MOJES MALAYSIAN ONLINE JOURNAL OF EDUCATIONAL SCIENCES APRIL 2026, 14 (2)

RECONSTRUCTING LOCAL WISDOM INTO ETHNO-STEM TEACHING MATERIALS: A NEED ANALYSIS STUDY AMONG SCIENCE TEACHERS

Henie Poerwandar Asmaningrum[1]
***Renuka V Sathasivam[1]**
Edy Hafizan Mohd Shahali[1]
[1] Department of Mathematics and Sciences Education Faculty of Education, Universiti Malaya
**renukasivam@um.edu.my*

ABSTRACT

Science teachers in multicultural regions consistently encounter difficulties in incorporating indigenous knowledge into their curricula, particularly when practical and contextually relevant support resources are absent. Although the challenge of Ethno-STEM integration has been documented globally, it remains largely unaddressed in the specific geographic and cultural context of Merauke, Papua, Eastern Indonesia, where teachers serve students from highly diverse indigenous Papuan and migrant communities simultaneously. This study investigated the needs of senior secondary science teachers in Merauke for the transformation of local wisdom into Ethno-STEM teaching materials, generating an empirical basis for handbook development. Grounded in the needs analysis framework of Nation and Macalister (2010), the study employed a quantitative descriptive cross-sectional survey design. Data were collected from 54 certified Biology, Physics, and Chemistry teachers in all public and private senior secondary schools across Merauke Regency using total population sampling. The instrument, the Teachers' Need for Ethno-STEM Material Development Scale (TNEMDS), comprised 24 closed-ended items across three sections (Necessities, Lacks, and Wants) and three open-ended prompts. Data were analyzed using descriptive statistics (mean and standard deviation) and thematic content analysis of open-ended responses. Reliability was confirmed through Cronbach's alpha (α = 0.84–0.91). Findings indicate that teachers recognize Ethno-STEM competencies as a high professional necessity (M = 4.15), report substantial gaps in their current capacity to reconstruct local wisdom into structured materials (M = 4.06), with the most critical gap being the absence of contextually relevant references and systematic reconstruction procedures for Eastern Indonesian settings, and express very high demand for a practical Ethno-STEM teaching handbook (M = 4.52), particularly one containing concrete examples drawn from Merauke cultural practices. The study contributes an empirically validated needs profile and a context-specific instrument (TNEMDS) for Ethno-STEM material development research in multicultural Eastern Indonesia, offering direct practical guidance for handbook developers, teacher educators, and educational policymakers in Papua Province.

Keywords: *Ethno-STEM, needs analysis, local wisdom, science teachers, multicultural education.*

INTRODUCTION

Science education has long faced the challenge of staying relevant and useful for students of all kinds. This issue is especially important in areas with many different cultures (Maulidiyah, 2021). Students possess extensive cultural knowledge that is seldom recognized or incorporated into the educational

experience. The outcome is a continual disjunction between students' community knowledge and the educational expectations in school (Sumarni & Kadarwati, 2020).

The Ethno-STEM approach has surfaced as a viable solution to this challenge. It incorporates indigenous knowledge and local cultural insights into the learning of Science, Technology, Engineering, and Mathematics, enhancing contextual relevance and cultural inclusivity (Gumilar et al., 2022). Empirical research in Indonesian educational settings demonstrates that Ethno-STEM enhances students' conceptual comprehension, fortifies higher-order thinking abilities, and reinforces cultural identity within the science classroom (Primadianningsih et al., 2023; Sumarni et al., 2023). The evidence is becoming increasingly consistent.

Ethno-STEM has a lot of potential, but Indonesian schools don't use it all the time. This is especially true in Eastern Indonesia, where there are still a lot of indigenous knowledge systems across ethnic groups that aren't being used as teaching tools (Asmaningrum et al., 2023). Teachers in places like Merauke, Papua have a hard time because they have to teach students from both indigenous Papuan communities, like the Marind, Muyu, and Mandobo, and migrant populations from all over the archipelago. In this case, teaching science is more than just telling people what to do. It needs teachers who are aware of different cultures, are creative, and have a clear way to turn what people know about their own culture into structured learning materials.

Transforming local knowledge into Ethno-STEM teaching materials is not an easy job. It takes figuring out which cultural practices include scientific ideas, checking to see if they fit with the goals of the curriculum, and creating learning experiences that are both scientifically sound and respectful of other cultures (Khusna & Adji, 2024). Most teachers haven't been formally trained to develop the skills needed for this process. Previous research has consistently shown this gap (Annisa et al., 2021; Sudarmin et al., 2020). Science teachers generally agree that they should include indigenous knowledge in their lessons, but they say they don't have the right tools or training to do it well (Black & Tylianakis, 2024; Naah & Osei-Himah, 2024). Teachers know that local knowledge can be a useful teaching tool, but they don't have access to structured, practical advice that helps them put this knowledge to use in the classroom.

