DEVELOPMENT OF ETHNO-STEM BASED MODULES INTEGRATED WITH CREATIVE THINKING ON ELEMENTS, COMPOUNDS AND MIXTURES MATERIAL

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ABSTRAK

Keterbatasan relevansi pembelajaran sains dan dominasi metode pengajaran konvensional telah menyebabkan rendahnya kemampuan berpikir kreatif di kalangan siswa. Studi ini bertujuan untuk mengembangkan modul berbasis Etno-STEM yang terintegrasi dengan kemampuan berpikir kreatif pada topik unsur, senyawa, dan campuran. Model pengembangan yang digunakan adalah model 4D (Definisikan, Rancang, Kembangkan, dan Sebarkan), yang dibatasi oleh validasi ahli, Guru dan respons siswa. Modul ini mengintegrasikan kearifan lokal dan konteks budaya dengan tahapan pembelajaran STEM, mendorong kelancaran, fleksibilitas, orisinalitas, dan elaborasi. Hasil validasi menunjukkan bahwa modul tersebut memenuhi kriteria "sangat valid" dari para ahli materi (Aiken's V = 0,85), ahli pembelajaran (0,84), ahli media (0,81), dan validator instrumen tes (0,83). Guru IPA juga menilai modul tersebut sangat valid (0,89). Respons siswa mencapai rata-rata 89%, dikategorikan sebagai "sangat praktis," menunjukkan bahwa modul tersebut menarik, mudah dipahami, relevan secara budaya, dan efektif dalam merangsang berpikir kreatif. Dengan demikian, modul Ethno-STEM yang dikembangkan sangat layak, praktis, dan relevan sebagai bahan ajar alternatif dalam mendukung Kurikulum Mandiri dan meningkatkan pemikiran kreatif siswa.
Kata Kunci: *Ethno-STEM, Keterampilan Berpikir Kreatif, Modul Sains, Unsur, Senyawa dan Campuran.*

ABSTRACT

The limited relevance of science learning and the dominance of conventional teaching methods have led to low creative thinking skills among students. This study aims to develop an Ethno-STEM-based module integrated with creative thinking skills on the topic of elements, compounds, and mixtures. The development model used is the 4D model (Define, Design, Develop, and Disseminate), limited to expert validation, teacher and student responses. The module integrates local wisdom and cultural contexts with STEM learning stages, fostering fluency, flexibility, originality, and elaboration. The validation results show that the module meets the "very valid" criteria from material experts (Aiken's V = 0.85), learning experts (0.84), media experts (0.81), and test instrument validators (0.83). Science teachers also rated the module very valid (0.89). Student responses reached an average of 89%, categorized as "very practical," indicating that the module is attractive, easy to understand, culturally relevant, and effective in stimulating creative thinking. Thus, the developed Ethno-STEM module is highly feasible, practical, and relevant as an alternative teaching material in supporting the Independent Curriculum and enhancing students' creative thinking.
Keywords: *Ethno-STEM, Creative Thinking Skills, Science Module, Elements Compounds and Mixtures.*

INTRODUCTION

Science education plays a crucial role in developing students' critical and creative thinking skills. Through science learning, students are not only expected to understand scientific concepts but also to analyze problems, evaluate information, and generate solutions relevant to real-life situations. Interactive learning strategies, such as discussions and project-based activities, encourage students to actively express ideas and scientific arguments, which are essential components of critical thinking. In addition, science education supports the development of 21st-century skills, including digital literacy, collaboration, and effective communication, which are vital for facing global challenges. Therefore, science learning should emphasize not only content mastery but also the development of creative and critical thinking skills that are beneficial for students' daily lives and future careers (Saputra et al., 2024).

However, the achievement of Indonesian students in science remains relatively low. Data from the Programme for International Student Assessment (PISA) indicates that Indonesian students' science literacy is below the global average, reflecting weak conceptual understanding and limited ability to apply scientific knowledge (OECD, 2022). In the 2019 PISA survey, Indonesia ranked 70th out of 78 participating countries, with a decline in science scores from 403 in 2015 to 396 (Hikmawati et al., 2020). This condition is influenced by learning materials that are less contextual and predominantly theoretical, making it difficult for students to connect science concepts with real-life experiences (Susanti & Kurniawan, 2020). Moreover, science instruction often prioritizes rote memorization over conceptual understanding and higher-order thinking skills, which are essential in 21st-century education (Hanum et al., 2023). Limited use of effective instructional media further hinders students' scientific literacy and critical thinking development (Parawansa, 2023).

