

## Research Article

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## Development of a Natural and Social Sciences Teaching Module Oriented Towards Local Wisdom of Bebus Lombok to Enhance Students' Critical Thinking Skills

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### Abstract

**Background.** The integration of culturally responsive pedagogy into elementary education is crucial for contextualizing learning and strengthening students' cognitive engagement. However, Indonesian elementary curricula still lack structured modules that incorporate local wisdom. This study aimed to develop and validate a Natural and Social Sciences (IPAS) teaching module based on the Bebus tradition of East Lombok to enhance fourth-grade students' critical thinking skills.

**Materials/methods.** The module was developed using the ADDIE model, which includes five sequential stages: Analysis, to identify learning needs and cultural relevance; Design, to formulate learning objectives and structure the module content; Development, to create teaching materials and activities; Implementation, involving pilot testing in three elementary schools; and Evaluation, using expert validation and pre-post assessments to measure practicality and effectiveness. Validation was conducted by subject-matter, media, and language experts, while effectiveness was assessed by improvements in students' critical thinking scores.

**Results.** Expert validation indicated high levels of feasibility, with content validity at 90.7%, media design validity at 93.4%, and language suitability at 88.2%. Practicality tests across SDN 2 Tebaban, SDN 1 Kembang Sari, and SDN 3 Pancor demonstrated strong usability, with average scores exceeding the 63-point threshold. Effectiveness testing revealed an increase in critical thinking, with pre-test and post-test averages improving from 47.8 to 74.9, corresponding to an N-Gain score of 0.57 (56.63%), categorized as moderately effective.

**Conclusion.** The IPAS module integrating Bebus local wisdom is valid, practical, and moderately effective in fostering students' critical thinking. Embedding indigenous knowledge into formal education enhances cultural relevance, supports contextual understanding, and contributes to educational equity. This framework offers a replicable model for integrating local traditions into science curricula.

## 1. Introduction

The rapid evolution of 21st-century education necessitates a shift toward more contextualized and culturally responsive pedagogies. This transition underscores the importance of integrating local wisdom into educational practices, thereby connecting students' learning experiences with their socio-cultural environments. Research demonstrates that instruction grounded in local cultural traditions fosters both academic competence and essential life skills such as problem-solving and analytical thinking. For example, Jamilah et al., (2024) highlight how incorporating local cultural arts into teaching materials significantly enhances student engagement and strengthens cultural identity. Further studies affirm the value of local wisdom in developing educational resources that resonate with students' backgrounds and lived experiences (Jamilah et al., 2024; Rahman & Fadlillah, 2023).

Moreover, integrating local wisdom into learning materials situates knowledge within students' immediate realities, deepening their understanding of scientific concepts while promoting environmental stewardship and social cohesion. (Hikmawati et al., 2022) emphasize the transformative potential of embedding local wisdom into curricula, arguing that it supports both academic achievement and the cultivation of social responsibility and ecological awareness (Rahman & Fadlillah, 2023). Similarly, Ghaderi (2023) demonstrates that incorporating local practices into education strengthens community ties. Smith et al. (2020) also underscore the efficacy of contextual learning rooted in cultural heritage in equipping students to navigate complex environmental and societal challenges. Among Indonesia's diverse local traditions, the Bebus practice of the Sasak community in East Lombok exemplifies a rich cultural heritage with ecological, medicinal, and communal significance. This indigenous practice, which utilizes plant-based remedies for healing, embodies values such as collective responsibility and sustainable resource use. As Ghaderi (2023) asserts, embedding such cultural elements into curricula can enrich the learning environment by making it more engaging and meaningful. Introducing Bebus into science education offers a culturally grounded framework through which students can explore pressing environmental and social issues, thereby fostering critical thinking and promoting innovation and sustainability (Inocian et al., 2020).

Despite the recognized benefits of contextual learning, Indonesian elementary schools largely continue to adopt conventional pedagogical approaches, often neglecting the potential of local wisdom to enhance student engagement and cognitive development. This situation highlights the urgent need to reform instructional materials, particularly by developing a Natural and Social Sciences (IPAS) teaching module grounded in traditions such as Bebus. Such an approach would not only contextualize scientific concepts but also promote students' analytical reasoning. Supporting this, recent research confirms that incorporating local wisdom into educational content improves both cognitive and affective learning outcomes. Hikmawati et al. (2022), for instance, emphasize the ethnoscientific value of Lombok traditions in junior high school curricula, showing how cultural integration facilitates a deeper understanding of science. Likewise, R.A Rizka Qori Yuliani Putri et al. (2024) identified Bebus as a powerful pedagogical tool for conveying environmental ethics, medicinal plant knowledge, and community-based values. Nurhasnah et al. (2022) further support this view, demonstrating that digital learning modules derived from local cultural practices significantly enhance students' critical thinking dispositions.

