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Development of Local Wisdom-Based Worksheets to Improve Science Understanding and Environmental Awareness in Grade IV Students

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Abstract

Elementary science learning requires contextual materials that help students understand scientific processes and develop environmental responsibility. Preliminary analysis showed that grade IV IPAS worksheets still focused on routine exercises, terminology recognition, and teacher-centered activities, with limited investigation, field observation, and local wisdom integration. This gap makes local wisdom-based worksheets necessary because they connect environmental change concepts with students' cultural and daily experiences. This study aimed to develop and examine the validity, practicality, and effectiveness of local wisdom-based IPAS worksheets for improving students' understanding of the nature of science and environmental awareness. The study used a Research and Development design with the 4D model: define, design, develop, and disseminate. The main field trial involved 29 fourth-grade students at SD Xaverius 3 Bandar Lampung. Data were collected using expert validation sheets, teacher and student practicality questionnaires, pretest-posttest tests, and instruments measuring Nature of Science understanding and environmental awareness. The worksheet was highly valid, with an average expert validation score of 97.22%. Practicality reached 96.0% from teachers and 90.8% from students. The overall pretest mean increased from 47.8 to a posttest mean of 85.0, with a mean N-Gain of 0.71 in the high category. The N-Gain reached 76.7% for Nature of Science and 81.5% for environmental awareness. Right-tailed t-tests showed significant results for Nature of Science ($t = 6.116$, $p = 0.000$) and environmental awareness ($t = 8.938$, $p = 0.000$). The worksheet is valid, practical, and effective for supporting contextual IPAS learning and strengthening scientific literacy and environmental responsibility in elementary schools.

Keywords: Student worksheets; Local wisdom; Nature of science; Environmental awareness

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INTRODUCTION

Quality science education plays a central role in preparing students to understand scientific concepts and respond to environmental challenges in daily life. At the elementary level, Natural and Social Sciences (Ilmu Pengetahuan Alam dan Sosial, IPAS) learning is designed to build both conceptual understanding and awareness of real-world phenomena, including environmental change. In addition, science education is aligned with Sustainable Development Goal 4, which emphasizes inclusive and quality education. Within this framework, students are expected not only to master scientific knowledge but also to develop an understanding of the Nature of Science and environmental responsibility as part of scientific literacy.

However, empirical observations in Grade IV classrooms at SD Xaverius 3 Bandar Lampung indicated several learning problems. Classroom instruction was still dominated by teacher-centered lectures, which accounted for approximately 70% of learning time. Student

participation remained low, with only a small proportion of students actively engaging in questioning or discussion. Environmental behavior was also concerning, as around 75% of students still disposed of waste improperly in classroom spaces. Furthermore, interviews showed that most students did not fully understand the purpose of learning the Nature of Science and environmental awareness in IPAS. These conditions indicate that learning had not yet successfully connected scientific concepts with students' daily environmental practices.

Education plays a fundamental role in building a sustainable and resilient society. Quality education is not only a means of transferring knowledge but also a process that shapes students' character, critical thinking skills, and competencies needed to contribute meaningfully to society (Rosyidah, 2025). In the context of sustainable development, science education integrated with SDG 4 plays a strategic role in preparing students to face future environmental and social challenges (Rosyidah, 2025).

In Indonesia, the commitment to inclusive and quality education is reflected in efforts to strengthen science learning at the elementary level. One important subject in elementary schools is IPAS, which aims to build students' understanding of scientific concepts and natural phenomena. Effective IPAS learning should not only emphasize theoretical mastery but also encourage contextual and meaningful learning experiences (Pratiwi et al., 2024). The integration of ethnoscience or local wisdom in science learning has also been shown to enhance students' conceptual understanding and engagement (Sihombing et al., 2025).

A key component in science education is the Nature of Science (NoS), which shapes students' understanding of how scientific knowledge develops and changes over time. Strengthening students' understanding of NoS contributes significantly to improving scientific literacy and environmental awareness (Pratiwi et al., 2024). Environmental awareness has become increasingly urgent due to global environmental issues, and early environmental education plays a crucial role in building responsible behavior (Yamin et al., 2024). Therefore, instilling environmental concern from an early age is essential for preparing young generations to face future challenges responsibly.

The implementation of science learning that integrates local wisdom is considered effective in empowering environmental literacy and contextual understanding (Arma, 2024). Local wisdom-based environmental education programs can foster environmentally responsible attitudes and strengthen students' connections to their cultural environment (Fitri & Hadiyanto, 2022). In line with this, the development of Student Worksheets (LKPD) that incorporate ethnoscience elements is a strategic effort to enhance students' understanding of the Nature of Science and environmental awareness (Pratiwi et al., 2024).