Creative thinking is one of the key competencies required to face the challenges of the 21st century, as it is closely related to innovation and scientific advancement (Pratiwi et al., 2021; Fitri et al., 2023). Creativity enables students to explore diverse solutions, approach problems from multiple perspectives, and adapt to changing conditions (Runco & Acar, 2020). In line with this, the Merdeka Curriculum emphasizes the development of creative thinking as a core competency to prepare students for future challenges (Kemendikbud, 2022). Nevertheless, several studies indicate that students' creative thinking skills in science learning are still low. Pratiwi et al. (2021) reported low achievement across creativity indicators, including fluency, flexibility, elaboration, and originality. Similar findings were reported by Amaliyah et al. (2023) and Hidayati and Ardiansyah (2023), revealing that most students tend to follow instructions passively rather than actively generating innovative ideas. This situation is largely caused by conventional, teacher-centered learning methods that provide limited opportunities for exploration, experimentation, and creative problem-solving (Yulianti & Supriyanto, 2022).

In science learning at the junior high school level, students also face conceptual difficulties, particularly in the topic of elements, compounds, and mixtures. Cahyanto et al. (2019) found that students' understanding of this material was relatively low, with only 38.43% achieving mastery and 52% experiencing misconceptions, especially in distinguishing between elements, compounds, and mixtures. One contributing factor is the inadequacy of existing teaching materials, which often lack conceptual depth, clear indicators, and alignment with curriculum competencies. Some textbooks even contain conceptual inaccuracies, which may further strengthen students' misconceptions. As a result, students struggle to understand scientific concepts meaningfully and apply them in everyday contexts.

Findings from a needs analysis conducted at SMP Negeri 27 Medan support this issue. Although most students expressed high interest in science learning and recognized its importance in daily life, many reported difficulties in understanding science concepts. Students indicated that they would be more motivated if learning materials were connected to real-life situations and local contexts. While teachers occasionally provided supplementary materials, learning modules were still considered difficult to understand and insufficiently contextual. Students also expressed strong interest in hands-on activities and learning resources such as modules and videos. Teacher interviews revealed that although discussions and question-and-answer sessions were implemented, students' creativity remained low, and their ability to relate science concepts, particularly elements, compounds, and mixtures to real-life situations was limited. Teachers believed that integrating local culture into learning materials could make science learning more engaging and support students' creative thinking development.

One learning approach that is considered effective in fostering creative thinking is the STEM (Science, Technology, Engineering, and Mathematics) approach. STEM-based learning encourages students to solve problems, design solutions, and apply interdisciplinary knowledge in real-world contexts (Pratiwi et al., 2021; Sawu et al., 2023). When combined with project-based learning, STEM can create active and meaningful learning experiences that support creativity development (Rachmawati & Prabowo, 2022). However, STEM learning alone may not fully address contextual relevance, particularly in culturally diverse settings like Indonesia.

Indonesia possesses rich local cultures and traditional knowledge that can be integrated into science learning through an ethnoscience approach. Ethnoscience connects scientific concepts with local wisdom, allowing students to understand science within their own social and cultural environments (Murwitaningsih & Maesaroh, 2023). This approach makes learning more contextual, meaningful, and relevant to students' lives, while also contributing to the preservation of local culture (Lightner et al., 2021; Suprapto et al., 2021). However, the implementation of ethnoscience in science education is still limited and requires further innovative development (Rizki et al., 2025).