Broadly speaking, numerous studies advocate for educational reforms that incorporate local cultural perspectives into science education. Murwitaningsih & Maesaroh (2023) argue that embedding ethnoscientific content within curricula not only enriches the learning experience but also strengthens students' cultural identity and environmental awareness. Ethnoscience research suggests that aligning educational content with local narratives enhances student engagement and comprehension. Aisyah & Khotimah (2023) and Wati et al. (2021) stress that effective education in Indonesia must reflect historical and cultural contexts to ensure inclusivity and relevance. In addition,

several scholars emphasize the importance of teacher preparation in embedding local wisdom into classroom practices, advocating for professional development environments that foster innovative pedagogical approaches (Dewi & Kuswanto, 2023; Pan et al., 2023). Lestari et al. (2024) analyzed the symbolic and ritual dimensions of *Bebubus*, revealing its potential role in environmental education by connecting cultural identity to ecological sustainability. Indigenous knowledge systems play a vital role in introducing students to environmental ethics and responsibilities. Nesterova (2020), for instance, advocates for incorporating Indigenous Ways of Knowing into environmental education, promoting narrative-based approaches to ecological stewardship. This view is echoed by Datta (2024), who highlights the pedagogical potential of intergenerational Indigenous knowledge for sustainable teaching practices. Acharibasam & McVittie (2022) similarly argue for the integration of Indigenous Ecological Knowledge into early childhood education to cultivate environmental consciousness. However, despite the promise of the *Bebubus* tradition, current IPAS curricula lack structured learning modules tailored for elementary education.

Another critical concern is assessing critical thinking outcomes derived from culturally grounded learning materials. Although many studies recognize the role of Indigenous knowledge in promoting responsibility and environmental ethics, few address how its impact on students' critical thinking can be systematically evaluated. Wantik et al. (2024) highlight that the integration of Indigenous Knowledge Systems into formal education frequently lacks robust assessment tools to measure their educational efficacy. Furthermore, most studies remain limited to theoretical discussions or small-scale interventions, lacking scalability and empirical validation. There is also insufficient interdisciplinary integration among science, culture, and pedagogy within a cohesive framework. These limitations signal the need for a comprehensive, empirically validated teaching module that leverages culturally meaningful content to enhance critical thinking measurably.

In the context of this study, critical thinking is defined as students' ability to analyze, evaluate, and draw reasoned conclusions from information obtained during the learning process. In science education, critical thinking is a core cognitive skill, enabling learners to interpret data, question assumptions, and apply concepts to real-world scenarios. This aligns with Paul and Elder's (2014) framework, which identifies clarity, accuracy, logic, and relevance as foundational elements of critical thinking. Embedding these competencies within culturally responsive learning environments allows students to engage with traditional knowledge, such as *Bebubus*, not only as cultural heritage but also as empirical content that can be examined critically. Therefore, this study situates the development of the IPAS module within a dual theoretical framework—cultural contextualization and cognitive development—by linking local values to scientific inquiry and critical thinking. This study aims to design and validate a Natural and Social Sciences (IPAS) teaching module for fourth-grade students, rooted in the *Bebubus* tradition of East Lombok, to enhance critical thinking skills. The novelty of this research lies in its systematic integration of indigenous ecological and social knowledge into a structured educational module, which will be evaluated through expert validation and classroom implementation. The study encompasses the design, development, and empirical testing of the module's validity, practicality, and effectiveness within the IPAS educational framework. Based on the background and identified research gaps, this study was guided by the following research questions:

1. How can a Natural and Social Sciences (IPAS) teaching module be developed by integrating the *Bebubus* local wisdom of East Lombok through the ADDIE model?
2. How valid, practical, and effective is the developed IPAS module in enhancing fourth-grade students' critical thinking skills?

## 2. Literature Review

The integration of local wisdom into education is increasingly recognized as a vital component of culturally responsive pedagogy. Contextual learning rooted in indigenous traditions has been shown to support not only academic achievement but also the development of essential life skills such as problem-solving, collaboration, and critical thinking (Jamilah et al., 2024; Rahman & Fadlillah, 2023). In particular, instructional designs that incorporate local cultural practices enable learners to relate abstract concepts to real-world experiences, thereby enhancing engagement and deepening understanding (Smith et al., 2020).

Critical thinking is widely acknowledged as a core competency in 21st-century education, especially in science learning, where inquiry and problem-solving are emphasized. In science education, critical thinking is fostered through investigation, experimentation, and evidence-based reasoning (Purwati et al., 2018). Research indicates that contextual and culturally embedded approaches can significantly enhance students' critical thinking dispositions by linking abstract concepts with familiar socio-cultural experiences (Hikmawati et al., 2022; Nurhasnah et al., 2022). Integrating local wisdom, such as the Bebus tradition, not only provides cultural relevance but also offers a meaningful platform for nurturing students' analytical and evaluative thinking skills in real-world contexts.