However, previous studies indicate that many existing worksheets still focus primarily on exercises and terminology rather than facilitating concept discovery and investigative activities (Pratiwi et al., 2024). The absence of laboratory activities, field observations, and local wisdom-based learning approaches reduces opportunities for students to construct knowledge independently (Sihombing et al., 2025). Previous studies have developed ethnoscience-based learning materials and local wisdom-based worksheets to improve science understanding or environmental literacy. However, most of these studies have focused on a single outcome variable, either conceptual understanding or environmental awareness, rather than integrating both simultaneously. In addition, local wisdom integration has often been presented in a general form and has not been specifically contextualized within regional culture, such as Lampung. Assessment tools in previous research have also tended to rely on conventional tests, with limited use of Two-Tier Multiple Choice Questions (TTMCQ) to diagnose misconceptions. Moreover, few studies have focused specifically on Grade IV environmental change material using a structured 4D development approach that integrates the Nature of Science and environmental awareness in one instructional system. These limitations indicate the need for a more integrated and context-specific instructional design.

Based on these issues, this study aimed to develop and examine the validity, practicality,

and effectiveness of a Lampung local wisdom-based IPAS Student Worksheet (LKPD) on environmental change material for Grade IV elementary students, as recommended by recent research on ethnoscience-based learning development (Pratiwi et al., 2025). This study was guided by three research questions: (1) How valid is the local wisdom-based IPAS LKPD developed for Grade IV students? (2) How practical is the developed LKPD for teachers and students in classroom learning? and (3) How effective is the developed LKPD in improving students' understanding of the Nature of Science and environmental awareness?

The novelty of this study lies in the integration of Lampung local wisdom, Nature of Science understanding, environmental awareness, environmental change material, and TTMCQ-based assessment within a single 4D-based LKPD development framework for Grade IV IPAS learning. This study offers a more context-specific instructional design by positioning Lampung local wisdom not merely as cultural enrichment but as a learning context for connecting scientific concepts, environmental responsibility, and students' daily experiences.

METHOD

Research Design and Approach

This study employed a Research and Development (R&D) approach to develop a local wisdom-based IPAS Student Worksheet (LKPD) for Grade IV elementary students. The development procedure followed a modified 4D model consisting of four stages: Define, Design, Develop, and Disseminate. This model was selected because it provides a systematic procedure for developing, validating, revising, and testing instructional products before wider implementation. The development procedure used in this study is presented in Figure 1.

