Jurnal Pijar MIPA
https://jurnalfkip.unram.ac.id/index.php/JPM

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

Needs Analysis of Ethnoscience-Based STEM Teaching Materials for the Science Education Program

Agus Santoso*, Khoiro Mahbubah, Qonita Qurotul Aini

Science Education Study Program, Universitas Islam Lamongan, Lamongan, Indonesia
*e-mail: Agus_santoso@unisla.ac.id

Received: September 28, 2025. Accepted: November 17, 2025. Published: December 4, 2025

Abstract: This research is driven by the urgent need to produce university graduates who are not only scientifically competent but also creative and possess a strong appreciation for local wisdom, aligning with the Golden Indonesia 2045 vision and the National Research Master Plan's focus on local knowledge. A preliminary problem analysis identified a gap: the absence of ethnoscience-based STEM (Ethno-STEM) teaching materials specifically designed for university students to enhance their appreciation of local wisdom and creativity. This study aims to analyze the need for Ethno-STEM course materials, which will subsequently be developed into a valid, practical, and effective product. A descriptive mixed-methods approach was employed. Data were collected through document analysis of the semester learning plan, a questionnaire administered to 25 students, and semi-structured interviews with 4 science course lecturers. The quantitative data from the questionnaire were analyzed using descriptive statistics, while the qualitative data from interviews and document analysis were processed using thematic analysis. The results indicate a clear alignment between institutional goals and student needs, alongside a significant resource gap. This requirement is strongly supported by student perspectives, as questionnaire results showed that an average of 88% of students expressed a high need for Ethno-STEM teaching materials to improve four key aspects: appreciation of local wisdom, creativity, learning interest, and conceptual understanding. However, despite this clear institutional mandate and student demand, lecturers confirmed difficulties in finding ready-to-use, structured teaching resources to support Ethno-STEM project-based learning. It is concluded that there is a valid and urgent need to develop systematic Ethno-STEM teaching materials to support curriculum implementation. These materials are vital for enhancing the quality of learning and directly fostering student creativity and appreciation for local wisdom in the Science Education Program at UNISLA.

Keywords: Local Wisdom; Needs Analysis; Teaching Materials; STEM; Ethnoscience.

Introduction

Improving the quality of human resources is a critical endeavor for Indonesia to address global challenges and realize the Golden Indonesia 2045 vision. The government recognizes that university graduates play a central role in this effort, necessitating that they possess not only academic degrees but also adequate competencies and skills [1]. This aligns with the National Research Master Plan 2017-2045, which focuses on local wisdom issues that reflect knowledge systems and technologies emerging from society [2]. Achieving this objective requires high-quality educators and learning processes that align with contemporary demands.

The STEM (Science, Technology, Engineering, and Mathematics) approach offers students opportunities to develop critical and creative skills, aligning with educational goals that address 21st-century challenges [3]. However, its effective implementation requires teaching materials relevant to the students' cultural context. By integrating ethnoscience which encompasses local knowledge learning can become more contextual and meaningful [4]. This integration is not merely an addition of local content but serves as an epistemological framework that enriches the STEM learning experience [5]. The Ethno-STEM learning model enables students to understand how concepts of science and technology can be applied within their cultural context [6], such as the chemical reactions in making *gudeg* or the physical principles of the *gamelan*. This approach has been shown to enhance critical thinking skills while simultaneously fostering cultural literacy [5].

The efficacy of integrating ethnoscience is well documented. Pedagogical models that reconstruct scientific principles from community knowledge, such as analyzing the aromatic compounds in herbal teas [7] or utilizing traditional herbal remedies [8], serve as highly relevant and engaging learning resources. In the Indonesian educational context, the application of ethnoscience is expected to improve scientific literacy, foster a profound appreciation for culture, and develop essential 21st-century skills such as critical thinking, communication, and collaboration [3]. Moreover, the integration of local culture cultivates creativity and reinforces the cooperative spirit of *gotong royong*, a core value in Indonesian society [9]

Despite these significant and well documented advantages, persistent challenges in its practical implementation have hindered its widespread adoption. A primary obstacle, identified consistently across various educational levels, is the difficulty educators experience in seamlessly integrating learning materials with the local cultural context [10]. This issue is critically present at the higher education level. Specifically, within the Science Education Study Program at UNISLA, the conspicuous absence of teaching materials that systematically incorporate ethnoscience presents a significant research gap. This lack of

How to Cite:
A. Santoso, K. Mahbubah, and Q. Q. Aini, "Needs Analysis of Ethnoscience-Based STEM Teaching Materials for the Science Education Program", *J. Pijar.MIPA*, vol. 20, no. 7, pp. 1289–1295, Dec. 2025. https://doi.org/10.29303/jpm.v20i7.10316

structured, ready-to-use learning resources poses a considerable obstacle for both lecturers, who struggle to design and execute effective contextual learning, and students, who are denied a more meaningful and engaging educational experience [11], [12].