Ethnoscience research underscores the transformative potential of integrating indigenous knowledge into science education. Hikmawati et al. (2022) demonstrated that incorporating Lombok's cultural traditions into instructional practices improved students' cognitive outcomes. Similarly, Aisyah & Khotimah (2023) highlighted the effectiveness of ethnoscience-based modules in enhancing scientific literacy. Nurhasnah et al. (2022) also found that digital learning resources grounded in local culture significantly improved students' critical thinking dispositions. Collectively, these studies affirm that education informed by local wisdom yields both cognitive and affective benefits.

The Bebus tradition of the Sasak community in East Lombok embodies a rich cultural heritage encompassing ecological, medicinal, and communal dimensions. Research by R.A Rizka Qori Yuliani Putri et al., (2024) identified Bebus as a valuable pedagogical tool for promoting environmental ethics, medicinal plant knowledge, and social responsibility. Lestari et al. (2024) further emphasized that the symbolic and ritual elements of Bebus serve as an effective medium for environmental education, linking cultural identity to sustainable practices. Integrating such traditions into the science curriculum offers a unique opportunity to contextualize ecological concepts while reinforcing cultural relevance. Despite the acknowledged benefits of integrating local wisdom, several challenges persist. First, Indonesian elementary curricula primarily rely on conventional pedagogies and lack systematic incorporation of indigenous traditions (Suprpto et al., 2021). Second, although many studies highlight the role of local wisdom in character and values education (Damopolii et al., 2024), few offer empirically validated frameworks that directly link these traditions to measurable cognitive outcomes, particularly critical thinking. Third, much of the existing research remains limited in scope, focusing on small-scale interventions or theoretical discussions without addressing scalability.

These limitations underscore the need for structured, empirically tested teaching modules that integrate indigenous knowledge with formal science education. This study seeks to address these gaps by embedding Bebus wisdom into a Natural and Social Sciences (IPAS) teaching module. The proposed framework aims to enhance students' critical thinking skills, contribute to the broader field of ethnoscience, and offer practical innovations in curriculum design that reflect Indonesia's cultural and educational contexts.

### 3. Methodology

This study employed a research and development (R&D) design using the ADDIE model (Figure 1), which consists of five systematic phases: Analysis, Design, Development, Implementation, and Evaluation. This design was selected to ensure that the developed instructional module was theoretically grounded, pedagogically sound, and empirically tested for validity, practicality, and effectiveness.



Figure 1. Steps of the ADDIE Model Development and Research

#### 3.1. Research Design

The ADDIE framework served as the foundation for developing and validating the IPAS teaching module.

1. Analysis Phase: Identified curriculum needs, learner characteristics, and cultural relevance through interviews with teachers, classroom observations, and document reviews.
2. Design Phase: Defined learning objectives, selected teaching materials, and prepared assessment instruments aligned with the IPAS curriculum and local wisdom content.
3. Development Phase: Created the module prototype incorporating Bebus traditions, followed by expert validation (content, media, and language).
4. Implementation Phase: Conducted classroom trials in three schools to evaluate usability and learner engagement.
5. Evaluation Phase: Applied formative and summative evaluations to assess the module's overall effectiveness.

#### 3.2. Participants and Research Site

The study was conducted in three public elementary schools in East Lombok Regency, West Nusa Tenggara Province: SDN 2 Tebaban, SDN 1 Kembang Sari, and SDN 3 Pancor. Participants included 104 fourth-grade students (51 males and 53 females, aged 9–10 years) and six teachers who facilitated classroom instruction. Schools were purposively selected for their engagement with local cultural integration programs.

#### 3.3. Data Collection Procedures

Data were collected through three main procedures:

1. Expert Validation: To determine the validity of the module, involving three panels—subject matter experts, media design experts, and language experts.
2. Practicality Testing: Conducted during classroom implementation to evaluate user experience among teachers and students.
3. Effectiveness Testing: Used pre-test and post-test designs to assess the module's impact on students' critical thinking.

### 3.4. Instruments

Three instruments were developed and validated for data collection:

1. Expert Validation Sheets: Comprised 15 items each for content, media, and language assessment using a 5-point Likert scale (1 = inferior to 5 = excellent).
2. Practicality Questionnaires: Contained 25 Likert-scale items evaluating ease of use, clarity, engagement, and relevance (Cronbach's  $\alpha = 0.89$ ).
3. Critical Thinking Test: Included 20 multiple-choice questions developed based on Facione's (2015) indicators interpretation, analysis, inference, explanation, and evaluation.

Each instrument underwent expert review and pilot testing to ensure content validity and reliability prior to data collection.

