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LOCAL WISDOM AND STEM IN SCIENCE EDUCATION TO SUPPORT SDG-4: A SYSTEMATIC REVIEW

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ABSTRACT

The integration of local wisdom into science learning is a global pedagogical trend that leads to the Sustainable Development Goals (SDGs 4). Local wisdom serves to make scientific concepts contextual, meaningful, and culturally relevant for students. The challenge of contextual implementation can be addressed through interdisciplinary approaches such as STEM (Science, Technology, Engineering, and Mathematics), which serve as a bridge between local wisdom and education. This systematic literature review (SLR) modified with Bibliometric Analysis aims to map the global research landscape on the integration of local wisdom and STEM in formal science education from 2014 to 2024. A total of 155 articles indexed in the Scopus database were analyzed using Bibliometric analysis tools, including VOSviewer, Microsoft Excel, and Datawrapper. The results show an increase in publications post-pandemic, driven by the urgency of advancing SDG 4 and the need for adaptive learning innovation. Geographically, research is concentrated in the United States, Indonesia, and South Africa, with global collaborations indicating this issue as a transnational agenda. An in-depth review of 21 inclusive articles reveals a predominance of qualitative-exploratory approaches. Subject distribution indicates a strong focus on General Science Education, Environment/Ecology, and Biology. Furthermore, research is predominantly focused on higher education and junior high school levels, while high school and elementary school levels remain underrepresented. The study's conclusions highlight the central role of STEM as a bridge in integrating local wisdom.

Keywords: local wisdom; science education; STEM; sustainability; curriculum integration; systematic literature review

INTRODUCTION

The terms "local wisdom," "indigenous knowledge," "traditional knowledge," and "local knowledge" are often used interchangeably to refer to traditional knowledge systems encompassing cultural values, ecological practices, and local beliefs passed down across generations through interactions between communities and their environment (Erman & Wakhidah, 2024; Onyancha, 2024). Local wisdom not only reflects adaptive strategies for dealing with nature and culture but also has the potential to become a modern learning resource that connects scientific knowledge with students' everyday realities (Imaduddin et al., 2020; Suprapto et al., 2021; Cirkony et al., 2023; Annur et al., 2024).

The integration of local wisdom into education has become an urgent global pedagogical trend and is widely supported in academic lite-

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rature, positioning it as a key strategy for advancing SDG 4 on quality and inclusive education. (Arjaya et al., 2024). This is highly relevant for ensuring the quality of education (SDG 4) (Chotibuddin et al., 2025). Local wisdom not only provides a context for learning but also serves as an adaptive approach for curricular innovation (Asmayawati et al., 2024). This utilization results in authentic, relevant, and sustainable learning to address environmental challenges, such as ecosystem degradation and local climate change, as well as to maintain traditional cultural practices, including disaster mitigation and traditional health practices (OECD, 2020).

In science education, integrating local wisdom has been shown to produce more contextual, meaningful, and culturally relevant learning experiences. This is because local wisdom allows for direct connections between scientific concepts, such as physics, biology, and chemistry, and students' real-life experiences (Greenall & Bailey, 2022; Mustafaoglu et al., 2022; Parmin & Trisnowati, 2024). Local wisdom-based learning also supports the development of inquiry skills, critical thinking, and ecological awareness through investigative activities based on local phenomena (Martawijaya et al., 2023; Noviana et al., 2023; Yuliarti et al., 2023; Parmin & Trisnowati, 2024). However, UNESCO (2023) and OECD (2020) reported that the implementation of science in various countries has not fully integrated local and cultural contexts in the learning process.