A useful guidebook made just for creating Ethno-STEM teaching materials could fill this gap. A handbook can help teachers design Ethno-STEM lessons by giving them a clear, step-by-step process for rebuilding, real-life examples from their own culture, and templates that have been tested (Maryanti et al., 2023). But before making such a resource, it is important to have a clear idea of what teachers really need (Muttaqiin et al., 2021). Without this real-world basis, any handbook could be out of touch with what teachers really deal with in the classroom.

Although the lack of Ethno-STEM integration has been documented in diverse global settings, systematic empirical investigation of what science teachers specifically need to perform this integration remains scarce in the Eastern Indonesian context. Merauke, Papua presents a unique constellation of challenges: teachers serve simultaneously indigenous Papuan students from communities such as the Marind, Muyu, and Mandobo alongside migrant populations from across the archipelago, within a region where indigenous knowledge systems have rarely been formalized as instructional resources. No validated instrument currently exists to measure the needs of science teachers in this setting, and no empirical study has examined whether teachers themselves regard a practical handbook as a necessary and appropriate response to these challenges. This study addresses that gap. It examines what science teachers in Merauke identify as necessary competencies for material development in Ethno-STEM, the gaps between their current capacity and those requirements, and their anticipated use of a practical handbook as a professional support resource. The study makes two distinct contributions. Theoretically, it extends the application of Nation and Macalister's (2010) needs analysis framework beyond language curriculum design into the domain of Ethno-STEM teacher education, demonstrating its analytical utility for mapping professional development needs in multicultural science contexts. Practically, it produces an empirically validated needs profile and a context-specific instrument, the TNEMDS, that can directly

guide the development of a Merauke-specific Ethno-STEM teaching handbook and inform teacher professional development programs in Papua Province.

Theoretical and Conceptual Framework

The needs analysis framework by Nation and Macalister (2010) and the Ethno-STEM educational framework by Sudarmin (2015) are the two main theoretical bases for this study. These frameworks collectively inform the development of the research instrument, the analysis of teachers' responses, and the theoretical rationale for an Ethno-STEM teaching handbook.

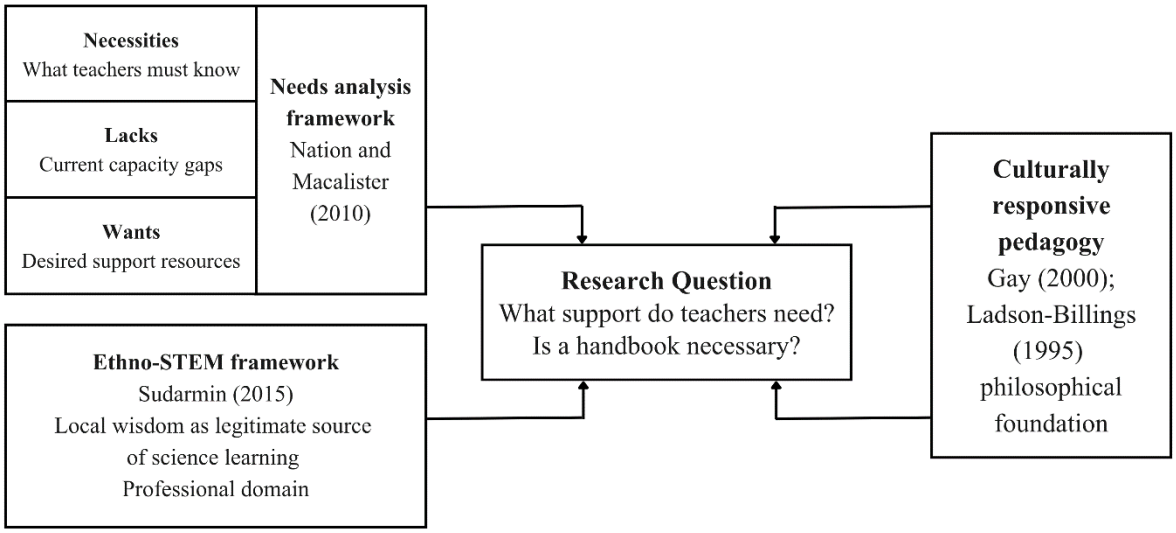
According to Nation and Macalister (2010), three distinct yet interconnected categories of educational needs can be comprehended systematically. Students or professionals need to know and be able to do certain things in order to do their jobs well in a certain situation. Lacks are the things you need to do to meet your needs that you don't know how to do yet. Wants are the things that practitioners want to help them fill in the gaps they have found. A lot of needs analysis research in schools has used this three-part framework to show that instructional resources and professional support tools should be made. This study employs the framework to examine the professional lives of science teachers in Merauke. Needs show the skills teachers need to make Ethno-STEM materials, Lacks show the gaps between teachers' current skills and those needs, and Wants show teachers' desire for a practical handbook as a support resource.