### 3.5. Data Analysis

Data were analyzed using both descriptive and inferential statistics:

1. Validation Results: Expressed as percentages representing average expert ratings.
2. Practicality Tests: Analyzed using descriptive statistics to determine mean scores and categorical interpretation (Very Good, Good, Fair).
3. Effectiveness Tests: Examined using pre-test and post-test comparisons, analyzed through the N-Gain formula:

$$N - Gain = \frac{Skore\ Post_{test} - Skore\ Pre_{test}}{Maximum\ skore - Skore\ Pre_{test}} \quad (1)$$

Where the results were categorized as high ( $>0.7$ ), moderate ( $0.3-0.7$ ), or low ( $<0.3$ ), additionally, normality and homogeneity tests were applied to ensure data reliability.

## 4. Results

This section presents findings that directly address the two research questions stated in the Introduction. The results are organized to show (a) the validity of the developed IPAS module, (b) its practicality during classroom implementation, and (c) its effectiveness in improving students' critical thinking skills. Each subsection corresponds to the specific data collected through the instruments described in the Methodology section. The first set of findings (Section 4.1) addresses the validity of the IPAS module, obtained through expert validation sheets covering content, media, and language aspects (15 items each, rated on a 5-point Likert scale). The second set of findings (Section 4.2) relates to the module's practicality, evaluated through student and teacher questionnaires comprising 25 Likert-scale items designed to measure usability, clarity, and engagement. The third set of findings (Section 4.3) reports the effectiveness of the module, based on students' pre-test and post-test scores on a 20-item multiple-choice critical thinking test developed using Facione's (2015) indicators. This structure ensures that each result presented in this section directly responds to the study's guiding questions and reflects data obtained from validated instruments.

#### 4.1. Validation Results of the Module

The validation of the developed IPAS module oriented towards the local wisdom of Bebus Lombok was assessed by three expert groups: subject matter, media, and language experts, as shown in Figure 2.

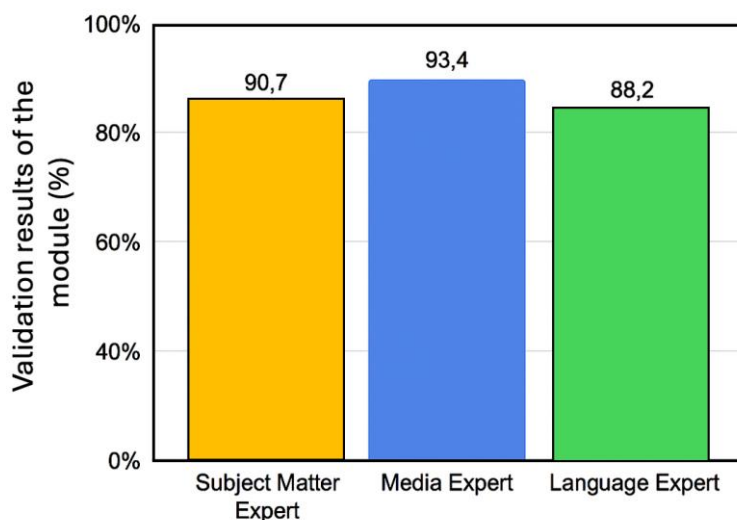


Figure 2. The validation of the developed IPAS module

The validation results for the IPAS teaching module, designed to integrate local wisdom from Bebus Lombok into educational practice, show strong support across various expert assessments. Specifically, the subject matter expert rated the module at 90.7%, reflecting its strong alignment with curriculum standards, which is essential for fostering critical thinking in students. Research indicates that curriculum alignment significantly influences educational outcomes, as it establishes connections between instructional practices and desired learning goals and standards. This correlation underscores the necessity of aligning teaching materials with curriculum objectives to enhance pedagogical effectiveness and support student engagement (Pape-Zambito & Mostrom, 2018; Turan-Özpolat & Bay, 2017).

Additionally, the media expert's score of 93.4% highlights the module's high-quality visual and instructional design. Effective media utilization is associated with increased learner engagement, underscoring the importance of thoughtfully designed educational media in teaching and learning processes (Putriani, 2023; Setiawan et al., 2022). Incorporating engaging media aligns with best practices in instructional design, fostering an interactive and immersive learning environment (Widarti et al., 2023).

The language expert's assessment of 88.2% indicates that, while the module's linguistic features are appropriate for elementary students, they are slightly lower than those in other dimensions assessed. Language proficiency in educational materials is critical, particularly in multicultural settings where local wisdom must be conveyed effectively (Chen et al., 2019; Sudjarwo et al., 2018). A robust language framework ensures that content is accessible and comprehensible, promoting better educational outcomes (Novitasari & Walid, 2024).