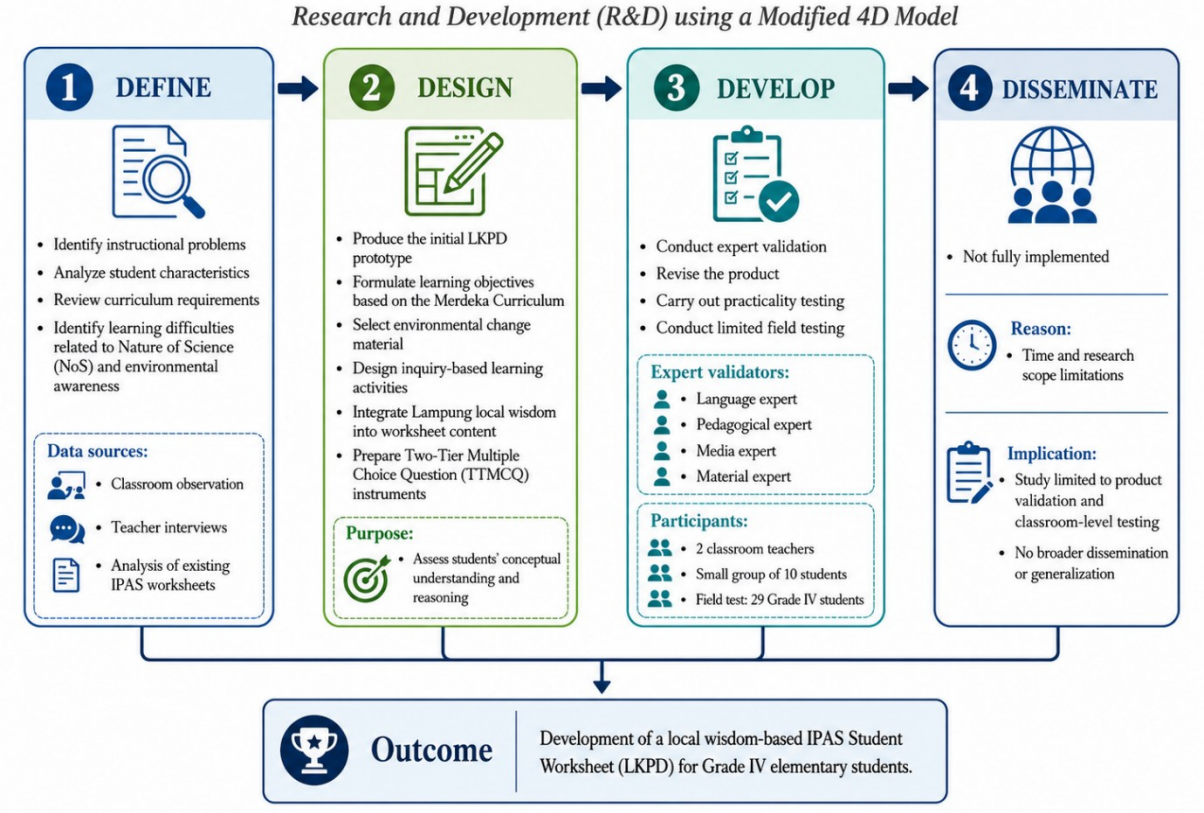

Figure 1. Research design and approach using a modified 4D model

The Define stage was conducted to identify instructional problems, student characteristics, curriculum requirements, and learning difficulties related to the Nature of Science (NoS) and environmental awareness. Data at this stage were obtained through classroom observation, teacher interviews, and analysis of the existing worksheets used in IPAS learning. This stage provided the basis for determining the need for a contextual worksheet that integrates environmental change material with Lampung local wisdom.

The Design stage focused on producing the initial prototype of the LKPD. This stage included formulating learning objectives based on the Merdeka Curriculum, selecting environmental change material, designing inquiry-based learning activities, integrating Lampung local wisdom into the worksheet content, and preparing Two-Tier Multiple Choice Question (TTMCQ) instruments. The TTMCQ instruments were designed to assess students' conceptual understanding and reasoning related to NoS and environmental awareness.

The Develop stage involved expert validation, product revision, practicality testing, and limited field testing. Expert validation was conducted by four experts, consisting of language, pedagogical, media, and material experts. The validation results were used as the basis for revising the LKPD before classroom implementation. Practicality testing involved two classroom teachers and a small group of 10 students, while the main field test involved 29 Grade IV students. These procedures were conducted to examine the validity, practicality, and effectiveness of the developed LKPD.

The Disseminate stage was not fully implemented due to time and research scope limitations. Therefore, this study was limited to product validation and classroom-level testing, without broader dissemination or generalization. The final product is intended as an initial instructional material that can be further tested and adapted in broader elementary school contexts.

Research Subjects and Data Sources

The research was conducted at SD Xaverius 3 Bandar Lampung. The main field test involved 29 fourth-grade students from Class IV A. The participants were selected using cluster sampling, also referred to as intact group sampling, in which one existing classroom was chosen based on school permission, accessibility, and the relevance of classroom conditions to the research objectives. This sampling technique was considered appropriate because the study focused on product development, validation, and limited classroom testing rather than population-level generalization.

The students were predominantly aged 9-10 years and were at the concrete operational stage of cognitive development. Initial classroom observations showed that students had limited participation in inquiry-based activities and still demonstrated low environmental awareness in daily classroom behavior. These conditions supported the need for contextual and interactive learning materials that integrate local wisdom, Nature of Science understanding, and environmental awareness.

The data sources in this study consisted of expert validators, classroom teachers, small group trial students, and main field trial students. Expert validators provided data on product validity. Classroom teachers and small group students provided practicality data. The 29 students in the main field test provided pretest and posttest data for measuring the effectiveness of the developed LKPD.

Data Collection Techniques

Data were collected using test and non-test techniques. The test technique used a Two-Tier Multiple Choice Question (TTMCQ) instrument consisting of 20 items. The instrument was designed to measure students' understanding of the Nature of Science and environmental awareness in the cognitive domain. The TTMCQ format was used because it allowed the researcher to assess not only students' answer choices but also the reasoning underlying their answers.

The non-test techniques consisted of expert validation sheets, teacher practicality questionnaires, student practicality questionnaires, interviews, and classroom observation sheets. Expert validation sheets were used to assess the feasibility of the LKPD in terms of language, pedagogy, media, and material content. Teacher practicality questionnaires were used to evaluate the clarity, usability, and classroom applicability of the LKPD. Student practicality questionnaires were used to determine students' responses to the readability,

attractiveness, and ease of use of the worksheet. Interviews and classroom observations were used to support the identification of instructional problems, learning conditions, student engagement, and environmental behavior during the learning process.

Data Analysis Techniques

The data were analyzed using descriptive quantitative and inferential statistical techniques. Product validity was analyzed using percentage scores obtained from expert validation sheets. The average validation score was then interpreted based on predetermined validity criteria. Practicality data from teacher and student questionnaires were also analyzed using percentage scores and interpreted based on practicality categories.

The effectiveness of the developed LKPD was analyzed using students' pretest and posttest scores. The improvement in students' learning outcomes was calculated using normalized gain (N-Gain). N-Gain was used to determine the level of improvement in students' understanding of the Nature of Science and environmental awareness after using the local wisdom-based LKPD. The N-Gain results were then categorized into high, medium, and low improvement levels.

Before hypothesis testing, assumption tests were conducted. The normality test was performed using the Kolmogorov-Smirnov test to determine whether the analyzed data were normally distributed. The homogeneity test was conducted using Levene's test as an additional assumption check to examine the variance of the analyzed scores. The criteria for both tests used a significance level of 0.05.