Therefore, this needs analysis represents a crucial foundational step. The primary objective of this study is to analyze the specific needs of lecturers and students regarding the development of Ethno-STEM-based teaching materials within the Science Education Study Program at UNISLA. This study aims to identify the challenges in current learning and the potential local wisdom that can be integrated. The contribution of this research is twofold: it provides a foundational, data driven basis for the design and development of teaching materials tailored to the specific institutional context, and it adds to the scholarly literature by empirically documenting the gap between the theoretical potential of Ethno-STEM and its practical implementation in Indonesian higher education.

Research Methods

This study employs a mixed-methods research design, which combines both quantitative and qualitative approaches [13]. The research is a needs analysis study on the requirement for Ethno-STEM teaching materials, utilizing a convergent parallel mixed-methods design. This approach was selected to obtain a comprehensive and complementary understanding by analyzing quantitative and qualitative data concurrently [14]. In this design, both data types were collected and analyzed in parallel during the same timeframe, and the results were subsequently integrated during the interpretation phase to generate valid and comprehensive conclusions.

The study was conducted within the Science Education Study Program at UNISLA from June to July 2025. Participants were selected using a purposive sampling technique to ensure the relevance and depth of the data obtained. The participants comprised two main groups: (1) 25 active students from the Science Education Study Program who had completed or were currently enrolled in the relevant course, Innovative Science Learning, and (2) four lecturers of core Science/STEM courses with a minimum of five years of teaching experience and active involvement in curriculum development.

Data were collected using three main techniques with instruments validated by experts to ensure their content validity. First, a document analysis of the Semester Learning Plan for the STEM course (Code: KKIPA24420) was conducted using an analysis sheet. This technique aimed to evaluate the alignment between the Course Learning Outcomes (CPMK) and Ethno-STEM principles. Second, a closed-ended questionnaire utilizing a Likert scale was administered to 25 students to assess their perceptions and needs. The content validity of the instrument was established through expert judgment prior to its distribution. Third, semi-structured interviews were conducted with 4 lecturers using an interview guide to qualitatively explore challenges, needs, and strategic input regarding the development of teaching materials.

Data analysis was conducted through several systematic stages. Quantitative data derived from the questionnaires were analyzed using descriptive statistics (percentages, means, frequencies) with the assistance of Microsoft Excel software. The results were presented in tables and diagrams. Meanwhile, qualitative data from document analysis and interview transcripts were analyzed using a thematic analysis approach, which included three primary flows: data reduction through coding, data display, and conclusion drawing to identify key themes.

The final stage of the analysis was data integration through the triangulation of findings from all three sources: documents, questionnaires, and interviews. This process was performed by comparing and confirming data from each source to enrich the interpretation. The objective was to present a comprehensive and robust picture of the need for the development of Ethno-STEM teaching materials.

Results and Discussion

Results of the Semester Learning Plan Document Analysis

An in-depth analysis of the Semester Learning Plan document for the STEM course (KKIPA24420) clearly indicates that the existing curriculum framework provides a robust foundation for integrating the Ethno-STEM approach. This support is not merely implicit but is explicitly articulated in the formulation of the Course Learning Outcomes (CPMK). As primary evidence, CPMK 3 mandates that students should be able to assess the social, ethical, and environmental implications of technological applications through case studies and propose alternative solutions grounded in humanistic values, local wisdom, ethnoscience, and community care. Furthermore, this requirement is translated into the practical domain through Sub-CPMK 4.2, which requires students to creatively develop a functional prototype (potentially utilizing local materials/techniques) in the form of a science medium or teaching aid and test it critically. These two formulations synergistically affirm that the curriculum not only provides space for but actively encourages learning that is contextual, culturally relevant, and product-oriented.