#### 4.2. Practicality of the Module in Learning Activities

The module's practicality was evaluated through limited and large-scale trials conducted in three different schools: SDN 2 Tebaban, SDN 1 Kembang Sari, and SDN 3 Pancor, as shown in Table 1.

**Table 1.** Summarizing the practicality test results of the module across the three schools:

School	Number of Respondents	Average Score	Threshold Score	Category
SDN 2 Tebaban	21	68	63	Very Good
SDN 1 Kembang Sari	23	66.87	63	Very Good
SDN 3 Pancor	60	72	63	Very Good

Table 1 summarizes the practicality test results of the IPAS teaching module oriented toward the local wisdom of Bebus Lombok, based on student responses from three elementary schools. The evaluations of the IPAS teaching module, designed around the local wisdom of Bebus Lombok, demonstrate its effectiveness and practicality in educational settings across three elementary schools. At SDN 2 Tebaban, 21 students achieved an average score of 68, categorizing the module's practicality as "Very Good," exceeding the threshold score of 63. Similarly, SDN 1 Kembang Sari recorded an average score of 66.87 from 23 respondents, reinforcing the module's usability. The largest cohort, comprising 60 students at SDN 3 Pancor, achieved an impressive average score of 72. These results not only affirm the module's high practical value but also highlight its acceptance across diverse educational contexts, showcasing its potential for enhancing learning environments through clarity and accessibility (Fernando & Mohammad Baihaqi Bin Md (Yusnan, 2022; Jumriani, Mutiani, et al., 2021; Setya et al., 2024).

The positive reception and evaluation of the IPAS module align with educational research emphasizing the importance of integrating local wisdom into teaching practices. Studies indicate that local wisdom plays a crucial role in character education, significantly contributing to students' cultural identity by allowing them to reflect community values within their learning experience (Damopolii et al., 2024; Tohri et al., 2022). The process of embedding local wisdom into education is associated with promoting moral and ethical values, improving educational outcomes, and increasing student engagement (Arjaya et al., 2024; Novitasari & Walid, 2024). Consequently, the findings related to the IPAS teaching module underscore the need to incorporate local wisdom principles into curricula, enhancing educational effectiveness and student character (Aura et al., 2023; Hidayati et al., 2020). Moreover, the data from the evaluations reinforce the notion that local wisdom is both relevant and fundamental to education. Hidayati et al. (2020) note that integrating character education based on local wisdom is essential for achieving better educational outcomes. This integration aids children in developing social competencies that align with their cultural heritage, as Sudjarwo et al. (2018) discuss the impact of cultural values on students' appreciation and understanding of their local contexts. The positive feedback regarding the IPAS module supports the need for educational tools that respect and incorporate local traditions and wisdom, fostering a sense of belonging and responsibility among students (Lestari et al., 2024; Pamenang, 2021).

### **4.3. Effectiveness of the Module in Enhancing Critical Thinking**

Table 2 presents the effectiveness test results of the IPAS module in enhancing students' critical thinking skills, based on a pre-test and post-test evaluation.

**Table 2.** The effectiveness test results of the IPAS module

Test Type	Pre-Test Score (Average)	Post-Test Score (Average)	N-Gain Score	N-Gain %	Effectiveness Category
Critical Thinking	47.8	74.9	0.57	56.63%	Moderately Effective

The presented data regarding the effectiveness of the IPAS module in enhancing students' critical thinking skills highlights a noteworthy improvement from a pre-test average score of 47.8 to a post-

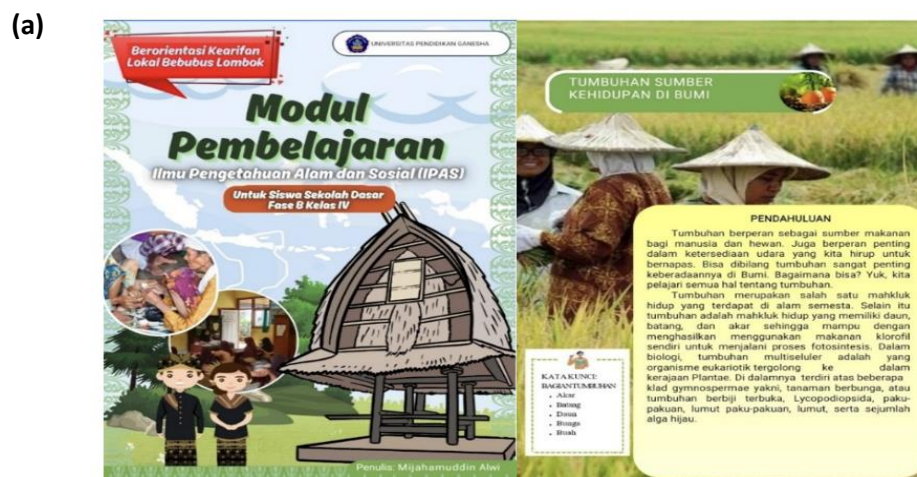
test average of 74.9, reflecting an increase in critical thinking performance. This substantial enhancement results in an N-Gain score of 0.57 and a percentage gain of 56.63%, categorizing the module's effectiveness as "Moderately Effective" according to educational intervention benchmarks (Iqbal & Kazmi, 2024; Stratton, 2019).