The Ethno-STEM framework regards indigenous knowledge and local cultural wisdom as valid and significant sources of scientific education (Izzah et al., 2020; Sari et al., 2023). It posits that science education attains greater significance when scientific concepts are contextualized within cultural frameworks that students acknowledge and appreciate (Sudarmin, 2015; Sumarni et al., 2020). Ethno-STEM is more than just a way to teach. It is an epistemological perspective that recognizes the scientific aspects of indigenous practices and regards local communities as collaborative participants in science education (Imani et al., 2026; Izzah et al., 2023). This framework directly informs the reconstruction process that this study examines, as it provides the theoretical rationale for why local wisdom deserves a structured place in the science curriculum and why teachers' capacity to reconstruct that wisdom is a professional necessity rather than an optional competency.

Figure 1 shows how these two frameworks fit together. The Nation and Macalister (2010) framework organizes the investigation by listing what teachers need to know (Necessities), what they don't have (Lacks), and what they want as help (Wants). The Ethno-STEM framework delineates the professional domain encompassing those needs. The convergence of these two frameworks gives rise to the principal inquiry of this study: what particular assistance do science educators in Merauke require to transform local wisdom into Ethno-STEM teaching resources, and does a practical handbook represent an essential and significant response to that requirement?

Figure 1

The Theoretical and Conceptual Framework of Teachers' Needs in Reconstructing Local Wisdom into Ethno-STEM Teaching Materials Based on Nation and Macalister (2010) and Sudarmin (2015)



The larger theoretical tradition of culturally responsive pedagogy (Gay, 2002; Ladson-Billings, 1995) underpins both frameworks. Culturally responsive pedagogy says that good teaching builds on what students already know, their cultural backgrounds, and their own experiences. It places culture not as a secondary issue but as a fundamental component of effective teaching. In the context of Ethno-STEM, culturally responsive pedagogy gives us the philosophical reasons why professionals need to turn local knowledge into teaching materials. This is especially true in multicultural areas like Merauke, where science teachers have to teach students from many different cultural and epistemic traditions at the same time.

RESEARCH OBJECTIVE AND RESEARCH QUESTION

In this context, the study aims to investigate the requirements of senior secondary science educators in Merauke, Papua, for transforming local wisdom into Ethno-STEM educational resources. Based on the needs analysis framework of Nation and Macalister (2010), it seeks to ascertain what teachers must know and be capable of (Necessities), the discrepancies between their existing competencies and the required proficiency (Lacks), and the specific support resources they wish to obtain (Wants). This study aims to provide empirical evidence that supports and guides the creation of a contextually relevant Ethno-STEM teaching handbook tailored for multicultural science classrooms in Eastern Indonesia by prioritizing the voices of teachers.

Consequently, this study is part of a larger research agenda aimed at creating an Ethno-STEM teaching handbook for science educators in multicultural contexts of Eastern Indonesia. It seeks to examine the needs of senior secondary science teachers in transforming local wisdom into Ethno-STEM teaching materials, serving as an empirical basis for the handbook's development. Specifically, it addresses the following research questions:

1. What do science teachers identify as the necessary competencies and contextual conditions for reconstructing local wisdom into Ethno-STEM teaching materials? *(Necessities)*
2. What gaps exist between science teachers' current proficiency and the situational demands of Ethno-STEM teaching material development? *(Lacks)*
3. To what extent do science teachers want an Ethno-STEM teaching handbook, and how do they anticipate using it? *(Wants)*

METHODOLOGY

This study utilized a quantitative descriptive research design to examine the needs of science teachers in transforming local wisdom into Ethno-STEM teaching materials. A cross-sectional survey methodology was utilized, as it effectively assesses teachers' current practices, perceived challenges, and resource requirements at a specific moment. This design aligns with needs analysis studies that seek to create an empirical foundation for the creation of educational resources (Kaufman, 1988).

Participants

Participants were senior secondary science teachers instructing Biology, Physics, and Chemistry in Merauke Regency, Papua Province, Indonesia. Inclusion criteria required that participants: (1) held an active teaching assignment in Biology, Physics, or Chemistry at the senior secondary level (SMA/MA) at the time of data collection; (2) possessed a minimum of one year of teaching experience in Merauke Regency, ensuring familiarity with the local cultural context; and (3) held a valid teacher professional certification (*Sertifikasi Guru*) or were registered as active civil servant or contract teachers under the Merauke Education Office. These criteria were established to ensure that respondents possessed sufficient professional experience and institutional accountability to provide informed responses about their needs for Ethno-STEM material development. A total population sampling strategy was utilized, inviting all science educators meeting these criteria from both public and private senior secondary institutions in Merauke to participate. This strategy is appropriate when the target population is limited and geographically bounded, as it ensures the findings represent the needs of the entire accessible population rather than a selected subgroup. A total of 54 science teachers participated, constituting the complete population of eligible senior secondary science teachers across all schools in the regency at the time of the study.