Hypothesis testing was conducted using a right-tailed one-sample t-test. This test was used to determine whether students' posttest scores for Nature of Science understanding and environmental awareness were significantly higher than the minimum standard score of 70. The results of the t-test were interpreted based on the significance value, with a significance level of 0.05. If the significance value was lower than 0.05, the students' scores were considered to have significantly exceeded the minimum standard.

RESULTS AND DISCUSSION

Product Development Results

This study developed a local wisdom-based IPAS Student Worksheet (LKPD) designed to improve Grade IV students' understanding of the Nature of Science (NoS) and environmental awareness in the topic of environmental change. The development process followed a modified 4D model consisting of Define, Design, Develop, and Disseminate. However, the Disseminate stage was not implemented on a broad scale because the study focused on product validation and classroom-level testing. Therefore, the findings should be interpreted as evidence of initial product quality and limited field effectiveness rather than broad implementation outcomes.

Define Stage Results

The Define stage was conducted to identify instructional problems, student characteristics, curriculum needs, and the limitations of the existing learning materials. Data from classroom observation, teacher interviews, and document analysis showed that IPAS learning in Grade IV was still dominated by teacher-centered instruction. Approximately 70% of classroom activities were conducted through lecture-based teaching, while only 28.6% of students actively participated by asking questions or responding during the lesson. This condition indicates that students had limited opportunities to construct scientific understanding through observation, inquiry, and discussion.

The observation also showed that 75% of students still demonstrated inappropriate environmental behavior, particularly in disposing of waste inside the classroom. This finding suggests that environmental awareness had not yet been sufficiently internalized through classroom learning. In addition, the analysis of the existing LKPD showed that the available worksheets mostly emphasized routine exercises, terminology recognition, and factual recall.

The worksheets had not sufficiently facilitated investigative activities, field observation, reflection, or the integration of local wisdom. These findings became the basis for developing an LKPD that connects environmental change material with Lampung local wisdom, Nature of Science understanding, and environmental awareness.

Design Stage Results

The Design stage produced the initial prototype of the local wisdom-based IPAS LKPD. The prototype was developed based on the Merdeka Curriculum and structured to support inquiry-based and contextual learning. The LKPD consisted of several components: (1) cover and identity section, (2) learning objectives aligned with NoS and environmental awareness indicators, (3) contextual introduction using environmental issues from students' surroundings, (4) guided inquiry activities involving observation, discussion, and problem-solving, (5) reflection activities to strengthen conceptual understanding, and (6) an assessment section supported by Two-Tier Multiple Choice Questions (TTMCQ).

The use of Lampung local wisdom was intended to make environmental change material more meaningful for students. Through this design, students were not only asked to understand scientific concepts but were also encouraged to relate those concepts to cultural values, local environmental practices, and daily experiences. The TTMCQ instrument was included to provide deeper information about students' conceptual understanding and possible misconceptions.

Develop Stage Results

The Develop stage included expert validation, product revision, practicality testing, and field testing. Expert validation was conducted by four validators consisting of language, pedagogical, media, and material experts. The validation results are presented in Table 1.

Table 1. Expert Validation Results

No	Validator	Score	Interpretation
1	Language Expert	98.1%	Very Valid
2	Pedagogical Expert	100%	Very Valid
3	Media Expert	98.7%	Very Valid
4	Material Expert	93.3%	Very Valid
	Average	97.22%	Very Valid

The validation results show that the developed LKPD obtained an average score of 97.22%, which falls into the very valid category. The language expert score of 98.1% indicates that the wording, sentence structure, and readability of the LKPD were appropriate for Grade IV students. The pedagogical expert gave a score of 100%, showing that the LKPD was highly aligned with curriculum requirements, learning objectives, and student-centered learning principles. The media expert score of 98.7% indicates that the visual design, layout, and presentation of the LKPD supported learning activities. Meanwhile, the material expert score of 93.3% confirms that the content was accurate and relevant to environmental change material, although minor revisions were still needed, particularly in reference currency and the organization of learning syntax.

Product Practicality

Practicality testing was conducted to examine whether the LKPD could be used easily by teachers and students in classroom learning. The practicality assessment involved two classroom teachers and 10 students in a small group trial. The teacher practicality results are presented in Table 2.

Table 2. Practitioner Practicality Assessment

Aspect	Score	Interpretation
Teacher 1 Assessment	96.0%	Very Practical
Teacher 2 Assessment	96.0%	Very Practical
Average	96.0%	Very Practical

The teacher assessment obtained an average score of 96.0%, indicating that the LKPD was very practical for classroom implementation. The teachers considered the LKPD easy to use because it provided clear instructions, systematic activity sequences, and learning tasks that could be implemented within the available instructional time. The activities were also considered relevant to the students' learning needs and appropriate for Grade IV IPAS learning.

Student practicality was assessed through a small group trial involving 10 students. The results are presented in Table 3.