This challenge becomes even more apparent when learning is required not only to be contextually relevant but also to be integrated across disciplines, including social, cultural, and humanities aspects (Zhan & Niu, 2023). In this regard, local wisdom can provide an authentic, multidisciplinary, and life-affirming learning context for students (Chen et al., 2021; Hartono et al., 2023; Erman & Wakhidah, 2024). However, without appropriate pedagogical strategies, students will struggle to connect abstract scientific concepts with local knowledge embedded in their cultural and ecological contexts (Cirkony et al., 2023; Yuliarti et al., 2023; Ogegbo & Ramnarain, 2024). This also paves the way for implementing the STEM (Science, Technology, Engineering, and Mathematics) approach, which is increasingly seen as important in 21st-century education. STEM aims to train students to think across disciplines to avoid knowledge fragmentation, prepare them to face real-life problems (Awad, 2023; Permanasari et al., 2024), and needs to be continuously integrated with authentic contexts to avoid being trapped in the isolation of science (; De Loof et al., 2022; Aslam et al., 2023; Hussim et al., 2024; Khuyen et al., 2024).

In Indonesia, the urgency of integrating local wisdom is increasingly relevant amid the currents of globalization that can erode traditional values. Several educational practices, from elementary school to university level, have adopted local wisdom into learning, both through integration into the curriculum and the use of folktales and traditional games as learning media (Sari et al., 2020; Hasan et al., 2024; Sawita et al., 2024; Suwandana et al., 2025). These efforts not only strengthen students' connection to local culture but also contribute to character development and enrich the learning experience.

The literature on local wisdom in science education has grown rapidly in the last decade. Several relevant studies have been conducted, including those focused on specific populations such as Indigenous students (Jin, 2021), single learning outcomes (Annur et al., 2024), or limited to the scope of Ethnoscience (Misbah et al., 2024; Muyassaroh et al., 2025; Hikmah et al., 2025; Verawati et al., 2025). However, these studies have not offered a comprehensive and systematic synthesis that maps a structured model integrating STEM with local wisdom in formal science education, especially in terms of empirical methodology and educational implementation patterns. Furthermore, recent insights into Culturally Responsive Science (Ismail et al., 2025) and general STEM and Indigenous Wisdom (Latip et al., 2024; Budiman & Suwarma, 2025) do not provide the in-depth, multi-stakeholder analysis needed. Therefore, systematic review aims to fill this critical gap by presenting an in-depth and substantial analysis of various models of STEM integration with local wisdom and mapping the dominance of empirical methodologies used in formal science education from 2014 to 2024.

The novelty of this study lies in the use of a hybrid approach, combining bibliometric analysis to identify general trends with a systematic literature review to provide an in-depth overview of implementation models. This allows for a comprehensive study that quantitatively and qualitatively maps the specific role of STEM in "Bridging Nature and Knowledge". This unique contribution results in a comprehensive global research roadmap. Specifically, this work contributes to the literature by (1) analyzing the typology and latest developments (2021–2024) of various STEM integration models with local wisdom, and (2) highlighting the global methodological landscape and the lack of robust development

studies (DBR/R&D). Specifically, this study aims to answer the following research questions: (1) What are the trends in publications on the integration of local wisdom and STEM in science education over time? (2) What is the geographical distribution of these studies? (3) What empirical methodologies (including methods, fields of study, and educational levels) are most frequently used?

METHODS

This study employed a modified Systematic Literature Review (SLR) design combined with bibliometric analysis. This design aimed to comprehensively identify, classify, and synthesize the literature on integrating local wisdom into STEM in formal science education. The modification refers to the integration of two complementary analytical approaches, macro-landscape mapping using bibliometric analysis and in-depth qualitative synthesis. This dual approach design aligns with the research objective (Page et al., 2021). The study selection process followed the four stages of PRISMA (identification, screening, eligibility, and inclusion) and was applied exclusively as a standardized framework for article selection.

On identification, article searches were conducted using authorized logins or subscriptions to the Scopus database using an institutional account from Surabaya State University, Indonesia. Scopus was used because it is a proven database with broad coverage, including in the field of education, offers high indexing accuracy, and supports standardized search procedures across all its indexed sources. These features ensure data consistency and reliability, which are essential for bibliometric analysis and scientific mapping (Ballaz et al., 2023; Núñez et al., 2024). The search used the following keyword combinations in the title, abstract, and keywords of the articles to reach the most relevant publications:

("local wisdom" OR "indigenous knowledge" OR "ethnoscience") AND ("science education" OR "scientific AND education"). This combination aimed to encompass a range of terms representing the main theme, the relationship between local cultural knowledge and contextually based science education practices. The use of this query was based on an appropriate strategy because science education is the foundational science component of the STEM framework, which focuses on how fundamental scientific concepts are taught and learned. This approach was further justified because Scopus is a recognized database for identifying research trends in interdisciplinary fields such as STEAM (Science, Technology, Engineering, Arts, and Mathematics) (Núñez et al., 2024). This confirms Scopus's ability to comprehensively capture the integration of local wisdom, and STEM is discussed in this study. The initial keyword search yielded 155 articles.

Following identification, the remaining three PRISMA stages, namely, Screening, Eligibility, and Inclusion, were processed using Covidence (www.covidence.org), a dedicated platform for systematic reviews, to handle duplicates and simplify the two-stage screening process. In the screening stage, the 155 articles were assessed by reviewing their titles and abstracts against the exclusion criteria (see Table 1). For the eligibility stage, a complete content review was conducted. Articles were assessed against strict inclusion criteria to ensure relevance to empirical studies of the integration of local wisdom into formal science education. The exclusion results yielded 21 selected articles, which served as the main focus of analysis in this study (see Figure 1).

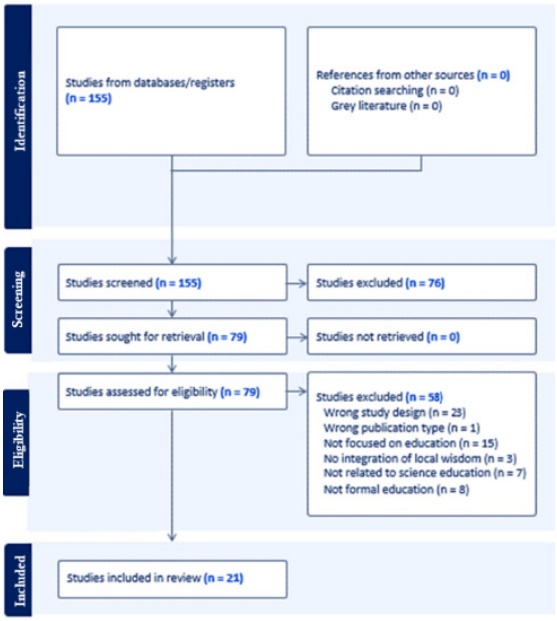

Figure 1. PRISMA Diagram

This data set was first used for a preliminary bibliometric analysis to map publication trends, geographic distribution, and thematic directions of research over the past decade, using VOSviewer, Microsoft Excel, and Datawrapper. Furthermore, a more focused data set consisting of 21 articles, selected through the PRISMA screening process, was used as the main data set for in-depth qualitative analysis using a manual open coding approach as part of a systematic litera-

ture review. Relevant articles were systematically identified and grouped into themes related to local policy implementation, research methods, and reported educational impacts. This combination of comprehensive bibliometric mapping and detailed qualitative synthesis provides a macro-level overview of global research and a micro-level understanding of the integration of local policies into STEM-based science education.

Table 1. The Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Publication Year	2014-2024.	2013 and before.
Source Type	Journal articles (full paper).	Books, book series, book chapters, and conference proceedings articles.
Language	Written in English.	Languages other than English.
Accessibility	Open access.	Full text is not accessible.
Study Design	Based on empirical studies (primary research).	Conceptual articles or other types of review papers.
Topic Focus	Explicitly discusses the integration of local wisdom in STEM within the context of formal science education.	Focuses only on policy, school management, or non-formal/informal learning contexts.