Although this curricular foundation is ideal, its existence highlights a classic challenge in education: the gap between curriculum policy (the written curriculum) and its classroom implementation (the taught curriculum). The finding that educators often struggle to translate innovative curriculum mandates into effective learning scenarios is not new. Research has consistently reported that a primary obstacle is the absence of relevant, structured, and ready-to-use teaching materials [10], [15]. Thus, it is understandable that although the need for Ethno-STEM learning has been formally accommodated, its practical implementation is hindered by a lack of supporting resources.

In this context, the development of these Ethno-STEM teaching materials is positioned not as an attempt to overhaul the curriculum, but as a strategic intervention. These materials are designed to act as an operational bridge connecting the ideal curriculum mandates with the practical realities of classroom instruction, an essential step in educational research and development methodology [14]. By providing content, case studies, and learning scenarios based on local wisdom, these materials will serve as a tool to facilitate both lecturers and students in effectively achieving the established CPMK. Ultimately, this effort not only

addresses a practical need at the local level but also contributes to the global research trend that increasingly recognizes the importance of bridging modern science with local culture and indigenous knowledge to enhance critical thinking skills, cultural literacy, and the relevance of science education in the 21st century [5], [16].

Results of the Needs Analysis from the Student Perspective

The needs analysis from the student perspective, gathered through questionnaires administered to 25 respondents, provides strong empirical justification for the urgency of developing Ethno-STEM teaching materials. The quantitative data reveal a highly positive perception, indicating significant support for learning materials that integrate STEM concepts with local cultural contexts. A summary of the descriptive statistical analysis of the student responses is presented in Figure 1.

Overall, the questionnaire results indicate a very high percentage of agreement across the four assessed aspects: Appreciation of local wisdom (92%), creativity (88%), learning interest (88%), and conceptual understanding (84%). These figures provide the foundation for a more in-depth analysis of why the Ethno-STEM approach is considered so crucial by students.

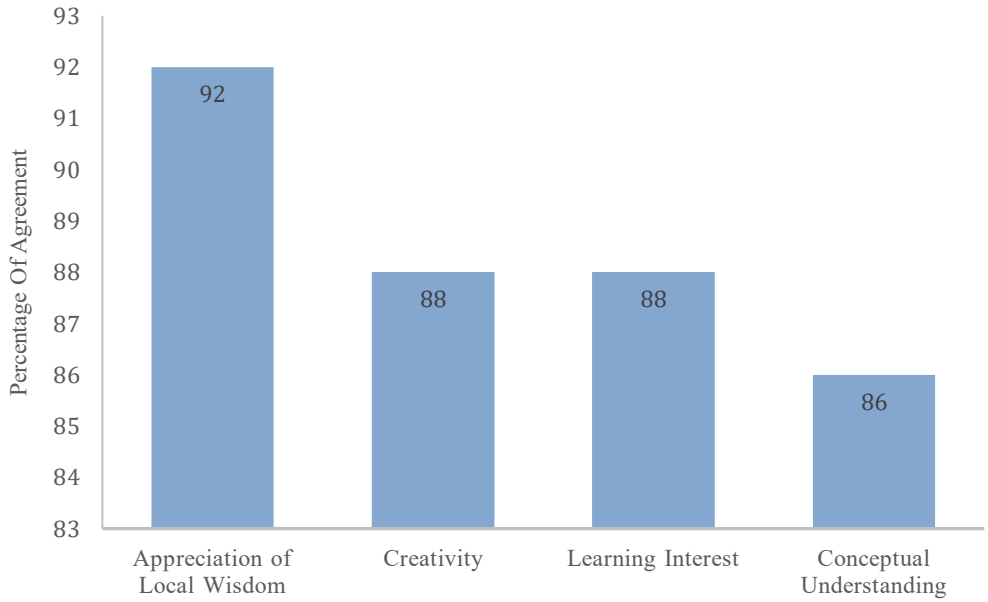

Figure 1. Percentage of positive student responses regarding the potential of the proposed Ethno-STEM teaching materials

The highest approval rating for the appreciation of the local wisdom aspect (92%) signifies a profound psychological and cultural need. Amidst globalization, students perceive a potential alienation from their cultural roots. Ethno-STEM learning is viewed as a pedagogical response to this challenge. This approach strategically repositions local wisdom from being merely ancient tradition to a valid indigenous science that can be scientifically analyzed. For instance, when students examine local culinary processes through the lens of chemistry (fermentation) or physics (heat transfer), they not only learn abstract concepts but also cultivate respect and pride for the intellectual heritage of their ancestors. This analysis is directly validated by the framework developed by Reffiane et al. [17]. The high figure of 92% empirically confirms the Value dimension, indicating that students place a very high value on STEM learning connected to their cultural identity. This is no longer a matter of preference but an affirmation that meaningful learning for them is learning that is culturally rooted.