The integration of ethnoscience with STEM learning has led to the development of the Ethno-STEM approach, which combines science, technology, engineering, and mathematics with local cultural knowledge. Ethno-STEM emphasizes the use of traditional practices and local wisdom as contexts for scientific exploration, enabling students to link scientific concepts with familiar cultural realities. Previous studies have shown that Ethno-STEM can improve students' understanding of scientific concepts and enhance their critical and creative thinking skills (Rahmawati et al., 2022). However, several studies also highlight limitations in existing Ethno-STEM modules, such as insufficient integration of STEM components, limited guidance during project activities, and incomplete assessment of creative thinking indicators (Almuharomah et al., 2019; Rinto et al., 2022; Shodiq et al., 2025).

Therefore, further research is needed to develop an Ethno-STEM-based module that systematically integrates STEM stages, incorporates local cultural contexts, and explicitly supports the development of all aspects of creative thinking. In this study, the module is designed for students at SMP Negeri 27 Medan, using ethnoscience derived from local wisdom in North Sumatra. The development of this module is expected to make science learning more contextual, engaging, and meaningful, while also enhancing students' creative thinking skills in learning elements, compounds, and mixtures.

RSEARCH METHODS

This research was conducted at SMP Negeri 27 Medan, located at Jl. Pancing Pasar IV No.2, Kenangan Baru, Percut Sei Tuan District, Medan, North Sumatra, during the even semester of the 2024/2025 academic year. The research subjects consisted of expert validators, including material experts, learning design experts, and media experts, as well as eighth-grade students and science teachers at SMP Negeri 27 Medan who provided responses to the developed module. The object of this study was the feasibility of an Ethno-STEM-based learning module integrated with creative thinking skills on the topic of elements, compounds, and mixtures for Grade VIII students.

This study employed a research and development (R&D) approach using the 4D model, which consists of the define, design, develop, and disseminate stages. The define stage focused on identifying learning needs through student questionnaires and teacher interviews, while the design stage involved structuring the module, integrating Ethno-STEM and ethnoscience contexts, and preparing assessment instruments. The develop stage emphasized module production and expert validation of content, media, and instructional design, and the disseminate stage involved revising the module and collecting teacher and student responses to assess practicality and attractiveness. The independent variable in this study was the development of an Ethno-STEM-based module integrated with creative thinking, while the dependent variable was the module feasibility, as indicated by expert validation and user responses; this study was limited to the validation and readability stages and did not measure students' creative thinking improvement directly.

Data were collected using interview guidelines, questionnaires, and creative thinking test instruments. Expert validation data were analyzed using Aiken's V index to determine the validity of each item in the module and research instruments. The Aiken's V formula is expressed as:

$$V = \frac{\Sigma\, s}{[n(c-1)]}$$

where $s = r - l_0$, r is the score given by the validator, l_0 is the lowest validity score, c is the highest validity score, and n is the number of validators. The validity criteria used in this study were: V > 0.80 (very valid, usable without revision), 0.60 < V ≤ 0.80 (valid, usable with minor revisions), 0.20 < V ≤ 0.40 (less valid, usable with major revisions), and V ≤ 0.20 (invalid, not usable).

To assess the practicality of the developed module, teacher and student response questionnaire data were analyzed using a descriptive percentage technique based on a 4-point Likert scale. The practicality percentage was calculated using the following formula:

$$Presentation = \frac{\Sigma\, Skor\ seluruh\ responden}{\Sigma\, Responden\ x\ 4}\, x\, 100\%$$

The practicality criteria were interpreted as follows: 76–100% (very practical), 51–75% (practical), 26–50% (less practical), and 0–25% (very impractical) (Sugiyono, 2019). The results of these analyses were used as the basis for revising and finalizing the Ethno-STEM-based module to ensure its feasibility and suitability for use in science learning.

RESULT AND DISCUSSION

Result

A. Development of the Ethno-STEM-Based Module

a. Define Stage
Student and Teacher Needs for Modules

Based on interviews with science teachers at SMP Negeri 27 Medan and analysis of student questionnaires, it was found that science learning in Grade VIII still faces challenges, particularly in fostering students' creative thinking skills. Teachers reported that students tend to have difficulty generating new ideas, solving problems independently, and connecting science concepts to everyday life, despite teachers' efforts through discussions and project-based learning. Learning resources used in class are still limited to PPTs and simple visual aids, and no structured learning module is consistently applied.