RESULTS AND DISCUSSION

Publication trends related to STEM, local wisdom, and science learning from 2014 to 2024 have shown progressive growth over the last decade, as shown in Figure 2. The data shows that publication growth during this period averaged 14 articles per year. Further analysis shows that publication trends are divided into three phases. During the initial period (2014-2016), the number of publications was relatively low, with a peak of 10 in 2014, and research remained exploratory. A stable number of publications began in 2017 and continued through 2020, with 11-12 publications per year. A surge occurred in 2021 with 18 articles published, followed by successive increases in 2022 (16 articles), 2023 (19 articles), and peaking in 2024 with 34 articles. The COVID-19 pandemic is one of the reasons for this surge in publication trends. This is because the COVID-19 situation has accelerated the need for adaptive, context-specific learning innovations. This finding aligns with Traxler & Smith (2020), who argue that the COVID-19 situation heightens the need for education, especially for contextual and culturally aware learning, to address the in reased barriers.

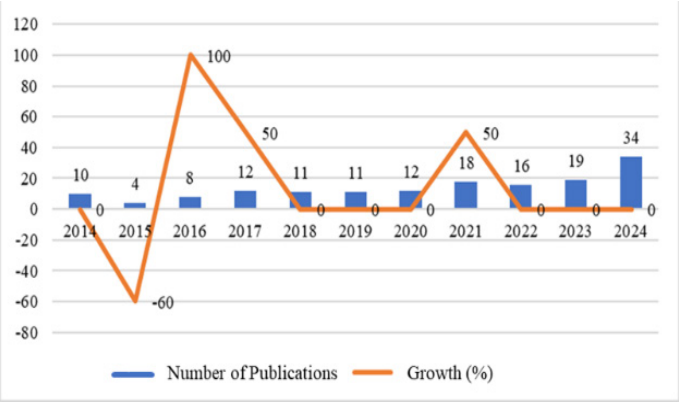

Figure 2. Articles per Year Chart

Complementing the quantitative data, a VOSviewer analysis of 155 articles during the period revealed a shift in research focus. The overlay visualization in Figure 3 shows relatively new and emerging themes, indicated by green to yellow. Themes such as sustainability, scientific literacy, and traditional ecological knowledge directly reflect the 'great pause' and the urgency of achieving SDG-4 post-COVID-19 (Clark et al., 2022). This dynamic is supported by the importance of digital technologies (Al-Ansi, 2022) and STEM (Rodríguez et al., 2021) in strengthening

quality education aligned with SDG 4 during the COVID-19 pandemic crisis. This has stimulated research on scientific literacy, which emphasizes STEM as a foundation for developing critical thinking needed to understand global challenges (Braund, 2021). Meanwhile, the strong link between traditional ecological knowledge and climate change suggests that research is seeking a more relevant, contextual approach. STEM serves as a methodological bridge to analyze traditional practices, aiming to encourage Local Context-Based Ethno-STEM Learning to strengthen quality education aligned with SDG 4 and to ensure that learning remains inclusive and meaningful for local communities (Pada et al., 2025).

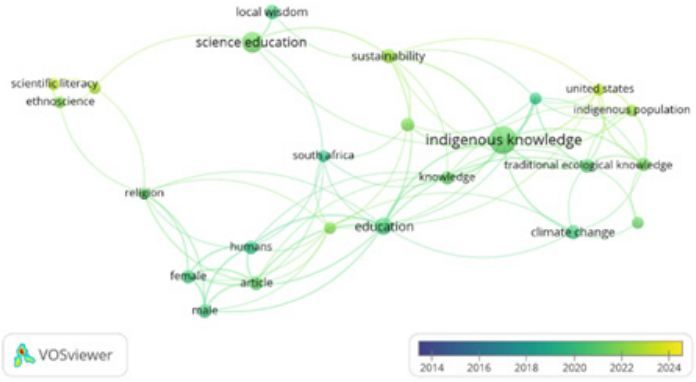

Figure 3. Publication Distribution Based on Keywords

The datawrapper visualization of the geographic distribution in Figure 4 shows that the country with the most publications is the United States (29), followed by Indonesia (23) and South Africa (20). This strong concentration suggests that the urgency of local wisdom and STEM research stems from the need for culturally contextualized solutions in developing countries with biodiversity (Sudarmin et al., 2024; Atmojo et al., 2025). Furthermore, it reflects the push for indigenous education and the decolonization of curricula in developed countries (Rosyidah et al., 2025).