The aspects of Creativity and increased Learning Interest both achieved 88% approval, indicating a strong expectation that Ethno-STEM can be a driving force for student engagement. A high level of learning interest is seen as an essential foundation for the emergence of creativity. Through these teaching materials, the role of students is expected to transform from passive consumers of knowledge to active and innovative producers of solutions. They are encouraged to conduct critical inquiries, for example, by examining how aerodynamic principles in traditional Javanese *joglo* houses can inspire energy efficient modern architecture, or by exploring how traditional fish preservation techniques (e.g., *pengasapan* or smoking) can be optimized through biotechnology.

This positive perception among students is not merely a subjective aspiration but is instead an expectation firmly rooted in a growing body of empirical evidence from previous research. The practical the application of Ethno-STEM project-based learning, for example, has been shown to directly translate into tangible innovation. This pedagogical approach facilitates a learning environment where students are empowered to produce novel products, such as chemical batik, while simultaneously developing what has been assessed as a very good creative character profile [18]. This link between the model and enhanced creativity is further substantiated by quantitative data from development research, which provides robust statistical evidence that an Ethnoscience-integrated Project-Based Learning (PjBL) model is a powerful tool for significantly elevating students' creative thinking skills [19].

Collectively, these findings provide a compelling argument that the high level of student interest observed in this study is a powerful and accurate predictor of genuine creative improvement. This interest aligns perfectly with the theoretical dimensions of Awareness and Commitment, which are considered foundational prerequisites for fostering creativity [17]. Therefore, the students' enthusiasm is not

just a passive preference but an active indicator that an Ethno-STEM approach can successfully bridge the gap between engagement and tangible creative achievement.

In the cognitive domain, the aspect of enhanced Conceptual Understanding received 84% approval. This very high figure indicates a perception among students of a relevance gap in conventional teaching materials. According to constructivist learning theory, learning is most effective when new information can be closely linked to pre-existing knowledge schemas in the learner's mind [4]. STEM concepts that are often abstract, such as reaction rates in chemistry or optical principles in physics, become much more comprehensible when explained through familiar phenomena in their culture and daily lives.

Thus, Ethno-STEM teaching materials serve as a vital cognitive bridge, connecting the formal, abstract scientific world with the concrete, context-rich reality of students' lives. The students' confidence that they will be better able to understand concepts through this approach accurately reflects the Perceived Ability dimension in the framework of Reffiane et al. [17]. They are confident in their ability to succeed because the teaching material speaks in a cultural language they understand. Overall, these data converge to conclude that the development of Ethno-STEM teaching materials is no longer merely an option, but an urgent need to realize a holistic learning experience: one that is culturally rooted, affectively engaging, and cognitively robust.

Results of Needs Analysis from the Lecturers' Perspective

Thematic analysis of interview transcripts with four lecturers yielded several key themes, which are summarized in Table 1.

Table 1. Summary of Needs Analysis Findings from the Lecturers' Perspective

Theme	Description of Findings
Implementation Challenges	Lecturers reported difficulty in finding reliable scientific references on local ethnoscience and expressed a lack of time to design Ethno-STEM project-based learning (PjBL) scenarios from scratch.
Characteristics of Needed Teaching Materials	Lecturers require a module/textbook that is: (a) systematic, progressing from theoretical concepts to project guidelines; (b) presents concrete and detailed examples relevant to the Lamongan/East Java context; and (c) is equipped with ready-to-use authentic assessment instruments (e.g., project assessment rubrics).
Curriculum Support	All lecturers agreed that the availability of such teaching materials would be highly beneficial for achieving the Course Learning Outcomes (CPMK) stipulated in the Semester Learning Plan (RPS), while also alleviating their teaching preparation workload.

Elaborating on the specific content and application needs from Table 1, the interview data provided concrete examples of local wisdom identified by lecturers as having high potential for integration. These included, but were not limited to, the chemical principles of traditional food production (such as the fermentation in *jelebut* and the Maillard reaction in *wingko babat*), the physics of traditional *perahu* (boat) construction adapted to coastal environments, and the biotechnology applications found in local *terasi* (shrimp paste) production. Furthermore, a key classroom application example requested by all lecturers was for the materials to contain clear, step by step Project Based Learning (PjBL) guides. They envisioned these guides as tools to help students scientifically analyze these local practices and then translate that analysis into innovative projects, such as developing standardized natural food colorants from local flora or designing modernized, efficient smoking ovens for fish preservation.

