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Contextual Teaching Materials Development and Its Impact on Science Learning Outcomes

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Abstract

This study aimed to develop contextual-based science teaching materials on the topic of pressure and to evaluate their validity, practicality, and effectiveness in improving students' science learning outcomes at YHS Christian Junior High School Makassar. The study employed a Research and Development (R&D) approach using the 4-D model, consisting of the Define, Design, Develop, and Disseminate stages. The effectiveness of the developed teaching materials was examined using a quasi-experimental design involving an experimental group and a control group. The field testing involved 30 Grade IX students, consisting of 16 students in the experimental group and 14 students in the control group. Data were collected using expert validation sheets, teacher practicality questionnaires, and students' learning achievement tests. The validation results indicated that the developed teaching materials achieved an average Aiken's V coefficient of 0.90, indicating high validity. The practitioners' evaluation yielded an average practicality score of 92.91%, categorizing the teaching materials as very practical. The effectiveness analysis showed that students who learned using contextual-based teaching materials achieved higher learning outcomes than those who learned using conventional teaching materials. The Independent Samples t-test revealed a calculated t-value of 6.15, which exceeded the critical t-value of 1.40 at the 5% significance level, indicating a statistically significant difference between the two groups. These findings demonstrate that the developed contextual-based science teaching materials are valid, practical, and effective in improving junior high school students' science learning outcomes.

Introduction

Education plays a strategic role in developing high-quality human resources capable of adapting to scientific advancements and societal needs (Mukhtar et al., 2026; Marlina et al., 2026; Saparuddin et al., 2026). The Ministry of Education, Culture, Research, and Technology of Indonesia emphasizes the importance of expanding access to quality education, strengthening educational quality and relevance, and fostering students' character development. In line with this vision, Law Number 20 of 2003 concerning the National Education System states that national education aims to develop learners' potential, build dignified national character and civilization, educate the nation, and produce responsible citizens. Therefore, educational practices should be designed to develop students who are not only academically competent but also possess the character and skills necessary to contribute positively to society (Ridwan et al., 2026; Handayani, 2026; Ramadhani et al., 2026).

Science education is one of the subjects that significantly contributes to achieving these educational goals (Ragadhita et al., 2026; Chen et al., 2026; Rahmawati & Turista, 2026). Science learning focuses on understanding natural phenomena and processes occurring in the surrounding environment, enabling students to relate scientific concepts to real-life situations

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(Aldya et al., 2022). Furthermore, science is an essential discipline that supports problem-solving in everyday life and helps learners develop a broader understanding of the world around them (Ningtyas et al., 2022). Science instruction is expected to improve learning effectiveness, enhance students' interest and motivation, and facilitate the achievement of multiple learning competencies simultaneously. In addition, science learning enables students to recognize meaningful relationships among concepts, improve higher-order thinking skills, understand practical applications of scientific knowledge, and increase learning motivation (Ramlawati, 2022; Cheng et al., 2026; Bawaneh et al., 2026).

Despite its importance, students' science learning outcomes, particularly in physics, at YHS Christian Junior High School Makassar remain relatively low. Formative assessment results from the second semester of the 2023/2024 academic year indicate that many students failed to achieve the Minimum Learning Achievement Criteria established by the school. These findings suggest the existence of learning challenges that hinder students' mastery of physics concepts.

Interviews conducted with science teachers revealed several factors contributing to the low learning outcomes, including students' lack of attention during classroom instruction, low enthusiasm for learning, insufficient understanding of physics concepts, passive participation in learning activities, and limited availability of engaging teaching materials aligned with the Merdeka Curriculum. Similarly, interviews with students indicated difficulties in understanding physics concepts, limited variation in teaching methods, insufficient involvement in learning activities, and a lack of understanding of the relevance of physics concepts to everyday life (Wawire et al., 2026; Abdullaha et al., 2026; Corpuz et al., 2022).

One potential solution to address these challenges is the development of appropriate teaching materials that meet students' learning needs (Cayabas & Sumeg-ang, 2023; Alsulami, 2025; Gadekallu et al., 2025; Oktavianti et al., 2026). Teaching materials encompass various forms of instructional resources, information, and tools systematically designed to facilitate teaching and learning processes, thereby creating an effective learning environment (Khoirunnisaa & Amidib, 2022). Well-designed teaching materials can support students' understanding of subject matter while promoting active engagement and interaction during learning activities.