Student questionnaire results showed that although students have a high interest in science learning (78%) and consider science important in daily life (91%), most still experience difficulties in understanding concepts (72%). Students were more motivated when learning was contextual (84%) and involved experiments or practical activities (81%). Moreover, most students expressed a strong need for additional teaching materials (85%) and showed high interest in learning that integrates local culture (80%). These findings indicate the need for an Ethno-STEM-based module that connects science concepts with everyday life and local culture to improve understanding and creativity.

Creative Thinking Skills

Interview and questionnaire results indicate that students' creative thinking skills are still relatively low. Students tend to rely on given examples, struggle to propose alternative ideas, and have difficulty applying concepts to real-life situations. Therefore, the developed module is designed to facilitate fluency, flexibility, originality, and elaboration by integrating ethnoscience and STEM-based activities so that students can develop creative thinking skills alongside conceptual understanding.

Quality Standards of the Module

The quality standards of the module were developed based on previous studies (Sarini & Selamet, 2019; Saputri et al., 2023; Oktaviana & Ramadhani, 2023), covering content quality, presentation, language, graphics, and learning implementation. These standards ensure that the module is accurate, systematic, visually attractive, culturally relevant, and able to actively engage students in learning.

b. Design Stage
Module Structure and Features

The module was designed with a systematic structure consisting of an introduction, content, and conclusion. The introduction includes module identity, usage instructions, Ethno-STEM learning orientation, learning outcomes, and a concept map. The module cover visually represents the integration of science concepts and local culture through culturally relevant illustrations combined with scientific symbols.

Picture 1. Cover Module

The module features include Introduction to Material, Did You Know?, Ethnoscience, Let's Get It Done, Science, Technology, Engineering, Mathematics, Let's Test Your Ability, Formative Assessment, Bibliography, and Glossary. These features are designed to support contextual learning, STEM integration, and the development of students' creative thinking skills.

Integrated Ethno-STEM Material

The module covers elements, compounds, and mixtures and integrates ethnoscience with STEM components. Cultural contexts from various Indonesian ethnic groups are used to illustrate scientific concepts, while STEM activities encourage students to apply knowledge through problem-solving, designing simple products, and mathematical calculations.

Instruments and Rubrics

Assessment instruments were developed based on Torrance's creative thinking indicators: fluency, flexibility, originality, and elaboration. Essay-type questions integrated with ethnoscience and STEM contexts were used to allow students to express ideas creatively. Each subtopic includes formative assessments, and a summative assessment is provided at the end of the module, supported by an analytical scoring rubric.

B. Module Feasibility / Validity

c. Develop Stage

The developed module was validated by test instrument experts, material experts, learning experts, media experts, and science teachers. Validation aimed to ensure content accuracy, instructional quality, media design, and relevance to learning needs.

Validation results from test instrument experts showed an average Aiken's V value of 0.88 (very valid), indicating that the instruments were suitable for measuring creative thinking skills (Table 1).

Table 1. Validity results of the integrated module of elements, compounds and mixtures with creative thinking by instrument experts

No.	Aspect	Items	Score V1	Score V2	S1	S2	Σf	N(c-1)	V	Criteria
1.	Content	1,2,3,4,5	18	19	13	14	27	30	0.90	Very valid
2.	Construction	6,7,8,9,10	19	18	14	13	27	30	0.90	Very valid
3.	Language	11,12,13,14	16	12	12	8	20	24	0.83	Very valid
	Total		**53**	**49**	**39**	**35**	**74**	**84**	**0.88**	**Very valid**

Validation by material experts resulted in an average Aiken's V value of 0.86 (very valid), with minor revisions suggested for improving depth and clarity (Tables 2 and 3).

Table 2. Comparison of the Module Before and After Revision in the Material Aspect

No.	Before Revision	After Revision
1.	Every Ethnoscience information, uses references.	