The challenges articulated by the lecturers are not an isolated phenomenon but rather a reflection of broader and more fundamental issues within the Indonesian educational landscape. This finding is consistent with previous research at the secondary education level, which also identifies the absence of efficient and effective teaching materials as a primary barrier for teachers in implementing Ethno-STEM-based learning [10], [15]. The similarity of challenges faced by educators at different levels, from secondary school to higher education, indicates that the scarcity of structured and relevant learning resources is a systemic problem hindering the nationwide integration of local culture into science education.

The difficulties faced by the lecturers become more understandable when considering the complexity of the required tasks. The process of deconstructing and reconstructing local knowledge, such as breaking down the production of traditional herbal medicine (*jamu*) into its respective S-T-E-M components, demands specific time and expertise that not all instructors possess [20]. Therefore, the need for ready to use and structured teaching materials is essentially a demand for pre-integrated, specific Pedagogical Content Knowledge (PCK) for Ethno-STEM. This reinforces the premise that the development of these teaching materials must take the form of a comprehensive learning package to facilitate classroom implementation [7]. Consequently, the cognitive load on lecturers can be alleviated, allowing them to focus more on their role as facilitators of the student learning process.

Integration and Triangulation of Findings

This research reveals a strong and multidimensional empirical justification for the urgent development of Ethno-STEM teaching materials. Through the triangulation process, mutually reinforcing confirmation was found across three primary data sources. First, the analysis of the semester learning plan document confirmed the existence of a curricular mandate supporting innovative and contextual learning. Second, data from the student questionnaire indicated a very high level of learning needs for culturally relevant materials that can enhance thinking skills. Third, the results of interviews with lecturers revealed teaching needs for structured, ready-to-use teaching materials. A clear gap

was identified, where no teaching materials currently exist to serve as a harmonious bridge connecting these three pillars.

The identification of a significant gap in teaching materials is not an isolated finding but rather builds upon a foundational body of work and represents a strategic progression from a series of previous studies conducted at UNISLA. Initial research had already established a pronounced need for integrated teaching materials based on the STEAM approach within the institution [21]. Subsequent research and development efforts provided empirical validation for this direction, demonstrating that a well-designed STEAM module was a highly effective intervention for significantly improving students' higher-order thinking skills [22]. More recently, the feasibility and success of incorporating local culture were confirmed through the development of an Ethno-STEM e-module centered on Lamongan's local wisdom, which proved to be a highly successful and well-received pedagogical tool [23]. Therefore, the present study synthesizes these preceding insights to articulate a more nuanced and culturally attuned need, sharpening the focus from a general integrated approach to a specific Ethno-STEM framework. For instance, building on the established success of a general STEAM module [22], the new materials will specifically guide students to apply principles of heat transfer (Physics) and material science (Engineering) to analyze and innovate upon the local practice of *batik sendang* (Lamongan's traditional *batik*), a specific classroom application example strongly implied by the aligned data sources. This has been empirically shown to be highly desired by students, thus positioning this development as an evidence-based and strategic evolution in curriculum enhancement.

Furthermore, the challenges articulated by the lecturers reflect a systemic issue within the broader national educational landscape rather than an isolated institutional problem. This observation is strongly corroborated by findings from the secondary education level, where the scarcity of accessible and effective teaching resources was identified as the principal barrier preventing teachers from implementing an Ethno-STEM pedagogy [15]. The remarkable consistency of this challenge across different educational tiers from secondary schools to universities suggests that the absence of relevant, structured learning materials constitutes a pervasive, cross-level impediment to integrating local culture into science education throughout Indonesia. The complexity of this task becomes even more apparent when considering the meticulous process required to translate tacit cultural knowledge into explicit learning content. For instance, transforming the traditional art of making herbal medicine (jamu) into a formal lesson requires a profound deconstruction of its indigenous science and a pedagogical reconstruction into its respective STEM components, a process demanding specialized expertise and significant time investment [20]. This inherent complexity fully validates the lecturers' call for ready-to-use materials, underscoring their need for scaffolded pedagogical tools that can bridge the gap between curriculum theory and classroom practice.