Table 3. Small Group Student Practicality Results

No	Respondent	Score	Interpretation
1	Student 1	90	Very Practical
2	Student 2	93	Very Practical
3	Student 3	91	Very Practical
4	Student 4	95	Very Practical
5	Student 5	85	Very Practical
6	Student 6	92	Very Practical
7	Student 7	88	Very Practical
8	Student 8	92	Very Practical
9	Student 9	94	Very Practical
10	Student 10	88	Very Practical
	Average	90.8%	Very Practical

The student practicality score reached 90.8%, which is categorized as very practical. This result indicates that students could understand the instructions, follow the learning activities, and engage with the content presented in the LKPD. The use of familiar local contexts helped students connect the environmental change material with their daily experiences, making the learning process easier to follow and more engaging.

Product Effectiveness

The effectiveness of the LKPD was tested through a pretest-posttest design involving 29 fourth-grade students. The assessment measured students' understanding of the Nature of Science and environmental awareness after using the developed LKPD. The overall pretest mean score was 47.8, while the posttest mean score increased to 85.0. The mean N-Gain was 0.71, which falls into the high category. These results indicate that students' learning outcomes improved substantially after the implementation of the local wisdom-based LKPD. For the Nature of Science aspect, the N-Gain reached 76.7%. The distribution of students' N-Gain categories is presented in Table 4.

Table 4. Nature of Science N-Gain Results

Category	Number of Students	Percentage
High ($g \geq 0.71$)	25	86.21%
Medium ($0.31 \leq g \leq 0.70$)	4	13.79%
Low ($g \leq 0.30$)	0	0%

Table 4 shows that 25 students, or 86.21%, achieved high N-Gain in Nature of Science understanding, while 4 students, or 13.79%, were in the medium category. No students were in the low category. This result suggests that the LKPD was effective in helping students understand that science is developed through observation, evidence, reasoning, and contextual interpretation. For environmental awareness, the N-Gain reached 81.5%. The distribution of N-Gain categories is shown in Table 5.

Table 5. Environmental Awareness N-Gain Results

Category	Number of Students	Percentage
High ($g \geq 0.71$)	26	89.66%
Medium ($0.31 \leq g \leq 0.70$)	3	10.34%
Low ($g \leq 0.30$)	0	0%

Table 5 shows that 26 students, or 89.66%, achieved high N-Gain in environmental awareness, while 3 students, or 10.34%, were in the medium category. No students were in the low category. This finding indicates that the LKPD helped students improve their understanding of environmental issues and encouraged them to recognize the importance of responsible environmental behavior.

The posttest achievement levels for Nature of Science understanding are presented in Table 6.

Table 6. Nature of Science Understanding Levels

Category	Number of Students	Percentage
Very Good (86-100)	23	79.31%
Good (71-85)	6	20.69%
Sufficient (56-70)	0	0%
Poor (≤55)	0	0%

Table 6 shows that 23 students, or 79.31%, reached the very good category, while 6 students, or 20.69%, reached the good category. No students were classified as sufficient or poor. This result strengthens the evidence that the LKPD supported students' understanding of NoS concepts. The posttest achievement levels for environmental awareness are presented in Table 7.

Table 7. Environmental Awareness Understanding Levels

Category	Number of Students	Percentage
Very Good (86-100)	16	55.17%
Good (71-85)	13	44.83%
Sufficient (56-70)	0	0%
Poor (≤55)	0	0%

Table 7 shows that 16 students, or 55.17%, achieved the very good category, while 13 students, or 44.83%, achieved the good category. No students were in the sufficient or poor categories. This indicates that the students showed positive cognitive achievement in environmental awareness after using the developed LKPD.

Statistical Analysis Results

Before hypothesis testing, assumption tests were conducted to examine the distribution and variance of the data. The normality test was conducted using the Kolmogorov-Smirnov test. The results are presented in Table 8.

Table 8. Normality Test Results (Kolmogorov-Smirnov)

	Unstandardized Residual
N	29
Mean	0.0000000
Std. Deviation	0.87916123
Test Statistic	0.165
Asymp. Sig. (2-tailed)	0.883

The Kolmogorov-Smirnov test produced a significance value of 0.883, which is higher than 0.05. This result indicates that the data were normally distributed. Therefore, the use of parametric statistical testing was considered appropriate.

The homogeneity test was conducted using Levene's test. Although the study used a one-group pretest-posttest design, the homogeneity test was retained as an additional assumption check for the variance of the analyzed scores. The result is presented in Table 9.

Table 9. Homogeneity Test Results (Levene Statistic)

	Levene Statistic	df1	df2	Sig.
Based on Mean	6.419	1	56	0.074

Table 9 shows that the significance value was 0.074, which is higher than 0.05. This result indicates that the variance of the analyzed data can be considered homogeneous. Thus, the assumption of homogeneity was fulfilled.

After the assumption tests were completed, hypothesis testing was conducted using a right-tailed t-test. The test was used to determine whether students' achievement exceeded the minimum standard score of 70. The result for Nature of Science is presented in Table 10.

