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Development of A Chemistry Teaching Module on Acids and Bases Based on Subulussalam Local Wisdom : Exploration of Batik, Bauh Buluh Fish, and Nakan Lancing

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Abstract: This study aims to develop a chemistry teaching module that integrates the local wisdom of Subulussalam, incorporating cultural elements such as Subulussalam batik, ikan bauh buluh, and nakan lancing, and to evaluate the responses of students and teachers to the module. The module is designed to contextualize acid-base chemistry concepts through local cultural practices, thereby making learning more meaningful and relevant. The research employs a Research and Development (R&D) approach, utilizing the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. Data collection is conducted through closed-ended questionnaires, and the data are analyzed using both quantitative and descriptive techniques. The module undergoes validation by experts in chemistry and instructional media and is tested on a sample of 66 students and 4 teachers. The results indicate that the chemistry teaching module based on Subulussalam local wisdom is both effective and relevant, as perceived by students and teachers. The integration of local content, such as Subulussalam batik, ikan bauh buluh, and nakan lancing, successfully links chemical concepts to students' real-life experiences, facilitating their understanding of abstract material. Furthermore, the module enhances learning motivation, argumentation skills, and scientific and cultural knowledge. Notably, learning based on local wisdom fosters cultural pride and strengthens global diversity character, aligning with the values of the Pancasila Student Profile and the Merdeka Curriculum. Consequently, this module not only teaches chemistry but also serves as a medium for character education, cultural preservation, and meaningful, contextual learning.

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Introduction

Chemistry learning is often perceived as abstract and distant from students' everyday lives. This leads to low learning motivation and limited student engagement in the learning process (Byusa et al., 2022). One effort to overcome this issue is through a contextual approach that connects the subject matter with local realities close to the students' lives (Amerstorfer & Freiin von Münster-Kistner, 2021; Helker et al., 2025).

The city of Subulussalam, located in the province of Aceh, possesses unique cultural richness with great potential to serve as a contextual learning resource, such as Subulussalam batik with its philosophical color symbolism, Bauh Buluh fish as a traditional fermented culinary item, and Nakan Lancing which uses turmeric as a natural indicator. These three elements not only carry cultural value but also contain chemical concepts, particularly related

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to acid-base solution material. By integrating this content into a teaching module, students not only learn chemistry conceptually but also appreciate and help preserve their local cultural heritage (Dini & Rini, 2024; Moro & Billote, 2023; Rahmawati et al., 2023).

In addition, the development of 21st-century education paradigms demands that students not only master academic content but also develop critical thinking, collaboration, communication, and creativity skills (4C) (Kesuma et al., 2021; Sholekha, 2023). Science learning, including chemistry, must be able to equip students with scientific and argumentative thinking skills (Al-Ajmi & Ambusaidi, 2022; Demircioglu et al., 2023; Gültepe & Kiliç, 2021). Through activities in the teaching module such as contextual discussions, observation of local materials, and simple culture-based experiments, students are encouraged to construct scientific arguments relevant to their environment (Hikmawati et al., 2021; Rahmawati et al., 2023; Wijayanti, 2025). This not only trains cognitive skills but also facilitates active participation and a sense of ownership in the learning process.

Furthermore, the development of this teaching module is also a concrete form of implementing the Pancasila Student Profile Strengthening Project (P5), particularly in the dimensions of "global diversity" and "local wisdom." By recognizing and understanding their own culture through a scientific lens, students will be better prepared to appreciate other cultural diversities on an equal footing (Kirsch & Hornberger, 2024; Nigar & Kostogriz, 2024). This process is essential in shaping a generation that is strongly rooted in local identity while remaining open to the world. Therefore, the integration of chemistry and local culture not only supports learning outcomes but also strengthens character and national identity in a global context (Hogan & O'Flaherty, 2022; Sakti et al., 2024).