The framework of utilizing pre-tests and post-tests is a recognized method for evaluating educational interventions. Research has shown that such testing can effectively identify learning gains and the impact of specific pedagogical approaches on student performance (Stratton, 2019). For instance, blended learning methodologies have shown significant improvements in learner outcomes, aligning with principles observed in implementing effective educational modules (Kang & Kim, 2021; Liu et al., 2024). Additionally, the emphasis on interactive and contextual learning strategies positively influences students' cognitive skills (Susiatty & Hodiyoanto, 2019).

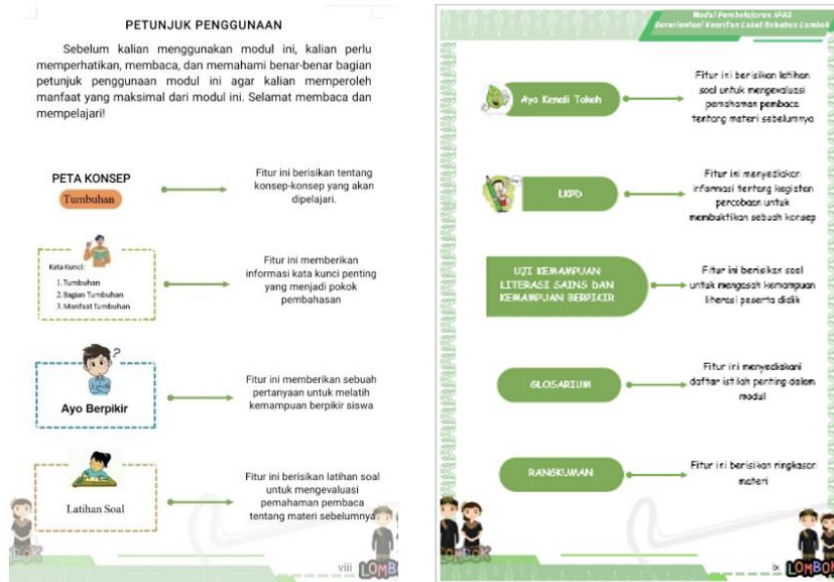
The improvement observed in students after the intervention suggests that contextual learning, particularly through structured content-delivery mechanisms such as the IPAS module, is pivotal to enhancing critical thinking comprehension. Research supports the notion that engaging learning environments that incorporate real-world scenarios can significantly boost cognitive skill development (L. U. Ali et al., 2023). These findings reinforce the hypothesis that effective educational strategies can optimize learning outcomes, guiding future modifications in instructional approaches to maximize educational effectiveness. Furthermore, data from comparative studies indicate that integrating interactive learning methodologies, such as the Think-Pair-Share approach, can increase student engagement and improve learning outcomes (Endang et al., 2023). The robust methodologies employed in the IPAS module align well with successful factors of existing educational frameworks aimed at improving critical thinking skills.

#### 4.4. Integration of Bebus Local Wisdom into Science Education

The integration of Bebus local wisdom into the IPAS module is visually supported by the instructional components shown in Figures 3(a), (b),(c), and (d).



(b)



(c)



(d)



Figure 3. The integration of Bebusus local wisdom into the IPAS module

The integration of Bebus local wisdom into the IPAS module is underpinned by a pedagogical framework that emphasizes culturally relevant science education. This integration is illustrated through various figures that demonstrate how local traditions can enhance scientific learning. For instance, Figure 3(a) presents a cover design inspired by Sasak traditions, thereby establishing contextual authenticity and engagement from the outset. This aligns with findings that underscore the importance of cultural relevance in educational materials for fostering engagement and improved learning outcomes among students (Roys et al., 2023). Additionally, Figure 3(b) outlines structured usage instructions that include concept maps and inquiry-based tasks, which are crucial for developing students' critical thinking skills within a context they can relate to. Research indicates that inquiry-based learning, when effectively supported through structured resources, significantly enhances students' engagement and confidence in science (Adeyele, 2023). Such instructional designs that incorporate local cultural elements can support students' understanding of scientific concepts, making learning more meaningful and effective (Nirmala et al., 2024).