Instrument

The Teachers' Need for Ethno-STEM Material Development Scale (TNEMDS) was used to collect data. This is a tool that was created by researchers based on the needs analysis framework suggested by Nation and Macalister (2010). According to Nation and Macalister, there are three types of educational needs: Necessities, which are the things teachers must know and be able to do; Lacks, which are the gaps between what teachers can do now and what they need to be able to do; and Wants, which are the things teachers want as support resources. This three-part framework helped shape the TNEMDS, making sure that the tool gives a complete and theoretically sound picture of what teachers need.

There are 24 items in the TNEMDS, which are divided into three sections based on the three types of needs. Section A looks at Necessities in two ways: what teachers say they think are the skills needed to develop Ethno-STEM materials and how they think those materials will be used in their school. Section B looks at Lacks in two ways: teachers' own reports of their current gaps in proficiency and the problems they have when trying to use local knowledge in science classes. Section C looks at Wants in two ways: what teachers want in an Ethno-STEM teaching handbook and how they think they would use it if it were available. Three open-ended questions that matched each type of need were added to get more detailed information that the closed-ended questions didn't cover. The full instrument is presented in Table 1.

Table 1

Teachers' Need for Ethno-STEM Material Development Scale (TNEMDS) Based on Nation and Macalister (2010)

No	Item	Scale
Section A: Necessities		
A1.	***Proficiency (Self-report)***	
1	Science teachers must be able to identify local cultural practices that contain embedded science concepts	1 = Strongly Disagree,
2	Science teachers must understand how to map local wisdom to national science curriculum objectives	5 = Strongly Agree

3	Science teachers must be competent in transforming local wisdom into structured Ethno-STEM teaching materials	
4	Science teachers must be able to validate the cultural authenticity of teaching materials before classroom use	
A2.	***Situations of Use (Self-report)***	
5	In my school context, integrating local wisdom into science teaching is expected by the curriculum	1 = Never, 5 = Always
6	In my school context, students come from diverse ethnic backgrounds that require culturally responsive teaching	
7	In my teaching situation, Ethno-STEM materials would be relevant to the science topics I teach	
8	In my school context, there is institutional support for integrating local wisdom into science learning	
Section B: Lacks		
B1.	***Proficiency (Self-report)***	
9	I currently lack the ability to identify which local cultural practices in Merauke contain science concepts	1 = Strongly Disagree, 5 = Strongly Agree
10	I currently lack a systematic procedure for reconstructing local wisdom into Ethno-STEM teaching materials	
11	I currently lack confidence in designing science learning activities that are grounded in local cultural contexts	
12	I currently lack knowledge about the indigenous knowledge systems of ethnic communities in Merauke	
B2.	***Situations of Use (Self-report)***	
13	I find it difficult to connect local wisdom to the science topics I am required to teach	1 = Never, 5 = Always
14	I struggle to find culturally appropriate examples from Merauke to use in my science lessons	
15	I am unable to access practical references or models of Ethno-STEM teaching materials for Eastern Indonesian contexts	
16	I face time constraints that prevent me from developing local wisdom-based science teaching materials independently	
Section C: Wants		
C1.	***Wishes (Self-report)***	
17	I want a practical handbook that provides a step-by-step guide for reconstructing local wisdom into science teaching materials	1 = Strongly Disagree, 5 = Strongly Agree
18	I want concrete examples of Ethno-STEM teaching materials developed specifically from Merauke cultural practices	
19	I want validated teaching material templates that I can adapt for my own science lessons	
20	I want a clear reconstruction model that helps me decide which local wisdom is most suitable for science teaching	
C2.	***Use (Observation-based Self-report)***	
21	I would use an Ethno-STEM handbook if it were designed specifically for the Papua multicultural context	1 = Never, 5 = Always
22	I would recommend an Ethno-STEM handbook to my fellow science teachers if one were available	
23	I would integrate local wisdom into my science lessons more frequently if I had access to a practical handbook	
24	I would use handbook-based Ethno-STEM materials as the primary resource for at least one science topic per semester	

All items in Section A and Section C used a five-point Likert agreement scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Items in Section A2 and Section B2 used a five-point frequency scale

ranging from 1 (Never) to 5 (Always). Items in Section B1 used a five-point agreement scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Instrument Validation

Before data collection, the TNEMDS went through a two-step validation process. Content validity was confirmed via expert evaluation by six specialists: two in science education, two in indigenous knowledge or ethnography, and two seasoned science educators from Merauke. Each expert evaluated all 24 items for clarity, relevance, and representativeness regarding their respective need type. The Content Validity Index (CVI) was used to measure content validity at both the item level (I-CVI) and the scale level (S-CVI). Yusoff (2019) suggested that the I-CVI should be at least 0.78. Items that did not meet this threshold were either revised or removed. We then used Cronbach's alpha to check the reliability of internal consistency. The lowest acceptable value for each section was 0.70.

The results of the expert panel evaluation indicated strong content validity for the TNEMDS. Item-level CVI (I-CVI) values ranged from 0.83 to 1.00 across all 24 items. Six items received an I-CVI of 0.83, reflecting minor disagreement from one expert regarding item clarity or contextual specificity. These items underwent wording revision based on expert comments before finalization. The remaining 18 items received unanimous agreement (I-CVI = 1.00). The Scale-level CVI (S-CVI/Ave) was 0.96, exceeding the recommended threshold of 0.90 (Polit & Beck, 2006) and confirming strong content representativeness of the instrument as a whole.