This approach aligns with Contextual Teaching and Learning (CTL), which emphasizes the importance of connecting subject matter with students' real-life experiences (Jubhari et al., 2022; Sari et al., 2024), and supports the implementation of the Merdeka Curriculum, which emphasizes differentiated learning based on students' needs and backgrounds. Studies by Rahayu et al. (2025), Wardeny et al. (2025), and Marhayani et al. (2025) also show that integrating local wisdom into teaching materials can enhance conceptual understanding, learning motivation, argumentation skills, and the development of globally diverse character.

Although the integration of local wisdom into teaching materials has been explored in various regions, most studies tend to focus on widely recognized cultures and local practices. There remains a significant gap in the development of contextual learning resources that reflect the unique cultural identity of Subulussalam, a city in the province of Aceh. In particular, chemistry education has rarely been connected to local cultural elements in a way that supports both pedagogical goals and character education. This research offers a novel contribution by developing a chemistry teaching module based on the local wisdom of Subulussalam, incorporating traditional foods, textiles, and natural indicators that are unique to the region. The module is designed not only to make chemistry learning more contextual and meaningful but also to preserve cultural heritage and promote the values of the Pancasila student profile. The objectives of this research are to develop and implement this culturally integrated module, to evaluate its effectiveness in enhancing student understanding and engagement, and to explore its role in fostering cultural appreciation and strengthening students' character in accordance with national educational values.

Research Method

This study is a research and development (R&D) study that uses the ADDIE development model, which consists of five stages: analysis, design, development,

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implementation, and evaluation (Mudjisusatyo et al., 2024). In the analysis stage, an identification was carried out regarding students' needs, learning conditions, and the potential of local wisdom that could be integrated into chemistry learning, particularly on acid-base material. This stage was conducted through observation, interviews, and the distribution of needs assessment questionnaires to students and teachers at SMA Negeri 1 Simpang Kiri, located in Subulussalam City, Aceh Province.

Next, in the design stage, the structure and content of the teaching module began to be developed by integrating the potential of Subulussalam local wisdom such as Subulussalam batik, bauh buluh fish, and nakan lancing into the acid-base material. The development stage was carried out by drafting the teaching module and response questionnaire instruments, then validating them by two experts, namely a chemistry content expert and a learning expert. The validation process was conducted to assess the feasibility of the content, language, presentation, and the module's relevance to local wisdom. The validation questionnaire was arranged using a four-point Likert scale: (1) not valid, (2) less valid, (3) valid, and (4) very valid. Based on the expert assessment results, revisions were made to the module and questionnaire instruments according to the suggestions provided.

The revised teaching module was then implemented in learning activities involving 66 eleventh-grade students at SMA Negeri 1 Simpang Kiri. After the learning activities were completed, students were asked to fill out a response questionnaire regarding the module used. The chemistry teacher who taught the class was also asked to fill out a response questionnaire regarding the use of the teaching module. The final stage was evaluation, where the data obtained from validation results—conducted by a chemistry education expert and a learning media expert—and response questionnaires were analyzed to assess the feasibility and responses to the developed teaching module. Data analysis was conducted using the percentage achievement formula (Hanham et al., 2021). The resulting percentages were then categorized to determine the feasibility level of the teaching module and the acceptance level based on the responses of teachers and students.

Results and Discussion

Validation Results of the Teaching Module by Experts

The chemistry teaching module based on Subulussalam local wisdom on acid-base material was validated by two experts, consisting of a content expert and a learning expert. The validation was conducted on three main aspects: content feasibility, presentation, and language. The assessment was carried out using a four-point Likert scale. The expert validation results of the teaching module are presented in Table 1 below.

Tabel 1. Expert Validation Results of the Teaching Module

Indicator	Assessment Criteria	Score
Content Feasibility	Coverage of learning based on local wisdom	4
	Content relevance and up-to-dateness	3
	Learning materials align with learning objectives	3
	Learning objectives are aligned with the learning outcomes	3
Presentation	Use of images helps students understand the presented material	4
	Use of examples relevant to local wisdom (batik, *ikan bauh buluh*, *nakan lancing*)	4
Language	Language used is easy for students to understand	4

The validation results showed that the module obtained an average score of 3.625, which falls into the "valid" category. According to Jiménez (2025), content validity is a critical parameter in ensuring that teaching materials are suitable for use, and scores above 3.0

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generally indicate materials that are pedagogically sound with minor revisions needed. In this case, the high scores in the presentation and language aspects suggest that the module is communicative, well-structured, and accessible to students—qualities that are essential for effective instructional design (Hernández & Kilar-Magdziarz, 2023).