A contextual approach is considered particularly suitable for the development of science teaching materials (Danial et al., 2026; Barker et al., 2026; Sannert et al., 2026). Contextual learning helps students connect academic content with real-world situations, making learning experiences more meaningful and relevant. Through contextual instruction, students are encouraged to construct knowledge based on their experiences and observations of their surrounding environment (Azizi et al., 2026; Tambak et al., 2026; Adam et al., 2026).

Previous studies have demonstrated the effectiveness of contextual teaching materials in improving learning outcomes. These findings are consistent with Hadiprayitno et al. (2024), who found that the implementation of context-based teaching materials significantly improved students' scientific literacy skills and learning performance. This effectiveness is attributed to the ability of contextual materials to relate theoretical concepts to everyday phenomena, thereby stimulating students' curiosity and enhancing conceptual understanding. Furthermore, Gustina et al. (2020) found that the Contextual Teaching and Learning (CTL) approach effectively promotes active, innovative, creative, and enjoyable learning experiences by encouraging students to discover knowledge independently. Similarly, Astiti et al. (2018) reported that students who learned using contextual teaching materials achieved significantly higher learning outcomes than those who did not, with a t-value of 2.704, a significance level of 0.009, and an effectiveness rate of 70.1%.

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Although previous studies have confirmed the effectiveness of contextual teaching materials, the implementation of such materials tailored to the characteristics and learning needs of students at YHS Christian Junior High School Makassar remains limited. Therefore, the development of contextual-based science teaching materials is necessary to provide valid, practical, and effective learning resources capable of improving students' learning outcomes. The quality of the developed materials should be evaluated through expert validation, practitioner feedback, and effectiveness testing to ensure their suitability for classroom implementation (Zulfainar, 2024).

Based on the aforementioned considerations, this study aims to develop contextual-based science teaching materials, examine their validity and feasibility through expert and practitioner evaluations, and investigate their impact on students' science learning outcomes at YHS Christian Junior High School Makassar.

Methods

This study employed a Research and Development (R&D) approach using the 4-D development model proposed by Thiagarajan, consisting of four stages: Define, Design, Develop, and Disseminate. This model was used to develop contextual-based science teaching materials on the topic of pressure for Grade IX students and to evaluate the quality of the developed product in terms of validity, practicality, and effectiveness.

The study was conducted at SMP Kristen YHS Makassar during the second semester of the 2025/2026 academic year. The participants consisted of expert validators, science teachers, and Grade IX students. The validation process involved ten validators who assessed the feasibility of the developed teaching materials. The practicality evaluation involved ten junior high school science teachers, consisting of two science teachers from SMP Kristen YHS Makassar and eight science teachers who were members of the Science Teachers Association (MGMP IPA) of Makassar. The field testing involved 30 Grade IX students, consisting of 16 students in the experimental group and 14 students in the control group.

The development procedure followed the four stages of the 4-D model. During the Define stage, needs analysis, learner analysis, concept analysis, task analysis, and learning objective formulation were conducted to identify students' learning problems and instructional needs related to the topic of pressure. The Design stage involved selecting the instructional format, preparing contextual learning activities, designing assessment instruments, and developing the initial prototype of the contextual-based science teaching materials. The Develop stage consisted of expert validation, product revision, practicality evaluation by science teachers, and classroom implementation. The Disseminate stage was conducted by distributing the finalized teaching materials to science teachers and members of MGMP IPA Makassar for broader classroom use.

The effectiveness of the developed teaching materials was examined using a quasi-experimental design involving an experimental group and a control group. The experimental group was taught using contextual-based science teaching materials, while the control group was taught using conventional teaching materials commonly used at school. Both groups studied the same topic, namely pressure, within the same instructional duration of eight meetings. In the experimental group, the teaching materials were implemented through contextual learning activities integrated with the Discovery Learning model. The learning activities encouraged students to observe real-life phenomena, identify problems, collect data, conduct experiments, discuss findings, and draw conclusions. Meanwhile, the control group received instruction using the school's conventional science textbook and regular teacher-

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centered learning approach. This design was used to compare students' learning outcomes between the group taught using the developed contextual-based teaching materials and the group taught using conventional teaching materials, following the principle of control group comparison in learning outcome research (Mulyadi, 2015).