Data Collection Procedure

Data collection was conducted during regular school hours across all participating schools. Before administration, ethical clearance was obtained from the relevant institutional authority, and permission to conduct research was secured from the Merauke Education Office. Informed consent was obtained from all participants, who were assured of the confidentiality of their responses and their right to withdraw at any time. Questionnaires were distributed and collected either in person or through a validated digital platform to maximize response rate and data completeness.

Data Analysis

Data were analyzed using IBM SPSS Statistics in three consecutive stages. First, we used Cronbach's alpha to check the internal consistency of each section of the TNEMDS before we started to interpret the results. Second, we calculated descriptive statistics like mean scores and standard deviations for each item, section, and the whole scale. Mean scores were analyzed through a five-category classification system (Konting, 2000):

Mean Score	Interpretation
1.00 – 1.79	Very low
1.80 – 2.59	Low
2.60 – 3.39	Moderate
3.40 – 4.19	High
4.20 – 5.00	Very high

Third, a needs gap analysis was done by looking at the average scores for each of the three sections. A high mean in Section A and a high mean in Section B together show that there is a big gap between what is needed and what is currently possible. This proves a need for a practical support resource. A high mean in Section C further supports the idea that teachers see an Ethno-STEM handbook as a useful and important way to fill that gap. We used simple content analysis to look at the answers to the three open-ended questions. We grouped the answers thematically per need type (Necessities, Lacks, and Wants) to add to and put the quantitative results in context.

FINDINGS AND DISCUSSION

This section showcases findings from a needs analysis of 54 senior secondary science teachers in Merauke, Papua. The results are categorized based on the three need types identified by Nation and Macalister (2010): Necessities, Lacks, and Wants. Descriptive statistics for each need type are presented and analyzed in the context of current literature on Ethno-STEM education and culturally responsive science instruction.

Preliminary Analysis

Before the main analysis, internal consistency reliability was assessed for each section of the TNEMDS. The Cronbach's alpha values for Section A (Necessities), Section B (Lacks), and Section C (Wants) were α = 0.84, α = 0.87, and α = 0.91, respectively, all exceeding the minimum acceptable threshold of 0.70. These values confirm that the instrument demonstrated adequate reliability for use with this sample.

Necessities: What Science Teachers Must Know and Be Able to Do. Table 2 presents the mean scores and standard deviations for Section A items measuring teachers' perceived necessities for Ethno-STEM material development.

Table 2

Descriptive Statistics for Section A: Necessities (N = 54)

No Item	M	SD	Interpretation
1	4.31	0.61	Very high
2	4.24	0.67	Very high
3	4.39	0.58	Very high
4	4.17	0.72	High
5	3.76	0.84	High
6	4.52	0.54	Very high
7	4.28	0.63	Very high
8	3.54	0.91	High
Overall	**4.15**	**0.69**	**High**

The average score for Section A was M = 4.15 (SD = 0.69), which shows that science teachers in Merauke thought they needed a lot of things. Teachers overwhelmingly concurred that the students in their classrooms originate from diverse ethnic backgrounds, necessitating culturally responsive pedagogy (M = 4.52, SD = 0.54). On the other hand, the mean for institutional support for integrating local knowledge was the lowest (M = 3.54, SD = 0.91). This means that teachers know that Ethno-STEM skills are important for their jobs, but they don't think their schools are doing enough to help them actually use these skills.

These findings confirm that science teachers in Merauke recognize Ethno-STEM competencies as a core professional requirement. This aligns with Sudarmin (2015), who posits that the capacity to transform local wisdom into organized instructional materials is an essential professional skill for science educators in culturally diverse Indonesian classrooms. The exceptionally high mean for item 6 is particularly significant, as it mirrors the actual demographic composition of Merauke classrooms, where indigenous Papuan students from communities such as the Marind, Muyu, and Mandobo coexist with students from migrant communities throughout the archipelago. Nurbatra and Masyhud (2022) and Windiyani et al. (2025) found that teachers in Indonesia's multicultural regions consistently identify culturally responsive material development as a high professional priority, a pattern that this study's findings reinforce in the specific context of Eastern Papua.

These results show that science teachers in Merauke understand how important Ethno-STEM skills are in their work. This aligns with Sudarmin (2015), who posits that the capacity to transform local wisdom into organized instructional materials is an essential professional skill for science educators in culturally diverse Indonesian classrooms. The exceptionally high mean for item 6 is particularly significant, as it mirrors the demographic composition of Merauke classrooms, where indigenous Papuan students from

communities such as the Marind, Muyu, and Mandobo coexist with students from migrant communities throughout the archipelago. This is in line with what was found: teachers in Indonesia's multicultural areas always say that developing culturally responsive materials is a very important professional need.