The imperative for developing these materials is substantially amplified by a compelling body of empirical evidence that demonstrates the widespread effectiveness and transformative potential of the Ethno-STEM approach. A significant body of work has proven that its implementation in higher education yields multifaceted benefits, successfully enhancing students' 21st-century skills, conservation character, and entrepreneurial spirit [24]. More specifically, research has shown that project-based learning within an Ethno-STEM framework can effectively shape students' innovative and creative character profiles to the point of producing tangible, marketable products, thereby connecting academic learning with real-world application [18]. Moreover, the approach has been empirically validated for its capacity to produce a synergistic impact, simultaneously enhancing high-level cognitive skills such as critical and creative thinking while also significantly deepening students' cultural literacy [5], [19]. This collective success powerfully underscores that the Ethno-STEM approach is far more than a simple content addition; it functions as a comprehensive pedagogical framework that holistically enriches the learning experience in profound alignment with overarching educational objectives.

Ultimately, the significance of this research transcends its immediate local context to engage with a vital and expanding global academic discourse. A comprehensive bibliometric analysis has revealed a significant upward trend in scientific publications related to Indigenous STEM; however, it has concurrently identified the specific themes of ethno-STEM and culturally responsive higher education as being critically understudied [16]. This positions the current needs analysis strategically, as the proposed development of teaching materials serves as a tangible mechanism for implementing the principles of culturally responsive education at the university level. By fulfilling this well defined need, the new materials are expected to alleviate the significant cognitive load on lecturers, thereby empowering them to shift their focus from resource creation to facilitating the kind of transformative and engaging student learning processes that have been shown to be highly effective [6]. Furthermore, this aligns with findings that the ethnoscience learning paradigm is a proven and effective effort to develop students' science literacy [25]. Consequently, this research provides a dual contribution: it offers a practical solution to a pressing local problem while simultaneously addressing a clearly identified and significant gap in the international scholarly literature.

Conclusion

Based on the analysis and discussion, it can be concluded that there is a valid, significant, and urgent need for the development of ethnoscience-based STEM (Ethno-STEM) teaching materials for the Science Education Study Program at UNISLA. This conclusion is reinforced by the primary finding regarding curricular support, wherein the Semester Learning Plan (RPS) explicitly mandates the integration of local wisdom and ethnoscience into its learning outcomes. Thus, the development of these materials is a strategic step toward realizing this existing curricular mandate. Support for this need also comes from the perspective of the primary users: learners and instructors. From the students' perspective, there is a strong contextual demand, with a majority of students (an average of 88%) expressing a high need for Ethno-STEM teaching materials relevant to the local culture of Lamongan. They believe that such materials can enhance their interest in learning, conceptual understanding, and creativity. Correspondingly,

from the lecturers' perspective, an urgent practical need was identified for structured, ready-to-use teaching resources that present specific local examples and are equipped with relevant assessment instruments. Therefore, this research not only successfully maps the needs comprehensively but also provides a clear direction for the subsequent development phase. The Ethno-STEM teaching materials to be developed must be designed as a holistic learning system, not only presenting content but also guiding lecturers and students through authentic project-based learning designed to tangibly improve these key student competencies. As a follow-up, it is recommended that future research focus on the product development phase, utilizing an instructional design model such as ADDIE or 4D, to produce teaching materials that are tested for their validity, practicality, and effectiveness in enhancing the specific competencies of conceptual understanding, creativity, and appreciation for local wisdom.

Author's Contribution

Agus Santoso: Conceptualization, Methodology, Formal analysis, Project administration, Writing-original draft, Writing-review & editing; Khoiro Mahbubah: Investigation, Data curation, Writing - review & editing; Qonita Qurotul Aini: assisted with data collection.

Acknowledgements

The authors extend their sincere gratitude to the Ministry of Higher Education, Science, and Technology (Kemdiktisaintek) of the Republic of Indonesia through the Directorate General of Research and Development, Directorate of Research and Community Service (DPPM), which provided funding support for the implementation of this research in the 2025 fiscal year. This research was conducted through the DRPM Research scheme, with contract number 0419/C3/DT.05.00/2025; 128/C3/DT.05.00/PL/2025; 048/LL7/DT.05.00/PL/2025; and 011/SP2H/PL/LITBANG PEMAS/2025. We also express our gratitude to the Science Education Study Program, Faculty of Teacher Training and Education, Universitas Islam Lamongan for providing support and facilities that enabled this research to proceed smoothly. Finally, thanks are due to all parties who assisted in the smooth execution of this research, especially the lecturers and students who participated as respondents.