Meanwhile, the slightly lower scores in the content aspect highlight the need for better alignment with current scientific developments and more precise formulation of learning objectives. This feedback aligns with the principles of constructive alignment (Spangenberg, 2025), emphasizing that learning materials must consistently connect learning outcomes, activities, and assessments. These insights were used to refine the module before classroom implementation.

Figure 1. Several Images of The Developed Teaching Module

Overall, these validation results indicate that the developed teaching module has met feasibility standards and is ready to be tested on students.

Validation Results of the Teacher and Student Response Questionnaire Instrument

The teacher and student response questionnaire instrument used to assess the feasibility and effectiveness of the teaching module was validated by experts before being used in the trial. The validation was conducted on two aspects: questionnaire content and language. The expert validation results of the Teacher and Student Response Questionnaire Instrument are presented in Table 2 below.

Tabel 2. Expert Validation Results of the Teacher and Student Response Questionnaire Instrument

Assessment Aspect	Statement	Score
Content of the Questionnaire	The questionnaire statement aligns with the indicator that the worksheet contains tasks relevant to students' lives and is engaging	3
	The questionnaire statement aligns with the indicator that the worksheet stimulates student motivation and argumentation skills	4
	The questionnaire statement aligns with the indicator that the worksheet provides new insights to students	4
	The questionnaire statement aligns with the indicator that the worksheet enhances students' appreciation of local culture	4
	The questionnaire statement aligns with the indicator that the worksheet develops students' globally-minded character	3
Language Aspect	Uses language in accordance with Indonesian grammar rules	4
	Uses simple, understandable, and easily comprehensible words	3

The validation results showed that the questionnaire instrument obtained an average score of 3.57, which falls into the "valid" category. This indicates that the instrument is appropriate for use with minor revisions. In terms of content, the questionnaire was considered to comprehensively cover key indicators relevant to the characteristics of a teaching module based on local wisdom—such as contextual relevance to students' daily lives, the potential to enhance learning motivation, the development of student insight and character, and the instillation of local cultural values. These indicators align with the principles of culturally responsive pedagogy, which emphasize the integration of students' cultural contexts into teaching to promote meaningful learning and identity development (Anyichie et al., 2023).

Furthermore, in line with the framework proposed by Zhang (2022), the validation of a questionnaire instrument should assess both content relevance and clarity of language. In this study, the language used in the questionnaire was assessed as generally good; however, experts suggested simplifying some sentences to improve readability and ensure that students could easily comprehend each item. This aligns with guidelines for instrument development, which stress the importance of linguistic simplicity and age-appropriate vocabulary to avoid misinterpretation and response bias (Thompson, 2025).

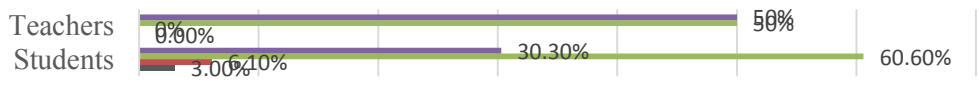
Thus, the questionnaire instrument was deemed valid and suitable for measuring both teacher and student responses to the developed chemistry teaching module. It serves as a reliable tool for capturing user perceptions related to the pedagogical effectiveness and cultural relevance of the module.

Implementation and Evaluation

After the validation stage, the chemistry teaching module based on Subulussalam local wisdom was implemented with 66 students and 4 teachers at SMA Negeri 1 Simpang Kiri. To evaluate the effectiveness of the module, questionnaires were completed by both groups of respondents. The questionnaire consisted of seven statements covering aspects of content relevance, motivation, insight, love for local culture, global diversity character, and language aspects.