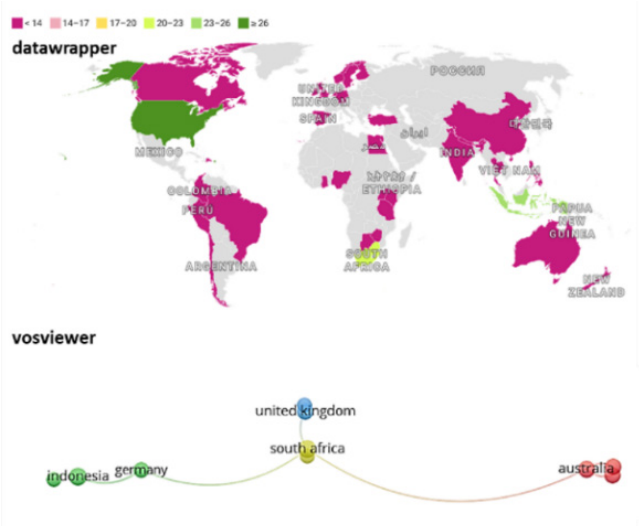

Figure 4. Publication Distribution Based on Geographic

Further analysis using VOSviewer (co-authorship by country) yielded four main clusters indicating collaboration between countries. The first cluster, Australia, Canada, and New Zealand, demonstrates a strong collaborative network among these three countries. The second cluster, Germany, Indonesia, and Thailand, demonstrates cooperation between Southeast Asian countries and Germany. Cluster 3, Peru and the UK, highlights collaboration between Peru, a developing country in Latin America, and the UK. Cluster 4, South Africa and Zimbabwe, demonstrates active research collaboration among African countries. This geographic distribution reflects that research on indigenous knowledge and STEM has attracted attention from develo-

ped countries through interdisciplinary and global collaboration, demonstrating that this issue has become a recognized transnational research agenda (Chen & Wu, 2024)

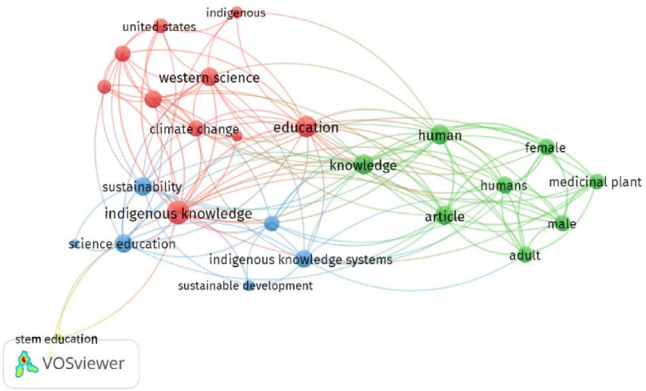

Figure 5. Keywords

Bibliometric analysis of 155 articles using VOSviewer shows a research focus on local knowledge in the first cluster. The visualization shows a strong relationship between local knowledge, sustainability, climate change, and science education (Figure 5). This strong link confirms that local wisdom is part of the SDGs 4 and science education (Zidny et al., 2020; Negara et al., 2025). Furthermore, keywords such as "humans," "medicinal plants," "men," and "women" frequently appear, indicating that research in this area often focuses on the role of humans in utilizing local knowledge, especially in relation to traditional medicine. This finding indicates that the study of local wisdom encompasses ecological, health, and educational aspects (Lestari et al., 2024)

Further analysis of keyword co-occurrence yielded five thematic clusters reflecting research directions in STEM education, local wisdom, sustainability, and science education. The first cluster, with the red node in Figure 6, indicates the integration of indigenous knowledge and sustainable development, confirming that local knowledge can support SDG 4.