Moreover, Figure 3(c) details learning outcomes and objectives that explicitly connect to critical scientific topics such as photosynthesis and the utility of plants, explored through the lens of Bebus healing traditions. This approach resonates with the growing emphasis on integrating local wisdom into science education, recognizing the role of traditional knowledge in understanding scientific concepts (Areepattamannil et al., 2020; Fadilla et al., 2023). Studies have shown that bridging local wisdom with scientific inquiry promotes more profound learning experiences and enhances students' affinity for science (Marasabessy & Baguna, 2020).

Furthermore, Figure 3(d) adds depth to this integration by introducing the "Charm of Local Wisdom," which underscores the significance of medicinal plants such as turmeric and ginger in Bebus practices. This inclusion of local ecological practices not only enriches the content but also fosters environmental stewardship in students by providing them with practical knowledge of their local ecosystem. The application of local wisdom in educational contexts has been linked to improved competencies in both cognitive and cultural dimensions, thereby equipping students for responsible citizenship (Nirmala et al., 2024; Roys et al., 2023).

#### **4.5. Implications for Culturally Responsive Pedagogy**

The evaluation of the IPAS module, which integrates local wisdom from the Bebus community, reveals significant findings concerning its scientific effectiveness and instructional relevance (Table 3). The reported content validity score of 90.7%, categorized as "Highly Suitable," underscores that the module meets national curriculum standards while efficiently embedding culturally contextualized scientific knowledge. This alignment with local cultural practices, particularly in subjects such as medicinal plants and ecological sustainability, effectively enriches students' learning experiences. The infusion of local knowledge into the curriculum has been endorsed by various studies, which emphasize the importance of contextually situated knowledge in enhancing learning outcomes (Alvi & Gillies, 2020; Salzman-Erikson et al., 2015).

**Table 3.** The implications for culturally responsive pedagogy

<b>Indicator</b>	<b>Observed Results</b>
Content Validity	90.7% (Highly Suitable) — validates the module's alignment with educational standards and local cultural relevance.
Media Design Validity	93.4% (Highly Suitable) — indicates effective visual communication integrating local symbols and contexts.

Language Validity	88.2% (Suitable) — confirms linguistic accessibility aligned with students' comprehension levels.
Practicality Score (SDN 2 Tebaban)	68 — Very Good; students engaged well with culturally contextualized materials.
Practicality Score (SDN 1 Kembang Sari)	66.87 — Very Good; indicates cultural content supports diverse learner comprehension.
Practicality Score (SDN 3 Pancor)	72 — Very Good; demonstrates strong acceptance and functional use in classroom settings.
Critical Thinking N-Gain Score	0.57 (56.63%) — Moderately Effective; signifies improvement in higher-order thinking via culturally rooted content.

Further supporting the module's educational efficacy is the media design validity, rated at 93.4%. This rating indicates a successful effort to engage students visually by using culturally familiar imagery and symbols. Research has established that effective visual representations can significantly enhance student engagement and comprehension by linking content to familiar cultural references, fostering deeper connections and understanding of scientific concepts (Moss & Godinho, 2019; Vlachopoulos et al., 2023). The language validity score of 88.2%, classified as "Suitable," reflects linguistic clarity appropriate for the cognitive levels of fourth-grade learners. This is crucial, as well-structured language is essential for facilitating comprehension and meaningful engagement among young students (Alwi & Gillies, 2020).

The practical application of the module was assessed through classroom trials across three diverse educational settings, yielding scores of 68 at SDN 2 Tebaban, 66.87 at SDN 1 Kembang Sari, and 72 at SDN 3 Pancor. Each of these scores exceeds the threshold of 63, signifying that the module functions effectively across various educational contexts. These findings support the notion that pedagogical approaches tailored to the local context enhance learner engagement and ease of implementation, thereby proving essential for effective learning (Juniarti et al., 2022; Sy, 2022). The N-Gain score of 0.57 (56.63%), categorized as "Moderately Effective," corroborates the module's positive impact on students' critical thinking. This aligns with broader educational research emphasizing the significance of local cultural contexts in instructional design to foster cognitive development and facilitate meaningful learning experiences (Easley et al., 2023; Nkambule, 2023).

## 5. Discussion

The findings of this study demonstrate that the development of an IPAS teaching module rooted in the Bebus tradition of East Lombok offers both pedagogical and cultural benefits. The module proved valid, practical, and effective in supporting students' learning and the development of critical thinking. Its strong performance during expert validation and classroom testing indicates that integrating local wisdom can meaningfully enrich science education when aligned with curriculum objectives. The results of this study demonstrate that the developed IPAS teaching module integrating Bebus local wisdom is both feasible and pedagogically effective. The module received high expert approval for content, media design, and language appropriateness, while classroom implementation confirmed strong practicality and positive student engagement. Furthermore, the

intervention led to a noticeable improvement in students' critical thinking skills, reflecting the module's ability to connect local cultural knowledge with scientific reasoning.