1) **The teaching module contains tasks that are relevant to life and interesting for students**

Most students (90.9%) agreed or strongly agreed that the teaching module contained tasks relevant to their lives. This indicates that the integration of local wisdom such as Subulussalam batik, bauh buluh fish, and nakan lancing was able to create a connection between chemistry material—specifically the acid-base concept—and students' real-life experiences. For example, the use of turmeric in nakan lancing as a natural indicator, or the fermentation process in bauh buluh fish linked to acid-base reactions, are phenomena familiar in students' daily lives and reflect the local practices of the Subulussalam community.



	Students	Teachers
Strongly agree	30.30%	50%
Agree	60.60%	50%
Disagree	6.10%	0%
Strongly disagree	3.00%	0.00%

Figure 2. Questionnaire Graph on The teaching module contains tasks that are relevant to life and interesting for students

This relevance is crucial, as the contextual teaching and learning (CTL) approach helps students connect academic material with real-life situations, making learning more meaningful (Nurmadiah & Jabu, 2022; Sarwari & Kakar, 2023). In this case, the developed teaching module has successfully presented tasks and activities that not only test conceptual understanding but also stimulate curiosity and emotional engagement due to their closeness to local cultural and social realities.

These findings are supported by Rahayu et al. (2025), who developed a science e-book based on local wisdom and found that the proximity of content to students' lives contributed to increased learning interest, digital literacy, and critical thinking skills. This means that local content not only enriches the context but is also effective as a pedagogical strategy.

From the teacher's perspective, all respondents (100%) agreed or strongly agreed that the module contained contextual and engaging tasks. This indicates an alignment of perceptions between teachers and students, which serves as an indicator of the module designer's success in creating material that matches the students' needs and backgrounds. This aligns with the spirit of the Merdeka Curriculum, which emphasizes differentiated learning based on students' characteristics and local context (Kusumawati et al., 2025). Thus, the tasks in the module carry not only academic value but also cultural values that strengthen students' identity (Ghufron & Wuryandani, 2025; Kurniawan et al., 2021).

2) Learning activities stimulate student motivation and argumentation skills

The results showed that 74.2% of students strongly agreed and 25.8% agreed that the activities in the module stimulated their motivation and argumentation skills. This indicates that the learning approach used in the teaching module successfully created a participatory and reflective space that encouraged active student involvement. Teachers also showed the same high level of agreement (100%), indicating consistency in perception regarding the effectiveness of the activities in promoting scientific thinking and reasoning skills.

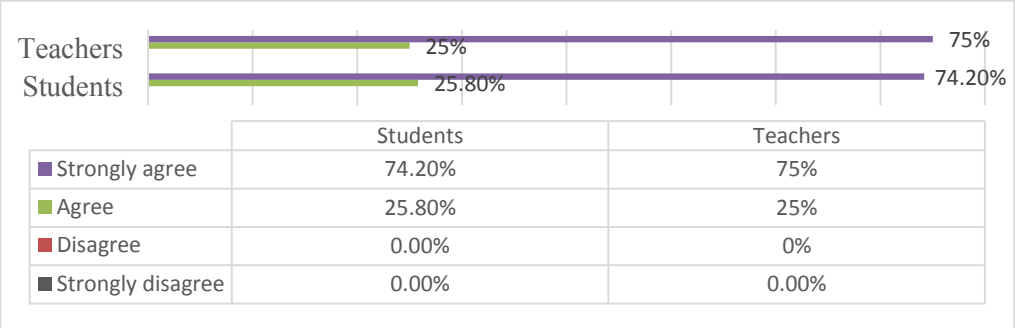


Figure 3. Questionnaire Graph on the Learning activities stimulate student motivation and argumentation skills