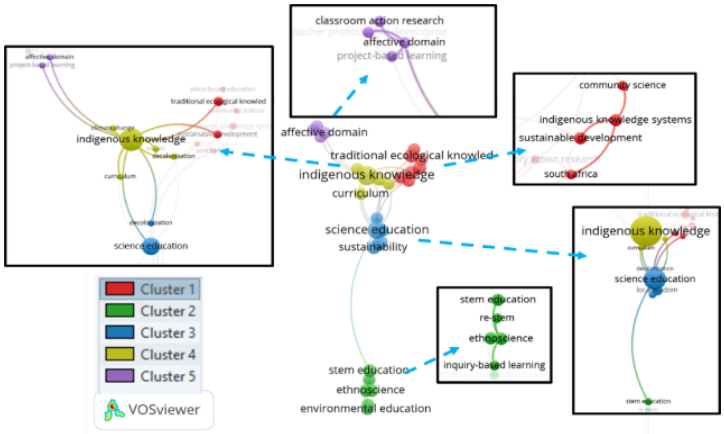

Figure 6. Keyword Co-occurrence Analysis

Clusters two to five cover contemporary issues such as STEM, PBL, and IBL, science education, and curricula that demonstrate the synergy between modern approaches and local values. These findings are in line with recent studies showing that the integration of Indigenous Knowledge Systems with STEM and technology-based learning can enhance the relevance and holistic impact of teaching (Nkopodi et al., 2024)

An analysis of 21 articles revealed that qualitative approaches were the most dominant (see Table 2), accounting for nine articles (42.8%). The designs used included exploratory studies, thematic analysis, participatory action research (PAR), and qualitative program evaluation. The focus of qualitative research tends to be on contextual exploration, teacher practices, student experiences, and the epistemological construction of local wisdom integration. This finding aligns with Michie et al. (2023), who explained that integrating Indigenous knowledge requires an exploratory approach to understand epistemological

barriers, structural resistance, and differences in paradigms between Western science and Indigenous knowledge. This indicates that studies in this area are still in the exploratory stage, although since 2021, there has been a shift toward quantitative and mixed-methods approaches for validation and impact measurement.

Table 2. Research Methods

Research Method	Design/ Approach	Number of Articles	References
Qualitative	Exploratory studies, thematic analysis, Participatory Action Research (PAR), qualitative program evaluation	9	De Jager (20190; Jackson et al. (2020); Rahmawati et al. (2020); Seehawer (2018); Seehawer & Breidlid (2021); Stocklmayer et al. (2024); Tolbert et al. (2025); Vergara & Albanese (2022); Zinyeka et al. (2016).
Quantitative	Quasi-experimental (one-group pretest–posttest), comparative/ cross-grade studies, instrument validation (EFA/CFA)	6	Dewi, et al. (2021); El Islami & Nuangchalerm (2020); Gumbo et al. (2021); Izzah et al. (2024); Subali et al. (2023); Wiyarsi et al. (2024)
Mixed Methods	Surveys, curriculum analysis, and skill assessments; pre- and post, and student reflections; instructional program evaluation combining quantitative measures and teacher reflections	3	Parmin & Trisnowati (2024); Reihana et al. (2021); Ward et al. (2023)
Action/ DBR	Action Research, Classroom Action Research, Design-Based Research (DBR)	2	Chaijalearn et al. (2023); De Beer (2019)
R&D/ Model	Model development (4D framework)	1	Rosa et al. (2020)

Quantitative approaches were used in 6 articles (28.6%), primarily with quasi-experimental designs and comparative studies, and instrument validation through EFA/CFA, focusing on intervention effectiveness, outcome comparisons, and the development of scientific literacy instruments. Meanwhile, mixed methods were reported in 3 articles (14.3%), action research in 2 (9.5%), and R&D in 1 (4.8%). These findings confirm that, despite considerable methodological variation, research remains dominated by qualitative exploration and quantitative measurement, while research based on model development and direct intervention remains relatively limited.

The analysis of 21 reviewed articles on integration (see Table 3) shows that research linking indigenous knowledge and science education has focused on integrating indigenous knowledge into science subjects (Theme 1; 5 articles). The discovery of the categories "STEM Integration" (Theme 2, 3 articles) and specifically "Integration of Local Wisdom & STEM (Hybrid)" (Theme 3, 2 articles) demonstrates the role of STEM as a bridge between local wisdom and modern curricula (Jackson et al., 2020; Dewi et al., 2021; Chaijalearn et al., 2023; Subali et al., 2023; Muyassaroh et al., 2025). This hybrid model explicitly connects local cultural practices, such as simple technology or ecological wisdom, with the STEM (Science, Technology, Engineering, and Mathematics) framework. This allows researchers not only to recognize the scientific underpinnings of local wisdom but also to provide a concrete, project-based platform for validation (Theme 7) and scientific communication (Theme 6).

