate that a culturally grounded science textbook can produce meaningful gains in student learning while meeting expectations for curricular alignment and product quality. Expert validation placed the textbook in the very good category across all criteria, and classroom implementation resulted in a statistically significant improvement in learning outcomes, with an average increase of 10.46 points on post-test scores. Taken together, these results support longstanding claims in the literature that science learning becomes more comprehensible and durable when instruction is anchored in learners' lived contexts and cultural practices.

Situating science ideas in culturally familiar activities such as traditional weaving, children's games, and local musical instruments addresses a core pedagogical challenge repeatedly identified in Indonesian classrooms. Prior studies have argued that learning tied to students' immediate environment promotes understanding, transfer, and motivation (Utari et al., 2016). The present mapping of Lampung local wisdom to the junior-high curriculum (Table 1) operationalizes this principle by linking, for instance, tapis weaving to fiber properties and material change, *kebabeng* and *englek* to force, motion, and balance, and *gambus tunggal* to vibration and wave phenomena. These linkages exemplify ethnoscience approaches that translate cultural practice into scientific explanation and inquiry, a strategy shown to elevate engagement and achievement in earlier work (Pamungkas et al., 2017; Damayanti et al., 2017; Mamu et al., 2023). The qualitative observations recorded during implementation, which heightened curiosity, fostered richer classroom dialogue, and led to explicit expressions of cultural pride, are consistent

with this body of evidence and with recent reports that culture-based contextualization strengthens both conceptual grasp and character formation (Harjono, 1982; Hasan, 1983; Husodo, 2013).

The observed learning gains align closely with past interventions that embedded local wisdom within science pedagogy. In physics, for example, Rosa et al. (2020; 2023) documented that integrating the Lampung value of *piil pesenggiri* within collaborative problem-solving models strengthened scientific attitudes and teamwork, while Widyaningtyas et al. (2024) showed improvements in creative thinking and problem solving when culturally situated tasks framed physics content. Likewise, Umamah et al. (2024) illustrated how pigeon-racing traditions in Madura can surface mechanics concepts in ways students find intuitive. The present study extends these insights from activity design toward a complete, curriculum-aligned textbook that teachers can adopt directly. In doing so, it addresses recurring calls in the literature for structured instructional resources beyond one-off tasks that teachers can use to enact contextual learning mandated by national policy consistently.

The results also speak to the aims of the Indonesian Merdeka Curriculum, which emphasizes autonomy, contextualization, and joy in learning. By providing worked examples, concept explanations, and activities that originate in Lampung culture, the textbook offers a concrete mechanism for realizing the curriculum's vision in routine classroom practice. This is particularly salient given persistent gaps in national science performance and student motivation. The significant pre- to posttest improvement reported here, combined with normality checks and paired-samples analysis (Tables 3–4), indicates that culturally responsive materials can be an effective lever for raising outcomes within existing instructional time and infrastructure.

From a theoretical perspective, the findings support a socio-constructivist account of learning, in which new scientific ideas are acquired through culturally meaningful tools and practices. Local wisdom functions not only as a context but as a semiotic resource that helps students bridge everyday reasoning and disciplinary explanation. For instance, mapping the rules and embodied experience of *kebabeng* to Newtonian dynamics invites students to articulate the forces, constraints, and energy transfer that are already implicit in play. Similarly, analyzing the acoustic properties of the *gambus tunggal* requires students to formalize intuitive understandings of vibration and resonance. Such movements from tacit, situated knowledge to explicit scientific modeling align with prior reports that ethnoscience-based instruction supports concept formation and literacy in science (Sarini & Selamet, 2019; Wijiningsih et al., 2017).

At the same time, expert feedback during validation usefully highlighted the need for completeness in identifying local cultural resources, noting that additional Lampung practices could be incorporated (Table 2). This observation concurs with historical and sociological accounts of Lampung as a heterogeneous, acculturated region shaped by transmigration and

interethnic interaction, which implies a broad and evolving repertoire of cultural forms (Arowolo et al., 2010; Hariyadi, 2010; Khoiriyah et al., 2019). Pedagogically, this heterogeneity is an asset: it widens the range of authentic entry points for science topics and allows teachers to select representations that resonate with their specific school communities. Future iterations of the textbook should therefore expand the cultural corpus and offer guidance for teacher-led localization, consistent with calls to treat culture as a dynamic resource within science curricula.

Several methodological considerations frame the interpretation of impact. The one-group pretest–posttest design employed in this study is suitable for early-stage product trials and, in conjunction with expert validation, provides convergent evidence for feasibility and promise. Nevertheless, the absence of a control group and the limited sample from a single school constrain claims about causality and generalizability. The statistically significant mean gain of 10.46 points indicates practical educational benefit under the conditions of use. Still, subsequent studies should incorporate comparison groups, larger and more diverse samples, and longer follow-up intervals to assess retention and transfer, as recommended in prior development studies of culture-based learning tools (Chomsun et al., 2024, 2025; Puspasari et al., 2019; Wati et al., 2024). In addition, future work could estimate effect sizes, examine differential impacts across subgroups, and integrate qualitative assessments of identity development and scientific disposition associated with *piil pesenggiri* and related values.

Despite these limitations, the convergence of high validation ratings, statistically reliable learning gains, and rich classroom observations presents a coherent argument for the educational value of integrating Lampung local wisdom within science instruction. The textbook's design directly addresses the frequently cited disconnect between school science and students' life worlds by embedding phenomena and problems that students already know, see, and value. This design plausibly explains the observed increases in engagement and achievement and is consonant with broader national goals to cultivate scientifically literate citizens who remain rooted in cultural identity (Ali et al., 2023; Haris et al., 2024). More broadly, the development process and mapping logic presented here offer a transferable template for other regions of Indonesia to contextualize science with their distinct cultural repertoires, thereby advancing equity and relevance across diverse school settings.

IV. CONCLUSION AND SUGGESTION

This study developed and validated a science textbook model based on Lampung local wisdom to address the persistent gap between science instruction and students' cultural contexts. Following the ADDIE framework, the textbook was systematically designed, validated by

experts, and implemented in classroom practice. The validation results rated the product very good across all dimensions, while the one-group pretest-posttest design with 30 eighth-grade students demonstrated a statistically significant improvement in learning outcomes, with an average gain of 10.46 points. Qualitative observations further confirmed that integrating cultural practices such as *tapis* weaving, traditional games, and *piil pesenggiri* values enhanced student engagement, curiosity, and cultural pride, thereby making science learning more meaningful and relevant.

Despite these promising results, the study is not without limitations. The limited sample size, the absence of a control group, and the focus on a single school restrict the generalizability of findings. Future research should therefore involve larger and more diverse populations, adopt experimental or quasi-experimental designs to facilitate stronger causal inference, and explore the long-term impacts on conceptual retention, scientific dispositions, and identity development. Nevertheless, this study contributes significantly to the field of physics and science education by providing empirical evidence that culturally contextualized textbooks can improve learning outcomes while reinforcing cultural identity. More importantly, it offers a replicable framework for integrating local wisdom into science curricula across diverse regions of Indonesia, thereby advancing the goals of contextualized, equitable, and culturally responsive science education.

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