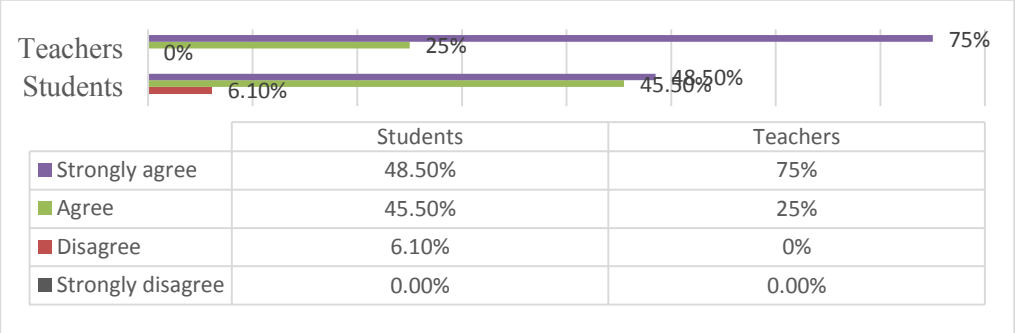
One of the main reasons for the high positive response is the presence of exploratory activities and discussions based on local culture (Bodzin et al., 2021; Cheng & Chen, 2022; Zuo et al., 2022). For example, students are invited to analyze chemical phenomena in the cooking process of *ikan bauh buluh* or the color change of turmeric in *nakan lancing* as a natural indicator. These activities not only present facts but also trigger questions such as "Why does the taste of the dish change?" or "What causes the turmeric to change color?", which are then discussed in groups. Such activities encourage students to present arguments, compare opinions, and draw conclusions based on evidence, thereby directly training critical thinking and communication skills—two key components in 21st-century student profiles.

These findings are in line with the research by Wardeny et al. (2025), which showed that learning based on local traditions such as *Larung Tumpeng* can develop students' scientific argumentation through discussion processes and cultural context enrichment in science learning. In other words, bringing local traditions into the classroom can serve as an entry point to stimulate higher-order thinking skills (Heffington & Coady, 2023; Kwangmuang et al., 2021; Pang et al., 2021).

Furthermore, according to Chen (2021), learning motivation increases significantly when students are given the space to actively explore material in a real and meaningful context. This is reflected in the local wisdom-based chemistry module of Subulussalam, which not only delivers chemical content but also sparks curiosity, activates reasoning, and strengthens argumentation skills through social interaction. The alignment of perceptions between students and teachers strengthens the evidence that this module not only contains informative content but also succeeds in designing a learning process that is active, communicative, and builds students' critical thinking skills, in accordance with the principles of differentiated and active learning in the Merdeka Curriculum.

3) The material in the teaching module provides new insights for students

As many as 94% of students agreed or strongly agreed that the material in the module provided new insights. Teachers also showed full agreement (100%), indicating that the module's content was able to broaden students' perspectives both scientifically and culturally.



	Students	Teachers
Strongly agree	48.50%	75%
Agree	45.50%	25%
Disagree	6.10%	0%
Strongly disagree	0.00%	0.00%

Figure 4. Questionnaire Graph on the The material in the teaching module provides new insights for students

The dimension of new insights gained by students encompasses two important aspects. First, from the scientific perspective, students were introduced to chemical concepts such as acid-base reactions in the traditional dish *ikan bauh buluh*, as well as the function of curcumin in turmeric as a natural indicator in *nakan lancing*. This helped them understand that chemistry is not merely theoretical, but also present in their everyday lives. Second, from the cultural aspect, they gained a deeper understanding of the color philosophy in Subulussalam batik, such as the symbolic meanings of black, green, white, red, and yellow within the community's social structure. This enriched their knowledge of local culture, not merely as heritage, but as an integrated part of scientific knowledge (Pijet-Migoń & Migoń, 2022).

This understanding reflects the concept of *meaningful learning* proposed by Ausubel, which emphasizes that new information is more easily understood and retained when connected to the learner's prior knowledge. By linking abstract chemical material with familiar cultural practices, this module effectively creates a bridge between theory and the students' reality (Shaharil et al., 2024).