Lacks: Gaps Between Current Capacity and Required Proficiency. Table 3 presents the mean scores and standard deviations for Section B items measuring teachers' perceived gaps in current proficiency and situational challenges.

Table 3
Descriptive Statistics for Section B: Lacks (N = 54)

No Item	M	SD	Interpretation
9	3.87	0.79	High
10	4.22	0.64	Very high
11	3.94	0.81	High
12	3.72	0.88	High
13	4.09	0.74	High
14	4.17	0.71	High
15	4.35	0.59	Very high
16	4.11	0.76	High
Overall	**4.06**	**0.74**	**High**

The overall mean score for Section B was M = 4.06 (SD = 0.74), indicating a high level of perceived lacks among participants. The highest mean was recorded for the inability to access practical references or models of Ethno-STEM teaching materials for Eastern Indonesian contexts (M = 4.35, SD = 0.59), suggesting that the absence of contextually relevant resources is the most pressing gap experienced by teachers in this study. The lowest mean was found for limited knowledge about indigenous knowledge systems (M = 3.72, SD = 0.88), though this score still falls within the high category.

The findings indicate that science educators in Merauke encounter significant challenges in transforming local knowledge into Ethno-STEM instructional resources. The most significant gap identified was the absence of a systematic reconstruction procedure (M = 4.22), which corresponds with a prevailing trend observed in the literature. Mkhwebane (2024) also found that science teachers from different cultural backgrounds always say that the biggest problem with integrating indigenous knowledge is that there isn't a systematic way to do it. The high mean for item 15 is especially important in Merauke, where it's harder to make the material because different ethnic groups know things differently. This finding is consistent with Madlela (2023), who notes that educators in multicultural contexts face heightened challenges in integrating diverse indigenous knowledge traditions into a cohesive science curriculum. A related challenge that this study's findings implicitly surface, and one that warrants explicit discussion, concerns the potential tensions between indigenous knowledge and standardized national science curricula. Local wisdom in Merauke is frequently embedded in oral traditions, ceremonial practices, and subsistence activities whose epistemological foundations do not always align with the propositional, evidence-based structure of formal science (Supriyadi & Nurvitasari, 2019). Teachers must therefore navigate not only a procedural gap, as confirmed by the high mean for item 10, but also an epistemological one: deciding which aspects of indigenous knowledge are compatible with curriculum objectives and how to represent local practices without distorting either their cultural meaning or their scientific validity. Zidny et al. (2020) argue that resolving this tension requires science teachers to adopt a multi-perspective stance that respects the integrity of indigenous knowledge while situating it within scientifically defensible learning experiences. The very high demand for a systematic reconstruction model, reflected in item 10 and item 20, suggests that teachers in this study are already aware of this epistemological challenge and are seeking structured guidance to navigate it responsibly. The Ethno-STEM handbook proposed by this study must therefore address not only procedural steps for material development but also the conceptual criteria that help teachers distinguish between culturally enriching contextualization and scientifically misleading representation.

Wants: Teachers' Desired Support Resources and Anticipated Use. Table 4 presents the mean scores and standard deviations for Section C items measuring teachers' wishes regarding an Ethno-STEM teaching handbook and their anticipated use of it.

Table 4
Descriptive Statistics for Section C: Wants (N = 54)

No Item	M	SD	Interpretation
17	4.57	0.52	Very high
18	4.63	0.49	Very high
19	4.48	0.57	Very high
20	4.54	0.53	Very high
21	4.61	0.50	Very high
22	4.44	0.59	Very high
23	4.56	0.53	Very high
24	4.31	0.64	Very high
Overall	**4.52**	**0.55**	**Very high**

The overall mean score for Section C was M = 4.52 (SD = 0.55), indicating a very high level of perceived wants among participants. Teachers most strongly expressed the desire for concrete examples of Ethno-STEM teaching materials developed specifically from Merauke cultural practices (M = 4.63, SD = 0.49). The lowest mean within this section was recorded for anticipated use as a primary resource for at least one science topic per semester (M = 4.31, SD = 0.64), though this score still falls within the very high category.

The results show that science teachers in Merauke strongly believe that an Ethno-STEM teaching handbook is a useful and necessary resource. The very high mean for item 21 shows that teachers would not only use this kind of resource, but they would also actively recommend it to their coworkers. This suggests that it could be used more widely than just in one classroom. The strongest preference for examples that are based on the local culture of the classroom, as shown in item 18, is in line with Zidny et al. (2020) argument that Ethno-STEM resources work best when they are based on the local culture of the classroom rather than on general or distant cultural examples. The very high expected use scores in items 21 to 24 further prove that the handbook would be useful in teachers' professional lives instead of just being a decoration.

Needs Gap Analysis

To establish the empirical justification for handbook development, mean scores across the three sections were compared to identify the gap between necessities and current capacity. Table 5 presents the overall mean scores for each section alongside the computed needs gap index.