Table 10. One-Sample Test for Nature of Science

	t	df	Sig. (2-tailed)	Mean Difference	95% CI Lower	95% CI Upper
NoS	6.116	28	0.000	6.666	4.43	8.90

The one-sample test for Nature of Science produced a t-value of 6.116 with df = 28 and a significance value of 0.000. Since the significance value was lower than 0.05, the result indicates that students' Nature of Science score was significantly higher than the minimum standard score of 70. The mean difference of 6.666 shows that the students' average score exceeded the standard by 6.666 points. The result for environmental awareness is presented in Table 11.

Table 11. One-Sample Test for Environmental Awareness

	t	df	Sig. (2-tailed)	Mean Difference	95% CI Lower	95% CI Upper
EA	8.938	28	0.000	10.880	8.39	13.37

The one-sample test for environmental awareness produced a t-value of 8.938 with df = 28 and a significance value of 0.000. This result shows that students' environmental awareness score was significantly higher than the minimum standard score of 70. The mean difference of 10.880 indicates that the students' average score exceeded the standard by 10.880 points. These findings confirm that the developed LKPD was effective in helping students achieve learning outcomes above the expected minimum standard.

Disseminate Stage

The Disseminate stage was not fully implemented due to limitations in research scope and time. The product was tested only at the classroom level involving 29 fourth-grade students at SD Xaverius 3 Bandar Lampung. Therefore, the dissemination of the LKPD was limited to internal classroom use and academic reporting. Wider dissemination through teacher training, school-based implementation, and publication is still needed to examine the applicability of the product in broader educational contexts.

Discussion

The findings of this study indicate that the developed local wisdom-based IPAS Student Worksheet met the three main quality criteria of instructional product development: validity, practicality, and effectiveness. The average expert validation score of 97.22% shows that the LKPD was categorized as very valid. This result indicates that the worksheet had strong content accuracy, pedagogical alignment, language appropriateness, and visual design quality. In Research and Development studies, expert validation is an important stage because it ensures that the product is theoretically, pedagogically, and practically feasible before classroom implementation (Sugiyono, 2019). This finding is also consistent with the logic of the 4D development model, in which product feasibility must be established through systematic design, expert judgment, revision, and limited testing before broader use (Noviani et al., 2022).

The high validation result also suggests that the developed LKPD was appropriate for Grade IV students and aligned with the objectives of IPAS learning in the Merdeka Curriculum. The language aspect showed that the worksheet used clear and communicative expressions suitable for elementary students. The pedagogical aspect indicated that the activities were consistent with student-centered learning principles. The media aspect showed that the layout and visual presentation supported readability and engagement, while the material aspect confirmed that the environmental change content was relevant and scientifically appropriate.

This is important because effective teaching materials should not only present information but also guide students to interact with concepts through structured activities, reflection, and meaningful tasks (Prastowo, 2018).

The practicality results further confirm that the developed LKPD can be implemented effectively in classroom learning. The teacher practicality score reached 96.0%, while student practicality reached 90.8%, both of which were categorized as very practical. These results indicate that the instructions, activity sequences, and learning tasks were understandable and applicable within the available instructional time. For elementary students, practicality is not a minor issue because learning materials must consider readability, task clarity, visual support, and students' cognitive development. The high student response also suggests that the LKPD was engaging and accessible for students who are still developing concrete operational reasoning.

The students' positive responses can be explained by the contextual nature of the LKPD. Environmental change is often taught as a general or abstract topic, but the integration of Lampung local wisdom made the material closer to students' lived experiences. Local wisdom-based science learning has been widely viewed as a way to translate indigenous or community knowledge into formal science concepts, making science more meaningful and culturally situated for students (Kartika et al., 2023; Lubis et al., 2022; Purwita & Rosana, 2020; Zidny et al., 2021). In this study, local wisdom was not treated as decorative content. It functioned as a contextual bridge that connected scientific concepts, environmental values, and students' daily practices.

The effectiveness results show that the LKPD contributed positively to students' learning achievement. The overall pretest mean increased from 47.8 to 85.0, with a mean N-Gain of 0.71 in the high category. For Nature of Science understanding, 86.21% of students achieved high N-Gain, while 89.66% of students achieved high N-Gain in environmental awareness. These findings indicate that the LKPD helped students improve both their understanding of scientific processes and their awareness of environmental issues. This result supports previous studies showing that local wisdom-based and ethnoscience-based learning materials can improve scientific understanding, ecological awareness, and students' engagement with science learning (Fitri & Hadiyanto, 2022; Hidayat et al., 2020; Rahmah, 2024; Rahmawati & Suryani, 2023; Suryadi & Rahmawati, 2021).

The improvement in Nature of Science understanding can be linked to the inquiry-oriented structure embedded in the LKPD. The worksheet guided students to observe phenomena, discuss evidence, solve problems, and reflect on their findings. These activities helped students understand that science is not merely a collection of facts but a way of constructing knowledge through observation, evidence, reasoning, and interpretation. This aligns with the view that understanding the Nature of Science is central to scientific literacy because students need to understand how scientific knowledge is developed, justified, and connected to social and cultural contexts (Lederman, 2007). The use of Two-Tier Multiple Choice Questions also strengthened the assessment process because it allowed the teacher to examine students' answers and the reasoning behind those answers.