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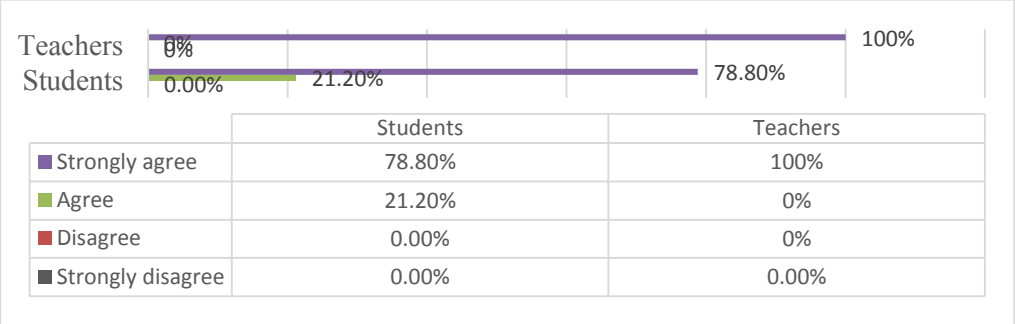
This is supported by the findings of Marhayani et al. (2025), which showed that local culture-based e-modules are capable of offering a new perspective on learning content, as students are encouraged to view the material from a standpoint that is closer to their own lives. Thus, the module does not merely transfer knowledge, but also shapes a new way of perceiving local culture as a scientific and contextual learning resource.

4) The teaching module increases students' appreciation for local culture

Students responded very positively to this statement, with 78.8% strongly agreeing and 21.2% agreeing. Teachers also showed unanimous agreement (100% strongly agree). This indicates that the module not only serves as a medium for delivering chemistry content, but also successfully acts as a tool to instill meaningful cultural values in students.



	Students	Teachers
Strongly agree	78.80%	100%
Agree	21.20%	0%
Disagree	0.00%	0%
Strongly disagree	0.00%	0.00%

Figure 5. Questionnaire Graph on The teaching module increases students' appreciation for local culture

From an affective perspective, learning through local content such as Subulussalam batik, *ikan bauh buluh*, and *nakan lancing* has been shown to foster a sense of pride in one's own culture, curiosity to learn more about local traditions, and motivation to preserve inherited wisdom. For example, when students learned about the symbolic meanings of the colors in Subulussalam batik, they not only understood the social structure of their community, but also felt that the batik represents their identity—something worth sharing with the outside world. In several students' written reflections, statements such as "I just found out that batik colors have meanings—now I like our regional batik even more," or "my grandma's cooking turns out to be related to chemistry lessons—makes me proud," emerged. These expressions show a strong emotional engagement with the content of the module.

This finding aligns with the research of Aditiyarini & SB (2025), who stated that learning media based on local wisdom can enhance students' emotional attachment to the learning content, as they feel that what they are learning is familiar and an integral part of their personal identity.

Furthermore, this increase in appreciation for local culture supports the implementation of the *Pancasila Student Profile Strengthening Project* (P5), particularly in the dimensions of "local wisdom" and "global diversity." Through such an approach, students are guided to recognize their own culture as a foundation for embracing diversity and building a strong national identity amid global challenges.

5) The teaching module enhances students' global diversity character

The majority of students (93.9%) agreed or strongly agreed with this statement, and the teachers also gave high approval (100%). This indicates that the module not only contributes to students' knowledge and skills development, but is also effective in shaping character—specifically in the "global diversity" dimension of the Pancasila Student Profile.

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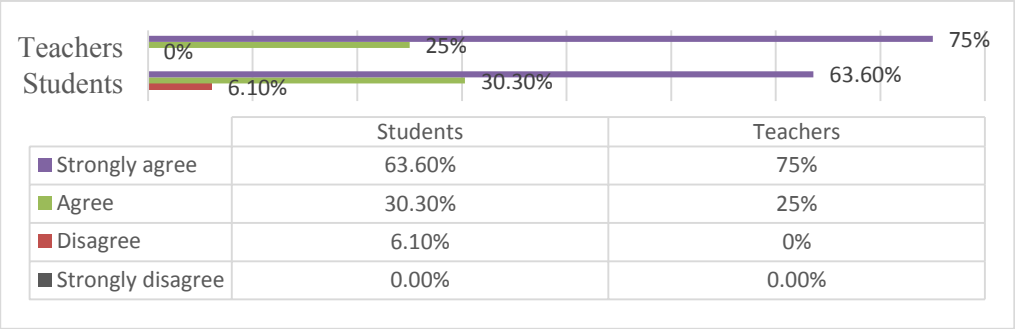