Table 5
Needs Gap Analysis Across Three Need Types (N = 54)

Section	Need Type	Overall Mean	SD	Interpretation
A	Necessities	4.15	0.69	High
B	Lacks	4.06	0.74	High
C	Wants	4.52	0.55	Very high
Needs Gap Index (A minus B)		**0.09**		**Minimal gap**

The mean for Section A (Necessities) was M = 4.15, and the mean for Section B (Lacks) was M = 4.06. This means that there was a needs gap index of 0.09. This small gap shows that teachers' scores for how necessary they think Ethno-STEM competencies are and how much they think they lack them are very close. This means that teachers know how important these skills are but also say that they don't have enough of them right now. The very high mean for Section C (Wants) at M = 4.52 shows that teachers really think that a practical handbook is a necessary and appropriate way to fill this gap.

The three-section profile, when looked at as a whole, gives strong empirical support for the creation of an Ethno-STEM teaching handbook for science teachers in Merauke, which is home to many different cultures. Nation and Macalister (2010) say that a well-evidenced need is recognized as important, currently unmet, and actively desired by the target population. This is shown by the fact that high Necessities scores, high Lacks scores, and very high Wants scores all come together.

CONCLUSION

Using the needs analysis framework of Nation and Macalister (2010), this study looked into what senior secondary science teachers in Merauke, Papua needed to turn local knowledge into Ethno-STEM teaching materials. The needs profile of 54 science teachers showed that all three types were the same. Teachers showed that they thought Ethno-STEM skills were very important for their jobs, especially since Merauke classrooms are made up of students from many different cultures. At the same time, they said that their current abilities were lacking in many important areas, the most important of which were the lack of easy-to-find, contextually relevant references and reconstruction procedures. They really wanted a useful handbook, with a lot of emphasis on real-life examples from Merauke culture and a clear step-by-step model for putting things back together.

The needs gap analysis shows that what teachers think they need and what they don't have are very similar and consistent. This is strong evidence for developing a handbook. These results have direct effects on curriculum developers, teacher educators, and educational policymakers in Papua Province. They are all responsible for giving science teachers the professional support they need to teach in multicultural settings.

Several limitations of this study merit acknowledgment. The single-region focus and cross-sectional design restrict the generalizability of the findings. Although these characteristics are deliberate, reflecting the study's intent to generate a context-specific needs profile for Merauke rather than a generalized account, they mean the findings cannot be automatically extended to other multicultural regions of Papua Province or Eastern Indonesia without further investigation. The instrument's reliance on self-report data also introduces the possibility of social desirability bias, as teachers may have over-reported perceived needs or underreported existing competencies. Future research should expand the participant pool to include other regencies in Papua Province, adopt a mixed-methods design incorporating classroom observation and teacher interviews to triangulate self-reported findings, and examine how the epistemological tensions between indigenous knowledge and standardized science curricula are navigated in practice. These investigations would strengthen both the theoretical generalizability of the needs analysis framework and the practical applicability of any handbook developed from these findings. The present results nonetheless provide a strong empirical foundation for the next phase of this research agenda: the development, validation, and field-testing of a contextually grounded Ethno-STEM teaching handbook designed to close the gap between science teachers' professional aspirations and their current capacity for local wisdom integration in Eastern Indonesian multicultural classrooms.

ACKNOWLEDGEMENTS

The greatest appreciation is given to Universiti Malaya for the support provided for the success of this research and publication.

REFERENCES

Annisa, N., Diliarosta, S., Novita, S., Alhamda, Z. M., Azmi, N., Novella, I., Fattia, D., & Amirza, F. (2021). Ethnoscience study of Rumah Gadang: The reconstruction of indigenous science into scientific knowledge. *SEMESTA, Journal of Science Education and Teaching*, *4*(1), 65–70.

Asmaningrum, H. P., Sudarmin, Supriyadi, Sumarni, W., & Palittine, I. D. (2023). Science teachers' perceptions of teaching material based on Malind Indigenous Science. *Journal of Southwest Jiaotong University*, *58*(4). https://doi.org/10.35741/issn.0258-2724.58.4.35

Black, A., & Tylianakis, J. M. (2024). Teach Indigenous knowledge alongside science. *Science*, *383*(6683), 592–594. https://doi.org/10.1126/science.adi9606

Gumilar, N. M. A. R., Sudarmin, S., Marwoto, P., & Wijayati, N. (2022). Ethno-STEM research trends through bibliometric analysis on science learning in elementary School. *Unnes Science Education Journal*, *11*(3), 166–172. https://doi.org/10.15294/usej.v11i2.58186

Imani, M. N., Widodo, W., Sukarmin, S., & Satriawan, M. (2026). Ethno-stem innovation in science learning: Developing scientific literacy using the local context of "Dawet Jabung." *Journal Evaluation in Education (JEE)*, *7*(1), 282–290. https://doi.org/10.37251/jee.v7i1.2378

Izzah, S. N., Sudarmin, Prasetyo, A. P. B., & Wiyanto. (2020). The development of science learning document grounded on STEM-approach integrated ethnoscience. *International Conference on Science and Education and Technology (ISET 2019)*, *443*, 554–558.