Three main instruments were used in this study, namely expert validation sheets, teacher practicality questionnaires, and students' learning achievement tests. The expert validation sheet was used to assess the validity of the developed teaching materials based on four aspects: content feasibility, presentation, language, and graphical design. The teacher practicality questionnaire consisted of 42 statements measured using a four-point Likert scale and was used to evaluate the practicality of the teaching materials in terms of content feasibility, presentation feasibility, language feasibility, and graphical feasibility. The students' learning achievement test was administered after the instructional intervention to measure students' conceptual understanding of pressure. The test assessed students' ability to understand pressure concepts, apply scientific principles, solve contextual problems, and interpret scientific phenomena related to the learning materials.

Data were collected through expert judgment, teacher responses, and students' learning achievement scores. The validity of the teaching materials was analyzed using Aiken's V coefficient. The teaching materials were considered valid when the Aiken's V coefficient reached or exceeded the minimum validity criterion of 0.40 (Azwar, 2015). The practicality of the teaching materials was analyzed using percentage scores obtained from the teachers' practicality questionnaire and interpreted according to the practicality criteria proposed by Sugiyono (2014). The effectiveness of the teaching materials was analyzed by comparing students' learning achievement scores between the experimental and control groups.

Before conducting hypothesis testing, prerequisite tests were performed to ensure that the data met the assumptions required for parametric statistical analysis. The normality of students' learning achievement data was tested using the Liliefors test at a significance level of 0.05, while the homogeneity of variance between the experimental and control groups was tested using the F-test. After the data were confirmed to be normally distributed and homogeneous, an Independent Samples t-test was conducted to determine whether there was a significant difference in learning outcomes between students who learned using contextual-based science teaching materials and those who learned using conventional teaching materials. The hypothesis was accepted when the calculated t-value was greater than the critical t-value at the 5% significance level.

Results and Discussion

Prerequisite Tests for Hypothesis Testing

Prior to hypothesis testing, prerequisite analyses were conducted to ensure that the data met the assumptions required for parametric statistical analysis. These analyses consisted of normality and homogeneity tests. The normality of students' learning outcome data was examined using the Liliefors test at a significance level of $\alpha = 0.05$, while the homogeneity of variance between the experimental and control groups was analyzed using the F-test.

Table 1. Results of the Normality Test (Liliefors)

Group	n	L-count	L-table ($\alpha = 0.05$)	Conclusion
Experimental	16	0.122	0.213	Normally distributed
Control	14	0.131	0.227	Normally distributed

Source: Research data analysis

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The results of the normality test showed that the calculated Liliefors values for both the experimental and control groups were lower than the corresponding critical values (L_{count} < L_{table}). Therefore, the learning outcome data in both groups were normally distributed, indicating that the normality assumption was satisfied.

Table 2. Results of the Homogeneity Test (F-test)

Data	Number of Students (n)	df	Mean ($\bar{X}$)	Variance (S^2)
Experimental Group	16	15	23.50	10.80
Control Group	14	13	16.71	7.14
F-value				1.51
F-critical				2.53

Source: Research data analysis

The homogeneity test indicated that the calculated F-value (1.51) was lower than the critical F-value (2.53), demonstrating that the variances of the two groups were homogeneous. Since both the normality and homogeneity assumptions were fulfilled, the data were considered suitable for further analysis using an Independent Samples *t*-test to determine whether there was a statistically significant difference in learning outcomes between students who learned using contextual-based teaching materials and those who learned using conventional textbooks. This prerequisite analysis confirmed that the assumptions underlying the parametric test had been met, thereby ensuring the validity of the subsequent hypothesis testing.

Validity of Contextual-Based Science Teaching Materials

The contextual-based science teaching materials were developed based on the needs analysis conducted at SMP Kristen YHS Makassar. The development aimed to provide learning resources that connect scientific concepts with students' daily experiences and support the improvement of learning outcomes. Prior to implementation, the initial prototype was evaluated by experts in physics education and instructional material development to determine its content validity and overall feasibility.