These findings are consistent with previous studies emphasizing the role of contextualized and ethnoscience-based learning in promoting cognitive development and cultural awareness. Hikmawati et al. (2022) and Nurhasnah et al. (2022) demonstrated that integrating local traditions into science instruction strengthens conceptual understanding and critical thinking. Similarly, Arjaya et al. (2024) and Murwitaningsih & Maesaroh (2023) found that cultural content fosters learner motivation and identity formation. The current study expands this literature by empirically validating a structured module that links the ecological and medicinal dimensions of Bebus to formal science concepts. This integration supports the argument that culturally responsive pedagogy enhances not only academic performance but also socio-cultural connection in the classroom. The module's effectiveness, though moderate, underscores the potential of sustained culturally grounded instruction to develop higher-order thinking skills. Consistent with F. Ali et al. (2021) and Endang et al. (2023), learning environments that incorporate inquiry and real-world context tend to nurture reasoning, reflection, and analysis. The improvement in students' thinking ability reflects the early stage of pedagogical adaptation, which could be strengthened through prolonged implementation and teacher training.

Beyond the cognitive outcomes, the inclusion of Bebus traditions also promotes cultural literacy and ecological awareness. As supported by Lestari et al. (2024) and Nirmala et al. (2024), integrating local ecological wisdom into teaching encourages students to understand the relationship between science and their community's environmental practices. This cultural dimension transforms science education into a platform for sustainability learning and identity preservation. Hence, the module not only contributes to academic skill development but also nurtures social responsibility and respect for indigenous knowledge systems. Overall, this study reinforces the importance of contextual pedagogy as a bridge between modern science education and indigenous ecological knowledge. The findings indicate that embedding cultural elements into science learning can create more meaningful, engaging, and inclusive classroom experiences, ultimately supporting students' cognitive, affective, and cultural growth.

## 6. Conclusion

This study advances culturally responsive science education by designing and validating an IPAS teaching module grounded in the Bebus tradition of East Lombok. The module achieved high validation scores of 90.7% for content, 93.4% for media design, and 88.2% for language, demonstrating its alignment with curriculum standards, visual engagement, and linguistic suitability. Practicality tests across three elementary schools yielded average scores above the 63-point threshold, confirming the module's usability in diverse classroom settings. Furthermore, the module showed a moderate improvement in students' critical thinking skills, as evidenced by an N-Gain score of 0.57 (56.63%). These results suggest that embedding local wisdom into science instruction provides a meaningful, though measured, contribution to enhancing educational relevance and student cognitive development. While the findings offer a valuable model for curriculum contextualization, future research should investigate long-term impacts, broader applicability, and policy integration to strengthen culturally grounded education further. Despite these promising findings, several limitations should be acknowledged. First, the study was conducted in a limited number of schools with a relatively small sample size, which may limit the generalizability of the results to other contexts. Second, the implementation period was short, allowing only a preliminary observation of the module's long-term impact on students' development of critical thinking. Third, the study relied on quasi-experimental and descriptive analyses; therefore, future research could employ longitudinal or mixed-method designs to provide a more comprehensive understanding of

pedagogical outcomes. Addressing these limitations in future studies would help refine the model and strengthen its applicability in diverse educational settings.

## 7. Suggestion

Based on the findings, it is recommended that the developed IPAS module be implemented more widely across schools to test its scalability, and that teacher training programs be implemented to enhance the ability to integrate local wisdom into science instruction. Educational practitioners and policymakers are encouraged to adopt culturally responsive approaches that connect classroom learning to students' socio-cultural contexts, as demonstrated by integrating Bebus traditions. For future research, long-term studies should examine the sustained impact of such culturally grounded modules on students' critical thinking and environmental awareness. Curriculum developers may also explore how local traditions can be systematically embedded in national frameworks to strengthen cultural identity and contextual understanding. Furthermore, refinement of the module through digital media, interactive assessments, and project-based learning could enhance engagement and effectiveness. Future studies may also consider interdisciplinary approaches linking science with social studies, health, and character education to promote broader learning outcomes.

## Declarations

**Author Contributions.** M.A.: Conceptualization, methodology, data analysis, original manuscript preparation. I.B.P.A.: Review-editing and writing. I.W.L.: Review-editing and writing, formal analysis, supervisor. I.G.M.: Review-editing and writing, data analysis. Methodology design. All authors have read and approved the published version of the article.

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**Ethical Approval.** This study was approved by the Research Ethics Committee of Universitas Pendidikan Ganesha (Undiksha), Indonesia (Approval No. 058-2024). All procedures involving human participants were conducted in accordance with institutional and national research ethics standards. Participation was voluntary, and informed consent was obtained from school administrators, teachers, and parents of the students involved.

**Data Availability Statement.** The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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