Izzah, S. N., Sudarmin, Wiyanto, & Wardani, S. (2023). Analysis of science concept mastery, creative thinking skills, and environmental attitudes after Ethno-STEM learning implementation. *International Journal of Instruction*, *16*(3), 777–796. https://doi.org/10.29333/iji.2023.16342a

Kaufman, R. (1988). Needs assessment: A menu. *Educational Technology*, *28*(7), 21–23. http://www.jstor.org/stable/44426572

Khusna, N., & Adji, T. P. (2024). Integrating local wisdom in independent learning: Urgency and innovative strategies. *Primaryedu: Journal of Elementary Education*, *8*(2). https://e-journal.stkipsiliwangi.ac.id/index.php/primaryedu/

Konting, Mohd. M. (2000). *Kaedah penyelidikan pendidikan* (5th ed.). Dewan Bahasa dan Pustaka.

Madlela, B. (2023). Prospect and challenges of integrating indigenous knowledge systems into the Natural Science curriculum in schools. *EUREKA: Social and Humanities*, *3*, 3–19. https://doi.org/10.21303/2504-5571.2023.002867

Maryanti, E., Suminar, T., & . E. (2023). Development of Ethno-STEM E-Module with project based learning model based on Yogyakarta local wisdom to improve student's creative thinking abilities. *International Journal of Research and Review*, *10*(10), 105–114. https://doi.org/10.52403/ijrr.20231014

Maulidiyah, F. (2021). the importance of integrating multiculturalism in teaching community interpreting. *Pendidikan Multikultural*, *5*(1), 148. https://doi.org/10.33474/multikultural.v5i1.10324

Mkhwebane, L. N. (2024). Life sciences teachers' integration of indigenous knowledge: A vision for making science classrooms culturally responsive. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(8), em2483. https://doi.org/10.29333/ejmste/14859

Muttaqiin, A., Murtiani, M., & Yulkifli, Y. (2021). Is integrated science book with Ethno-stem approach needed by secondary school students? *Journal of Physics: Conference Series*, *1788*(1). https://doi.org/10.1088/1742-6596/1788/1/012048

Naah, A. M., & Osei-Himah, V. (2024). Perspectives of pre-services teachers on indigenous knowledge practices and their integration into the teaching and learning of science. *European Journal of Education and Pedagogy*, *5*(4), 1–10. https://doi.org/10.24018/ejedu.2024.5.4.834

Nation, I. S. P., & Macalister, J. (2010). *Language curriculum design*. Routledge.

Polit, D. F., & Beck, C. T. (2006). The content validity index: Are you sure you know what's being reported? critique and recommendations. *Research in Nursing & Health*, *29*(5), 489–497. https://doi.org/10.1002/nur.20147

Primadianningsih, C., Sumarni, W., & Sudarmin, S. (2023). Systematic literature review: Analysis of Ethno-STEM and Student's Chemistry Literacy Profile in 21st Century. *Jurnal Penelitian Pendidikan IPA*, *9*(2), 650–659. https://doi.org/10.29303/jppipa.v9i2.2559

Sari, M. W., Wati, I. K., Nugraheni, F. S. A., & Suciati, S. (2023). Development of Ethno-STEM-based Science Learning Tools. *Journal Intellectual Sufism Research (JISR)*, *5*(2). https://doi.org/10.52032/jisr.v5i2.143

Sudarmin. (2015). *Pendidikan karakter, etnosains dan kearifan lokal: Konsep dan penerapannya dalam penelitian dan pembelajaran sains.* Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Negeri Semarang.

Sudarmin, S., Sumarni, W., Azizah, S. N., Yusof, M. H. H., & Listiaji, P. (2020). Scientific reconstruction of indigenous knowledge of batik natural dyes using ethno-STEM approach. *Journal of Physics: Conference Series*, *1567*(4). https://doi.org/10.1088/1742-6596/1567/4/042046

Sumarni, W., & Kadarwati, S. (2020). Ethno-Stem Project-Based Learning: Its impact to critical and creative thinking skills. *Jurnal Pendidikan IPA Indonesia*, *9*(1), 11–21. https://doi.org/10.15294/jpii.v9i1.21754

Sumarni, W., Wahyuni, S., & Sulhadi. (2023). The effect of application of Ethno-STEM integrated project-based learning on increasing students' scientific literacy. *AIP Conference Proceedings, 2614*(1), 030039. https://doi.org/10.1063/5.0126208

Supriyadi, & Nurvitasari, E. (2019). Inventarisasi sains asli suku Malind : Upaya dalam pengembangan kurikulum ipa kontekstual Papua berbasis etnosains. *EduSains: Jurnal Pendidikan Sains Dan Matematika*, *7*(1), 10–21.

Zidny, R., Sjöström, J., & Eilks, I. (2020). A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability. *Science & Education*, *29*, 145–185. https://doi.org/https://doi.org/10.1007/s11191-019-00100-x