No.	Before Revision	After Revision

2. In the mixed sub-chapter, the "Technology" information is made separate from the material.

3. Add "Learning Outcomes"

4. Add table caption.

Table 3. Validity results of the integrated module of elements, compounds and mixtures with creative thinking by material experts

No.	Aspect	Items	Score V1	Score V2	S1	S2	Σf	N(c-1)	V	Criteria
1.	Materia; Suitability	1,2,3,4	16	16	12	12	24	24	1.00	Very valid
2.	Depth and Breadth	5,6,7,8	15	12	11	8	19	24	0.79	Tinggi
3.	Ethno-STEM Integration	9,10,11,12	16	12	12	8	20	24	0.83	Very valid
4	Contextual Relevance	13,14,15,16	16	12	12	8	20	24	0.83	Very valid
5	Completeness of Material	17,18,19,20	15	13	11	9	20	24	0.83	Very valid
	Total		78	78	78	78	78	78	0.86	**Very valid**

Validation by learning experts produced an average Aiken's V value of 0.94 (very valid), indicating that the module is systematic, readable, and aligned with Ethno-STEM principles (Tables 4 and 5).

Table 4. Comparison of the Module Before and After Revision in The Learning Aspect

No.	Before Revision	After Revision
1.	Add instructions for using the module if the question score obtained is not sufficient to continue to the next lesson.	
2.	When writing acronyms, the full form is written first, followed by the abbreviation.	
3.	Add an introductory sentence to the image.	
4.	Foreign words must be written in italics.	

Table 5. Validity results of the integrated module of elements, compounds and mixtures with creative thinking by learning experts

No.	Aspect	Items	Score V1	Score V2	S1	S2	Σf	N(c-1)	V	Criteria
1.	Module View	1,2,3,4	16	16	12	12	24	24	1.00	Very valid

No.	Aspect	Items	V1	V2	S1	S2	Σf	N(c-1)	V	Criteria
2.	Learning Objectives	5,6,7,8	15	15	11	11	22	24	0.92	Very valid
3.	Ethno-STEM Integration	9,10,11,12	16	16	12	12	24	24	1.00	Very valid
4.	Presentation Systematics	13,14,15,16	14	14	10	10	20	24	0.83	Very valid
5.	Language	17,18,19,20	15	16	11	12	23	24	0.96	Very valid
6.	Readability and Ease	21,22,23,24	15	16	11	12	23	24	0.96	Very valid
	Total		91	93	67	69	136	144	0.94	**Very valid**

Validation by media experts yielded an average Aiken's V value of 0.81 (very valid), confirming that the module's design is visually attractive and feasible with minor improvements (Tables 6 and 7).

Table 6. Comparison of the Module Before and After Revision in the Media Aspect

No.	Before Revision	After Revision
1.	The image on page 12 does not need to be displayed in the module.	
2.	Question number 1 on page 14 has been replaced with a more Ethno-STEM based question.	

Table 7. Validity results of the integrated module of elements, compounds and mixtures with creative thinking by media experts

No	Aspect	Items	Score V1	V2	S1	S2	Σf	N(c-1)	V	Criteria
1.	Cover Design	1,2,3,4	16	12	12	8	20	24	0.83	Very valid
2.	Module Layout	5,6,7,8	16	12	12	8	20	24	0.83	Very valid
3.	Text Readability	9,10,11,12	16	11	12	7	19	24	0.79	Valid
4.	Image/ Illustration Quality	13,14,15,16	14	12	10	8	18	24	0.75	Valid
5.	Visual Appeal	17,18,19,20	15	12	11	8	19	24	0.79	Valid
6.	Design Consistency	21,22,23,24	16	12	12	8	20	24	0.83	Very valid
	Total		93	71	69	47	116	144	**0.81**	**Very valid**

Teacher validation showed an average Aiken's V value of 0.89 (very valid), indicating that the module is relevant, attractive, and has good potential to foster creative thinking (Table 8).