Content validity was assessed by 10 expert validators covering four aspects: content feasibility, presentation, language, and graphical design. The validity analysis employed Aiken's V coefficient, which measures the degree of agreement among experts regarding the relevance of each item to the intended construct. According to the established criterion, an item is considered valid when the Aiken's V coefficient is greater than or equal to 0.40 (Azwar, 2015).

Table 3. Content Validity Analysis of Contextual-Based Science Teaching Materials

No.	Assessment Aspect	S1	S2	$\sum S$	$n(c-1)$	V	Category
1	Content Feasibility	32	39	71	78	0.91	Valid
2	Presentation	21	27	48	54	0.89	Valid
3	Language	22	27	49	54	0.91	Valid
4	Graphical Design	29	36	65	72	0.90	Valid
	Average					0.90	Valid

Source: Validation results of expert judgments

As shown in Table 3. all assessed aspects achieved Aiken's V values above the minimum validity criterion of 0.40. The content feasibility and language aspects obtained the highest validity coefficient (V = 0.91), followed by graphical design (V = 0.90) and presentation (V = 0.89). The overall average Aiken's V coefficient was 0.90, indicating a high level of expert

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agreement and confirming that the developed teaching materials possess strong content validity and are suitable for classroom implementation.

Validity reflects the extent to which an instrument or educational product accurately performs its intended function (Azwar, 2015). In instructional material development, content validity is essential because it ensures that the learning content, presentation, language, and visual elements appropriately represent the targeted competencies and learning objectives (Sugiyono, 2014). Therefore, the high validity scores obtained in this study indicate that the contextual-based teaching materials are relevant, representative, and aligned with the curriculum requirements for Grade IX science learning.

The developed teaching materials focus on the topic of pressure and were designed according to the findings obtained during the *define* stage of the 4-D development model. The materials were developed in printed form to facilitate students' understanding of abstract physics concepts through structured learning activities and contextual examples. Previous studies have shown that well-designed teaching materials can improve conceptual understanding, increase learning motivation, and promote active student participation in the learning process (Widiastuti, 2020).

The structure of the teaching materials consists of three main sections. The introductory section includes the cover page, preface, instructions for use, and table of contents. The main section contains pressure-related learning materials presented systematically through contextual learning activities that connect scientific concepts to real-life situations encountered by students. Each learning activity is designed to encourage students to explore problems, construct understanding, and apply concepts in authentic contexts. The final section includes summaries, practice exercises accompanied by answer keys, a glossary, and references.

These findings are supported by Nasution et al. (2024), who emphasized that the integration of local and cultural contexts into physics learning creates meaningful learning experiences and facilitates students' understanding of physics concepts through real-life situations. By integrating contextual situations into learning activities, students are encouraged to relate scientific knowledge to everyday experiences, thereby fostering meaningful learning and deeper conceptual understanding. Consequently, the high validity results obtained in this study indicate that the developed contextual-based science teaching materials are appropriate for use as learning resources and have the potential to support improvements in students' learning outcomes.

Practitioners' Evaluation of the Quality of Contextual-Based Science Teaching Materials

The quality and practicality of the developed contextual-based science teaching materials were evaluated through practitioners' responses. The evaluation involved ten junior high school science teachers, consisting of two science teachers from SMP Kristen YHS Makassar and eight science teachers from other schools who are members of the Science Teachers Association (MGMP IPA) of Makassar. The practitioners assessed the teaching materials using a questionnaire consisting of 42 statements rated on a four-point Likert scale. The assessment covered four aspects, namely content feasibility, presentation feasibility, language feasibility, and graphical feasibility. The results of the practitioners' evaluation are presented in Table 4.