	Students	Teachers
Strongly agree	63.60%	75%
Agree	30.30%	25%
Disagree	6.10%	0%
Strongly disagree	0.00%	0.00%

Figure 6. Questionnaire Graph on the Indicator of The teaching module enhances students' global diversity character

Global diversity character not only includes the ability to live harmoniously within diversity, but also begins with the capacity to deeply understand and appreciate one's own culture. In the context of this module, students are invited to study *Subulussalam* batik, *ikan bauh buluh*, and *nakan lancing* from a scientific perspective—an approach that not only expands knowledge but also fosters a stronger awareness of cultural identity. When students have recognized the noble values of their own culture, they become more prepared and open to understanding and respecting other cultures in a fair and equal manner. This approach aligns with the spirit of the Merdeka Curriculum, which emphasizes the importance of learning based on local wisdom as a foundation for strengthening student character, including tolerance and open-mindedness (Dewi, 2024). By using local culture as a starting point for learning, this module contributes to shaping individuals who are firmly rooted in their national culture yet capable of interacting in a global society.

These findings are also supported by Marhayani et al. (2025), who stated that the development of e-modules based on diverse ethnic cultures can serve as effective tools for cross-cultural learning, as they help students understand cultural differences in an inclusive and scientific context. Thus, students are not only equipped with local knowledge but also instilled with universal values such as tolerance, empathy, and openness to diversity. The findings of this study have both conceptual and practical implications for chemistry education. Conceptually, the integration of local wisdom from Subulussalam—such as batik motifs, ikan bauh buluh, and nakan lancing—into the teaching module reinforces the theory of contextual learning, where abstract scientific concepts are connected to students' real-life experiences and cultural backgrounds. This supports the idea that meaningful learning occurs when new information is anchored in students' prior knowledge and cultural context. Practically, the module provides teachers with a concrete example of how to implement the Merdeka Curriculum through differentiated and culturally responsive teaching. It shows that local wisdom can be an effective pedagogical tool to enhance students' motivation, critical thinking, cultural appreciation, and character development. Moreover, the high level of agreement between students and teachers regarding the module's relevance and effectiveness indicates its potential scalability and adaptability for other topics and regions. Therefore, this study not only contributes to the development of teaching materials but also offers a model for integrating cultural values into science education to support both cognitive and affective learning outcomes.

Conclusion

The chemistry teaching module based on *Subulussalam* local wisdom has proven to be both effective and relevant according to students and teachers. The integration of local content—such as *Subulussalam* batik, *ikan bauh buluh*, and *nakan lancing*—has successfully linked chemical concepts to students' real-life experiences, thereby facilitating the understanding of abstract material. The module also boosts learning motivation, enhances argumentation skills, and broadens both scientific and cultural horizons. Moreover, learning based on local wisdom fosters pride in one's own culture and strengthens global diversity character, in alignment with the values of the Pancasila Student Profile and the Merdeka Curriculum. Therefore, this module not only teaches chemistry, but also serves as a medium for character education, cultural preservation, and meaningful, contextual learning.

Recommendation

The development of similar teaching modules can be extended to other chemistry topics such as redox reactions or electrolyte solutions, while continuing to highlight the local wisdom of Subulussalam to maintain contextual relevance. Teachers are encouraged to adapt and innovate by integrating interactive digital media, contextual experiment videos, and project-based assessments to further enhance student engagement, creativity, and critical thinking skills. Future researchers can explore the application of this module at different educational levels and in various regions to assess its broader effectiveness and adaptability in diverse learning environments.

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