Table 8. Validity results of the integrated module of elements, compounds and mixtures with creative thinking by science teachers

No	Aspect	Items	Score V1	V2	S1	S2	Σf	N(c-1)	V	Criteria
1.	Appearance Attractiveness	1,2,3	12	11	9	8	17	18	0.94	Very valid
2.	Readability and Language Use	4,5,6	9	12	6	9	15	18	0.83	Very valid
3.	Content Relevance	7,8,9	11	12	8	9	17	18	0.94	Very valid
4	Etno-STEM Integration Potential	10,11,12	11	12	8	9	17	18	0.94	Very valid
5	Creative Thinking Potential	13,14,15	10	10	7	7	14	18	0.78	Valid
	Total		53	57	38	42	80	90	0.89	**Very valid**

C. Practicality Based on Student Responses
d. Disseminate Stage

The dissemination stage involved collecting student responses to evaluate the practicality of the module. The results showed an average practicality score of 89%, categorized as very practical. Students rated the module highly in terms of visual attractiveness, ease of reading, interest in content, integration of local culture, and potential to stimulate creative thinking (Table 9). These results indicate that the Ethno-STEM-based module is practical, engaging, and suitable for use in science learning.

Table 9. Respont results of the integrated module of elements, compounds and mixtures with creative thinking by students

No	Aspect	Items	Total Poins	Presentation	Criteria
1.	Visual Attractiveness	1,2,3	309	92%	Very Practical
2.	Ease of Reading	4,5,6	302	90%	Very Practical
3.	Interest in Content	7,8,9	290	87%	Very Practical
4.	Local Culture (Ethno)	10,11,12	306	90%	Very Practical
5.	Creative Thinking Potential	13,14,15	293	88%	Very Practical
	Total		1500	89%	**Very Practical**

Discussion

The validation of the test instrument in this study was conducted to ensure that the developed items were capable of accurately measuring students' creative thinking skills and were aligned with the learning material on elements, compounds, and mixtures. Previous studies indicate that creative thinking assessment instruments are still limited and often rely on simple observations, resulting in students' creative abilities not being optimally measured (Rosidin et al., 2023). Therefore, expert validation focusing on content, construction, and language aspects was essential. The validation results showed very high validity, with Aiken's V values of 0.90 for content and construction and 0.83 for language, resulting in an overall validity of 0.88. These findings indicate that the instrument is theoretically valid and suitable for use, supporting the view that content validity is a fundamental requirement for high-quality

assessment instruments (Eliaumra et al., 2022; Suherman & Vidákovich, 2022; Ningsih et al., 2024). Furthermore, the instrument was developed based on Torrance's creative thinking indicators (fluency, flexibility, originality, and elaboration) ensuring comprehensive measurement of students' creative thinking abilities. This aligns with Tanjung et al. (2023), who emphasize that creative thinking instruments must integrate these indicators simultaneously to allow students to optimally express their creativity.

The validation of the Ethno-STEM-based learning module aimed to ensure that the material content was accurate, relevant to curriculum demands, and capable of facilitating creative thinking development. Learning modules serve as structured teaching materials that support student understanding and independent learning (Fitriyani et al., 2023; Fahmi et al., 2023). The material validation results showed a very high average Aiken's V value of 0.86, indicating that the module content was appropriate, contextual, and relevant to students' daily lives. The highest score was obtained in the material suitability aspect, while the depth and breadth aspect required minor refinement. Validator feedback primarily focused on improving clarity, referencing ethnoscience content, and organizing the presentation flow rather than revising the core material. This supports the assertion that effective modules must clearly represent learning concepts and align with learning outcomes (Irman & Waskito, 2020; Winarko et al., 2024). The integration of ethnoscience within the STEM framework further strengthens the module's relevance, enabling students to connect scientific concepts with cultural practices, which contributes to meaningful learning experiences.

Learning validation results further confirmed the feasibility of the developed module, with an average Aiken's V value of 0.94 categorized as very high. The module's appearance, learning objectives, ethno-STEM integration, readability, and language use were rated highly, indicating that the module is systematic, communicative, and aligned with the Merdeka Curriculum. The clear formulation of learning objectives using operational verbs supports competency achievement, consistent with Mujiburrahman et al. (2023). The strong ethno-STEM integration reinforces findings by Idrus (2022) and Amanah (2025), who highlight that connecting science learning with local culture enhances relevance, motivation, and student engagement. Minor revisions suggested by validators, such as improving instructions and presentation consistency, further enhanced the module's clarity and usability, indicating that the module is suitable for classroom implementation.