Table 4. Practitioners' Evaluation of Contextual-Based Science Teaching Materials

No	Aspect	Ideal Score	Obtained Score	(%)	Category
1	Content Feasibility	104	97	93.27	Very Practical
2	Presentation Feasibility	72	66	92.67	Very Practical

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3	Language Feasibility	72	67	93.05	Very Practical
4	Graphical Feasibility	96	89	92.71	Very Practical
	Average			92.91	Very Practical

Based on Table 4, practitioners provided highly positive evaluations across all assessed aspects of the developed teaching materials. The highest percentage score was obtained for the content feasibility aspect (93.27%), followed by language feasibility (93.05%), graphical feasibility (92.71%), and presentation feasibility (92.67%). The overall average score reached 92.91%, indicating that the teaching materials fall within the "Very Practical" category.

The high practicality score demonstrates that the developed teaching materials are considered easy to use, relevant to curriculum objectives, and appropriate for classroom implementation. In particular, practitioners acknowledged that the contextual learning activities, examples, and exercises successfully connected pressure concepts with students' everyday experiences, thereby supporting meaningful learning. Furthermore, the systematic organization of the material, the clarity of language, and the attractive visual design contributed positively to the usability of the teaching materials during instruction.

The findings suggest that the contextual-based science teaching materials meet the practical requirements expected by science teachers and can effectively support the teaching and learning process. These results are consistent with the validity findings presented in the previous section, indicating that the developed product is not only valid in terms of content but also practical for implementation in classroom settings.

The results of this study are in agreement with previous research conducted by Nggia et al. (2023), which reported that contextual-based teaching materials are highly practical and feasible for classroom use. Similarly, Widiastuti (2020) found that contextual-based science teaching materials possess good quality and meet instructional feasibility standards, thereby improving students' conceptual understanding. Furthermore, the findings are supported by the study of Nadhifah et al. (2025), which concluded that contextual-based science learning modules are suitable for science instruction and contribute to the development of junior high school students' scientific literacy.

Overall, the practitioners' evaluation confirms that the developed contextual-based science teaching materials possess a high level of practicality and are suitable for broader implementation in science learning, particularly in the teaching of pressure concepts at the junior high school level.

Differences in Students' Learning Outcomes Between Classes Using and Not Using Contextual-Based Science Teaching Materials

Teaching materials play an important role in supporting effective learning because they serve as one of the primary learning resources used by students during the instructional process (Karimah, 2022). In this study, contextual-based science teaching materials were developed and implemented to determine their effect on students' learning outcomes. Following the validation and practicality testing stages, the materials were tested in an experimental class and compared with conventional teaching materials used in a control class. Students' conceptual understanding was subsequently measured using a validated essay-based test to examine differences in learning outcomes between the two groups.

The implementation of the teaching materials was carried out using a Control Group Pretest–Posttest Design involving 16 students in the experimental group and 14 students in the control group. After eight learning sessions, students' conceptual understanding was measured using

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the same assessment instrument to evaluate the effectiveness of the developed teaching materials.

The results revealed differences in learning achievement between the two groups. Students who learned using contextual-based science teaching materials demonstrated better performance than those who learned using conventional teaching materials. The comparison of students' learning outcomes is presented in Figure 1.