References

[1] S. Suharjo and M. Jacky, "Kebijakan Kurikulum Merdeka Belajar Kampus Merdeka Sebagai Penyongsong Indonesia Emas Tahun 2045," in *Prosiding Seminar Nasional Ilmu Ilmu Sosial (SNIIS) Universitas Negeri Surabaya*, Universitas Negeri Surabaya: Universitas Negeri Surabaya, 2023, pp. 1068–1078. [Online]. Available: https://proceeding.unesa.ac.id/index.php/sniis/article/view/884/366

[2] Kementerian Pendidikan Tinggi Sains dan Teknologi, *Buku Panduan Penelitian dan Pengabdian Kepada Masyarakat Tahun 2025*. Direktorat Jenderal Riset dan Pengembangan Kementerian Pendidikan Tinggi, Sains, dan Teknologi, 2025.

[3] A. Rahman *et al.*, "Meta-Analisis : Pengaruh Pendekatan STEM berbasis Etnosains Terhadap Kemampuan Pemecahan Masalah dan Berpikir Kreatif Siswa," *Innovative*, vol. 3, no. 2, pp. 2111–2125, May 2023, doi: 10.31004/innovative.v3i2.545.

[4] G. Siagian, T. Wulandari, L. Lufri, A. Asrizai, and H. Hardeli, "Peran Dalihan Na Tolu dalam Meningkatkan Pendidikan IPA pada Etnosains: Perspektif Filsafat," *j.n.a.pendidik.*, vol. 8, no. 1, pp. 152–157, June 2023, doi: 10.52060/mp.v8i1.1049.

[5] S. E. Atmojo, M. D. Anggriani, R. D. Rahmawati, M. Skotnicka, A. K. Wardana, and A. P. Anindya, "Bridging STEM and Culture: The Role of Ethnoscience in Developing Critical Thinking and Cultural Literacy," *jpii*, vol. 14, no. 2, June 2025, doi: 10.15294/jpii.v14i2.23505.

[6] I. Kartika, I. Wilujeng, and R. Rukiyati, "Critical thinking skills profile in the ETNO-STEAM science learning model implementation in the university: A case study," *Rev. Mex. Fis. E*, vol. 22, no. 2 Jul-Dec, July 2025, doi: 10.31349/RevMexFisE.22.020210.

[7] S. Sudarmin, E. N. Savitri, Rr. S. E. Pujiastuti, S. Yamtinah, H. H. B. Mohd Zaim, and Ariyatun, "Reconstruction of Ethno-STEM Integrated Project Learning Models for Explanation of Scientific Knowledge Regarding Aroma Compounds of Indonesian and World Herbal Teas," *jpii*, vol. 13, no. 2, July 2024, doi: 10.15294/wknw8m59.

[8] Amalia Putri, Nur Qomaria, and Ana Yuniasti Retno Wulandari, "Kajian Etnosains pada Ramuan Tradisional Keraton Sumenep dan Kaitannya dengan Pembelajaran IPA SMP," *jpm*, vol. 12, no. 4, pp. 1148–1155, Dec. 2022, doi: 10.37630/jpm.v12i4.762.

[9] M. Mery, M. Martono, S. Halidjah, and A. Hartoyo, "Sinergi Peserta Didik dalam Proyek Penguatan Profil Pelajar Pancasila," *basicedu*, vol. 6, no. 5, pp. 7840–7849, June 2022, doi: 10.31004/basicedu.v6i5.3617.

[10] A. Alfiana and A. Fathoni, "Kesulitan Guru dalam Menerapkan Pembelajaran IPA Berbasis Etnosains di Sekolah Dasar," *basicedu*, vol. 6, no. 4, pp. 5721–5727, May 2022, doi: 10.31004/basicedu.v6i4.3123.

[11] P. V. M. Risamasu, J. Pieter, and I. W. Gunada, "Rekonstruksi Pengetahuan Sains Ilmiah Berbasis Kearifan Lokal Masyarakat di Pinggiran Danau Sentani Jayapura," *JIPP*, vol. 8, no. 4, pp. 2687–2695, Nov. 2023, doi: 10.29303/jipp.v8i4.1866.

[12] J. B. Kelana, D. S. Wardani, and M. A. Wulandari, "Etnosains sebagai Sumber Belajar di Sekolah Dasar," *JKP*, vol. 5, no. 1, p. 74, Jan. 2021, doi: 10.26858/jkp.v5i1.16822.