The improvement in environmental awareness was also strengthened by the integration of local cultural values and environmental contexts. Through Lampung local wisdom, students were encouraged to relate environmental change material to their immediate surroundings, school environment, and daily behavior. This connection helped students recognize that environmental responsibility is not separated from cultural practices and community life. Local wisdom-based environmental learning can foster ecological awareness because it connects scientific concepts with values, habits, and environmental responsibilities that are familiar to students (Palmer, 1998). This finding is also consistent with studies that frame local wisdom, eco-pedagogy, and Education for Sustainable Development as important foundations for cultivating environmental care and sustainable behavior (Jahja, 2016; Khadim, 2023; Pratiwi,

2019; Yamin et al., 2024).

The findings also support the relevance of ethno-pedagogy in elementary science learning. Ethno-pedagogy emphasizes that local values, cultural practices, and community knowledge can become pedagogical resources for character development, environmental care, and science literacy. Prior studies have shown that ethno-pedagogical learning can help students develop a stronger relationship with their environment and cultural identity while still engaging with formal scientific concepts (Suarmika & Syarifah, 2019; Zidny et al., 2021). In the context of this study, the LKPD created opportunities for students to interpret environmental change not only as a scientific topic but also as a problem connected to local ways of living and caring for the environment.

The local wisdom-based design used in this study is also consistent with place-based and place-responsive education. Place-based learning treats the local environment, local culture, and community experience as authentic learning resources. This approach helps students understand science through real ecological and social contexts rather than isolated classroom explanations. Studies on place-based and place-responsive pedagogy have emphasized that learning becomes more meaningful when students investigate environmental issues connected to their own places, communities, and histories (Mendoza, 2017; Thornton et al., 2024; Yu, 2024). Therefore, the use of Lampung local wisdom in the LKPD can be understood as an effort to turn students' local environment into a living context for learning science.

The results are also relevant to broader discussions on indigenous knowledge and environmental education. Indigenous and local knowledge systems are often described as living systems of ecological understanding, cultural transmission, and environmental stewardship. When these knowledge systems are integrated carefully into formal education, they can enrich students' understanding of sustainability and environmental responsibility (Akhmar et al., 2023; Poelina, Paradies, Wooltorton, Guimond, et al., 2023; Poelina, Paradies, Wooltorton, Mulligan, et al., 2023). However, such integration must be designed thoughtfully so that local wisdom is not simplified into superficial cultural symbols. In this study, the LKPD attempted to position Lampung local wisdom as a meaningful context for inquiry, reflection, and environmental awareness.

The statistical analysis further strengthens the effectiveness findings. The normality test showed a significance value of 0.883, indicating that the data were normally distributed. The homogeneity test showed a significance value of 0.074, indicating that the variance of the analyzed data was homogeneous. These results support the use of parametric testing in the analysis. Furthermore, the right-tailed t-test showed significant results for both Nature of Science and environmental awareness. The Nature of Science score significantly exceeded the minimum standard score of 70, with a mean difference of 6.666 points, while environmental awareness exceeded the standard by 10.880 points. These results indicate that the LKPD did not only produce descriptive improvement but also helped students achieve learning outcomes above the expected minimum standard.

Compared with previous studies, this research provides several specific contributions. Several studies have developed local wisdom-based, ethnoscience-based, or Subject-Specific Pedagogy products to improve conceptual understanding, scientific literacy, environmental care, or cultural awareness (Kartika et al., 2023; Lubis et al., 2022; Poelina et al., 2023; Purwita & Rosana, 2020). Other studies have also shown that ethnoscience-based worksheets or e-worksheets can support either Nature of Science understanding or environmental awareness separately (Pratiwi et al., 2024; Sihombing et al., 2025). However, many previous studies still focused on a single outcome variable or treated local wisdom as a general context rather than a specific regional learning resource.

This study addresses that gap by developing a local wisdom-based IPAS LKPD that simultaneously integrates Nature of Science, environmental awareness, and environmental change material for Grade IV students. Another important contribution is the use of Lampung

local wisdom as a specific cultural context, making the worksheet more context-sensitive and relevant to students' learning environment. This is in line with the argument that local potential in science learning can strengthen students' 21st-century skills, cultural awareness, and contextual understanding when integrated into inquiry-based or student-centered learning activities (Kamila et al., 2024; Lubis et al., 2022). In addition, the use of TTMCQ provides a more comprehensive assessment approach because it allows teachers to identify both students' answers and their reasoning.

The findings also show that local wisdom-based worksheets require support beyond product development. Sustainable implementation depends on teacher readiness, curriculum alignment, school policy, and the availability of contextual learning resources. Previous studies have noted that integrating local wisdom into formal education can face challenges related to teacher preparation, curriculum constraints, and the need for institutional support (Jackson-Barrett & Lee-Hammond, 2019; Mambu, 2023; Zidny et al., 2021). Therefore, although this LKPD was found to be valid, practical, and effective in the limited field trial, broader implementation would require teacher training and adaptation to different classroom contexts.