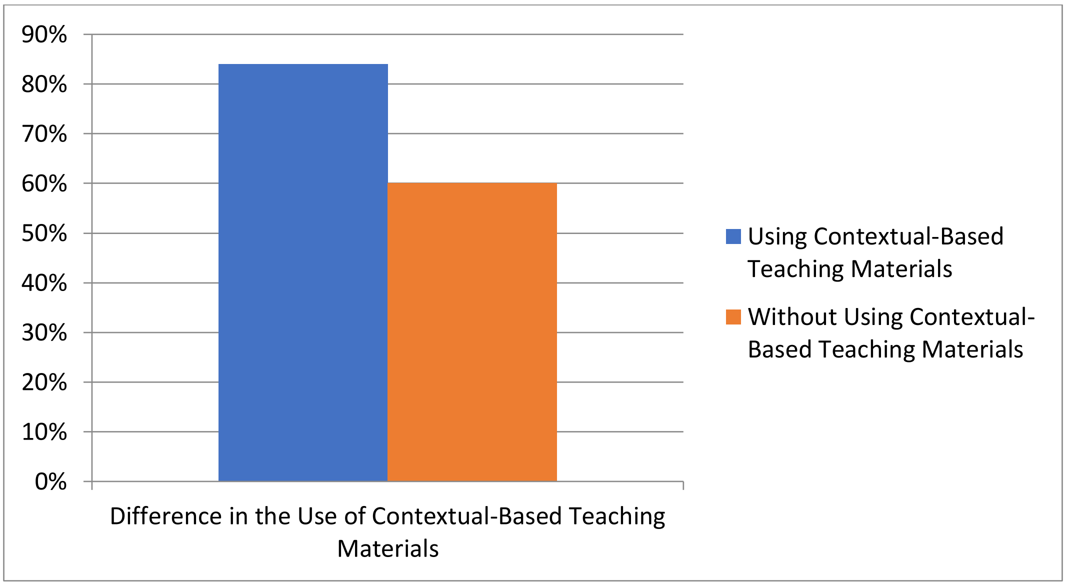

Figure 1. Students' Learning Outcomes

Based on Figure 1. the percentage of students' learning outcomes in the experimental group reached 83.92%, whereas the control group achieved 69.67%. These findings indicate that students who learned using contextual-based science teaching materials obtained higher conceptual understanding scores than those who learned using conventional teaching materials. The results suggest that integrating learning materials with real-life contexts can facilitate students' understanding of scientific concepts and improve learning achievement.

To determine whether the observed difference was statistically significant, an Independent Samples *t*-test was conducted. Prior to hypothesis testing, prerequisite analyses consisting of normality and homogeneity tests were performed. The results confirmed that the data met the assumptions required for parametric statistical analysis. The complete data of students' conceptual understanding scores are presented in Appendix B4, page 103.

Table 5. Independent Samples t-Test Results for Conceptual Understanding Scores

Statistic	**Experimental Group**	**Control Group**
N	16	14
Mean	23.50	16.71
Variance (S^2)	10.80	7.14
t-value	6.15	
t-critical	1.40	

Source: Research data analysis

As shown in Table 5. the calculated *t*-value (6.15) was greater than the critical *t*-value (1.40) at the 5% significance level. Therefore, the null hypothesis (H_0) was rejected, indicating a statistically significant difference in conceptual understanding between students who learned

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using contextual-based science teaching materials and those who learned using conventional teaching materials. These results demonstrate that the developed teaching materials positively influenced students' learning outcomes.

The effectiveness of the contextual-based teaching materials can be attributed to their ability to connect scientific concepts with students' everyday experiences. Through contextual learning activities, students were encouraged to actively construct knowledge, explore real-life problems, and relate abstract physics concepts to meaningful situations. This learning process enhanced student engagement and facilitated deeper conceptual understanding compared to conventional instruction.

The findings of this study are consistent with those reported by Paudi & Ngaito (2026), who found that contextual-based teaching materials improve conceptual understanding, learning motivation, and academic achievement by increasing student engagement and critical thinking skills. Similarly, Astiti et al. (2018) reported that contextual-based teaching materials significantly improved students' conceptual understanding of temperature and heat concepts, with an effect size of 70.1%. These studies support the present findings that contextual learning materials are effective in promoting meaningful learning and improving students' academic performance.

The results indicate that the contextual-based science teaching materials developed in this study are valid, practical, and effective in improving students' learning outcomes. Therefore, they can be recommended as an alternative instructional resource for science learning, particularly for teaching pressure concepts at the junior high school level.

Conclusion

The results of this study indicate that the contextual-based science teaching materials developed for the topic of pressure are valid, practical, and effective for use in science learning at the junior high school level. The content validity assessment demonstrated that the teaching materials met the criteria for validity in terms of content, presentation, language, and graphical design. Furthermore, practitioners provided positive evaluations, indicating that the teaching materials were highly practical and feasible for classroom implementation. The effectiveness test revealed a significant difference in learning outcomes between students who learned using the contextual-based teaching materials and those who learned using conventional teaching materials ($t$count = 6.15 > $t$table = 1.40). Therefore, the developed teaching materials can be considered effective in improving students' learning outcomes. Future studies are recommended to further develop contextual-based science teaching materials by incorporating more diverse activities related to technology, environmental issues, and societal contexts. In addition, similar studies should be conducted on different science topics and educational levels with larger sample sizes to examine the consistency and generalizability of the effectiveness of contextual-based teaching materials in improving students' learning outcomes.

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