[13] Sugiyono, *Metode penelitian pendidikan: Kuantitatif, kualitatif, kombinasi, R&D dan penelitian pendidikan*. Bandung: Alfabeta, 2023.

[14] J. W. Creswell and J. D. Creswell, *Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.)*. SAGE Publications, 2018.

[15] H. Azis and Yulkifli, "Preliminary research in the development of smartphone-based e-module learning materials using the ethno-STEM approach in 21st century education," *J. Phys.: Conf. Ser.*, vol. 1876, no. 1, p. 012054, Apr. 2021, doi: 10.1088/1742-6596/1876/1/012054.

[16] Budiman and I. R. Suwarma, "Global research trends of indigenous STEM in science education: A bibliometric analysis," presented at the THE 5TH INTERNATIONAL CONFERENCE ON INFORMATION TECHNOLOGY, ADVANCED MECHANICAL AND ELECTRICAL ENGINEERING, Yogyakarta, Indonesia, 2025, p. 080024. doi: 10.1063/5.0259698.

[17] F. Reffiane, Sudarmin, Wiyanto, and S. Saptono, "Students' behaviour towards etno-STEM: instruments for students of etno-STEM based science education," *J. Phys.: Conf. Ser.*, vol. 1567, no. 4, p. 042021, June 2020, doi: 10.1088/1742-6596/1567/4/042021.

[18] Sudarmin, W. Sumarni, S. Mursiti, and S. S. Sumarti, "Students' innovative and creative thinking skill profile in designing chemical batik after experiencing ethnoscience integrated science technology engineering mathematic integrated ethnoscience (ethno-stem) learnings," *J. Phys.: Conf. Ser.*, vol. 1567, no. 2, p. 022037, June 2020, doi: 10.1088/1742-6596/1567/2/022037.

[19] A. Muliadi, J. Rokhmat, and Aa. Sukarso, "Ethnoscience integrated project-based learning model for enhancing students' creative thinking skills and cultural literacy: Expert perspectives and preliminary testing," *ijirss*, vol. 8, no. 3, pp. 3676–3685, May 2025, doi: 10.53894/ijirss.v8i3.7376.

[20] W. Sumarni, S. Sudarmin, S. S. Sumarti, and S. Kadarwati, "Indigenous knowledge of Indonesian traditional medicines in science teaching and learning using a science–technology–engineering–mathematics (STEM) approach," *Cult Stud of Sci Educ*, vol. 17, no. 2, pp. 467–510, June 2022, doi: 10.1007/s11422-021-10067-3.

[21] A. Santoso, K. Mahbubah, and S. F. Alim, "Needs Analysis Teaching Materials of STEAM Approach in Innovative Learning Courses," *Didaktika: Jurnal Kependidikan*, vol. 13, no. 4, 2024, doi: https://doi.org/10.58230/27454312.1223.

[22] A. Santoso, K. Mahbubah, and S. F. Alim, "Development of a STEAM-Based Module to Enhance HOTS (Analytical, Critical, and Creative Thinking) for Pre-service Science Teachers at UNISLA," *Konstan*, vol. 10, no. 01, pp. 68–79, July 2025, doi: 10.20414/konstan.v10i01.698.

[23] K. Mahbubah, A. Santoso, and R. Djatmiko, "Preliminary Design: Development of Capillarity e-Module Based Ethnoscience to Promoting Students' Science Literacy," *J. Pendidik. Fis. Teknol.*, vol. 11, no. 1, pp. 1–7, Mar. 2025, doi: 10.29303/jpft.v11i1.7261.

[24] S. Sudarmin, Rr. S. E. Pujiastuti, R. Asyhar, A. Tri Prasetya, S. Diliarosta, and A. Ariyatun, "Chemistry project-based learning for secondary metabolite course with ethno-STEM approach to improve students' conservation and entrepreneurial character in the 21st century," *J. Technol. Sci. Educ.*, vol. 13, no. 1, p. 393, Feb. 2023, doi: 10.3926/jotse.1792.

[25] W. Nabilah, E. Sudibyo, and V. Aulia, "Foster student's science literacy skills on environmental pollution topics through the etnoscience approach," *J. Pijar.MIPA*, vol. 17, no. 3, pp. 387–393, May 2022, doi: 10.29303/jpm.v17i3.3506.