Nevertheless, the findings should be interpreted carefully. The field testing involved only 29 students from one elementary school, so the results represent classroom-level effectiveness rather than broad generalization. The Disseminate stage was also not fully implemented, meaning that the LKPD has not yet been tested across different schools, teachers, or regional contexts. In addition, although the pretest-posttest results and right-tailed t-test indicate strong learning achievement, future studies should involve a control group to provide stronger evidence of comparative effectiveness. This caution is important because previous literature on local wisdom-based learning also notes that many studies rely on validation, limited trials, or pretest-posttest designs, making effect sizes and generalizability context-dependent (Kartika et al., 2023; Poelina, Paradies, Wooltorton, Guimond, et al., 2023; Purwita & Rosana, 2020).

Despite these limitations, the results of this study indicate that the developed local wisdom-based IPAS LKPD is a promising instructional material for improving Grade IV students' Nature of Science understanding and environmental awareness. The integration of Lampung local wisdom, inquiry activities, reflection, and TTMCQ assessment provides a more contextual and diagnostic learning experience. The study contributes to elementary science education by showing that local wisdom can be used not only to increase cultural relevance but also to strengthen scientific understanding, environmental responsibility, and meaningful IPAS learning.

CONCLUSION

This research successfully developed a local wisdom-based IPAS student worksheet (LKPD) to enhance fourth-grade elementary students' understanding of Nature of Science (NoS) and environmental awareness on environmental change material. Employing the 4D development model (Define, Design, Develop, Disseminate), the resulting product underwent rigorous validation, practicality testing, and effectiveness evaluation.

First, the developed LKPD demonstrated very high validity with an average score of 97.22% across expert assessments. Language experts confirmed communicative appropriateness for fourth-grade students (98.1%), pedagogical experts affirmed exceptional alignment with Merdeka Curriculum and student-centered learning principles (100%), media experts validated visual design quality (98.7%), and material experts confirmed content accuracy and relevance (93.3%). These results establish the LKPD as a theoretically sound and academically rigorous instructional material.

Second, the LKPD proved highly practical for classroom implementation. Teacher assessments averaged 96.0%, highlighting clear instructions, systematic activity organization, and ease of use within available time constraints. Student responses averaged 90.8%, indicating strong engagement, comprehension, and relevance to daily experiences. The integration of Lampung local wisdom significantly enhanced practicality by connecting academic content

with students' familiar cultural context.

Third, the LKPD demonstrated significant effectiveness in improving both learning outcomes. N-Gain analysis revealed 86.21% of students achieved high category for Nature of Science understanding and 89.66% for environmental awareness, with no students in the low category. Right-tailed t-tests confirmed statistically significant improvements exceeding minimum standards ($p < 0.001$), with mean differences of 6.67 points for NoS and 10.88 points for environmental awareness. Students exhibited sophisticated understanding that science develops through observation, evidence, and cultural context, alongside strong knowledge of environmental issues and positive conservation attitudes.

This research contributes validated instructional materials ready for fourth-grade IPAS implementation and provides a replicable model for developing contextualized, culturally responsive science education. The findings demonstrate that local wisdom integration effectively bridges scientific concepts with students' lived experiences, fostering meaningful learning and sustainable environmental consciousness. The LKPD addresses critical needs for innovative teaching materials that enhance both scientific literacy and ecological responsibility in elementary education, supporting broader goals of quality education and environmental sustainability.

RECOMMENDATION

Based on the findings of this study, it is recommended that elementary school teachers utilize local wisdom-based IPAS student worksheets (LKPD) as supporting instructional materials to enhance students' understanding of the Nature of Science and environmental awareness. Teachers are encouraged to integrate project-based learning, collaborative discussions, and reflective activities to optimize the implementation of the worksheets while accommodating students' diverse characteristics and learning abilities.

Schools are advised to support the implementation of local wisdom-based IPAS learning through the provision of adequate facilities, contextual learning policies, and sustainable programs that integrate local values into daily school activities. Such integration is expected to strengthen students' environmental responsibility and scientific attitudes from an early age.

For future research, it is recommended to develop and test local wisdom-based IPAS worksheets across broader subject matters, grade levels, and regional contexts to examine their wider applicability. Further studies may incorporate additional variables such as critical thinking skills, creativity, and scientific literacy, as well as apply experimental designs involving control groups to obtain more comprehensive findings and stronger generalizability.

Several potential barriers should also be considered in future implementations, including limited teacher readiness in applying innovative learning models, time constraints in classroom instruction, variability in students' academic abilities, and differences in local wisdom contexts across regions. Addressing these challenges through teacher training, instructional planning, and contextual adaptation will help ensure more effective implementation and research outcomes.

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CONFLICT OF INTEREST STATEMENT
Authors state no conflict of interest.

DATA AVAILABILITY
The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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