Media validation results also demonstrated that the module was visually feasible and supportive of the learning process, with an average Aiken's V value of 0.81 categorized as very high. The strengths of the module were evident in its cover design, layout, and design consistency, while aspects such as text readability and illustration quality required slight improvements. These findings align with Sundari et al. (2023) and Shiddiqy et al. (2024), who state that effective learning media must balance visual attractiveness with clarity and functionality. Revisions made based on media expert suggestions improved focus and relevance, confirming that validation plays a critical role in enhancing media quality (Rahmi et al., 2020; Andira et al., 2021). Attractive and interactive visual elements are known to increase student motivation and reduce learning boredom (Fanny, 2013; Kuswanto, 2019), supporting the feasibility of the developed module as a learning medium.

Teacher validation further reinforced the feasibility of the Ethno-STEM-based module, with an average Aiken's V value of 0.89 categorized as very high. Teachers highlighted the module's attractive appearance, relevant content, and strong integration of Ethno-STEM principles. Although the creative thinking potential aspect received a slightly lower score, it

was still categorized as valid, indicating that the module has the potential to stimulate creativity with further refinement. This aligns with Marsitin and Sesanti (2021), who found that ethno-STEM learning supports the development of creative thinking skills. Teachers' positive responses also indicate that the module meets key characteristics of effective teaching materials, such as being self-instructional, adaptive, and user-friendly (Mubarok et al., 2020; Zendrato et al., 2022).

Student responses during the dissemination stage showed that the module was very practical, with an average score of 89%. High ratings were obtained for visual attractiveness, ease of reading, content interest, integration of local culture, and creative thinking potential. These findings suggest that the module successfully created an engaging and motivating learning experience, consistent with Savitri et al. (2021) and Arini and Lovisia (2019). The integration of ethnoscience and STEM made learning more contextual and meaningful, supporting students' understanding of abstract science concepts through real-life cultural examples.

Overall, the findings indicate that the Ethno-STEM-based learning module is valid, practical, and feasible for use in science learning. The integration of local culture with STEM learning supports the development of students' creative thinking skills by providing contextual problems, encouraging collaboration, and fostering problem-solving abilities. This is consistent with previous studies showing that Ethno-STEM learning positively impacts creative thinking and 21st-century skills (Mulbar & Bahri, 2021; Nurhasnah et al., 2022; Sumarni & Kadarwati, 2020; Tanjung et al., 2025). However, this study has limitations, as it focused only on feasibility and practicality without conducting an effectiveness test to quantitatively measure improvements in creative thinking skills. The research was also limited to one class and did not examine long-term impacts. Future studies should conduct experimental testing, expand implementation to diverse cultural contexts, and investigate the long-term effects of Ethno-STEM-based modules on students' creativity and learning motivation.

CONCLUSION

This study demonstrates that the development of an Ethno-STEM-based learning module integrated with creative thinking represents a meaningful effort to bridge science concepts with students' cultural contexts, thereby addressing the gap between abstract science learning and real-life experiences identified in the introduction. The development process resulted in a learning module that is pedagogically sound, culturally relevant, and aligned with creative thinking principles, indicating that Ethno-STEM can function not merely as an instructional approach, but as a contextual framework that enriches science learning. The validation and response findings collectively indicate that the developed module is feasible, practical, and well-accepted by both experts and users. More importantly, beyond numerical validity and practicality indicators, the results suggest that integrating local culture within STEM-based learning has strong potential to foster student engagement, contextual understanding, and creative exploration. The module positions students not only as recipients of scientific knowledge, but also as active learners who connect science with their cultural environment.

Although this study was limited to feasibility and practicality stages, the findings provide a strong foundation for future implementation and effectiveness testing. The results imply that Ethno-STEM-based modules can be further developed as a strategic learning resource to support creative thinking, 21st-century skills, and culturally responsive education.

Therefore, this research contributes both theoretically and practically by offering a validated learning product and reinforcing the relevance of cultural integration in science education, while opening opportunities for broader application, refinement, and long-term impact studies in diverse educational contexts.

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