Table 3. Form of Integration

Integration Theme (STEM / Local Wisdom)	Form / Model of Integration	Number of Articles	Authors (Year)
Integration of Local Wisdom in Science	Integration of indigenous knowledge (IK), cultural practices, and local phenomena into science learning	5	de Jager (2019); Seehawer (2018); Seehawer & Breidlid (2021); Rahmawati et al. (2020); Gumbo et al. (2021)
STEM Integration	Application of STEM approaches through simple technology, digital media, experiments, and inquiry	3	Jackson et al. (2020); Subali et al. (2023); Izzah et al. (2024)
Integration of Local Wisdom & STEM (Hybrid)	Hybrid model: linking local cultural practices with the STEM framework	2	Chaijalearn et al. (2023); Dewi et al. (2021)
Integration of Local Wisdom in Curriculum	Local wisdom as the basis for science curriculum design and decolonial pedagogy	3	Parmin & Trisnowati (2024); Tolbert et al. (2024); Vergara & Albanese (2022)
Integration of Cultural Values in Learning	Local cultural values (Lampung, Māori, Aboriginal, Torres Strait Islander) as sources for science learning	3	Rosa et al. (2020); Reihana et al. (2021); Ward et al. (2023)
Integration in Science Communication & Literacy	Local cultural contexts as stimuli for science literacy & communication, including socio-scientific issues (SSI)	3	El Islami & Nuangchalerm (2020); Stocklmayer et al. (2024); Wiyarsi et al. (2024)
Integration of Epistemology & Validation of IK	Epistemological dialogue approach, validation of local knowledge, and sustainability	1	Zinyeka et al. (2016)
Integration of Project-Based IK	Project-based learning with ethnobotany, traditional soap, water quality, and banana DNA contexts	1	de Beer (2019)

Furthermore, the findings suggest that STEM's role as a bridge extends beyond content integration to encompass pedagogical approaches and curriculum development. Categories such as "Integration of Local Wisdom in Curriculum" (Theme 4, 3 articles) (Vergara & Albanese, 2022; Parmin & Trisnowati, 2024; Tolbert et al., 2025) and "Integration of Project-Based IK" (Theme 8, 1 article) (De Beer, 2019) confirm that local wisdom serves as a contextual basis for curriculum design and project activities. Through a project-based approach that is characteristic of STEM, the Technology (T) and Engineering (E) aspects of STEM are used to dissect and reconstruct local wisdom practices, for example, traditional soap making, ethnobotany (De Beer, 2019), making them relevant and applicable in the context of contemporary science education. Thus, STEM plays a central role, transforming indigenous knowledge from a mere source of content into a framework for action and innovation. A review of 21 studies on the integration of local and cultural contexts in science education (See Table 4) shows a predominance of research in General Science Education/Approaches (24% of total articles), which emphasizes the development of pedagogical approaches for contextualized curricula (De Jager, 2019; El Islami & Nuangchalerm, 2020; Vergara & Albanese, 2022; Stocklmayer et al., 2024; Tolbert et al., 2025). In line with the "Bridging Nature and Knowledge" focus, Environment/Ecology (19%) and Biology/Life Sciences (14%) also feature prominently (Seehawer, 2018; De Beer, 2019; Jackson et al., 2020; Seehawer & Breidlid, 2021; Michie et al., 2023; Negara et al., 2025), reflecting global attention to sustainability, conservation, and ethnobotanical exploration—areas in which indigenous knowledge is inherently rich.

Table 4. Subjects

Field of Study Group	Number of Articles	Specific Focus Topics	Authors (Year)
Science Education (General/ Approaches)	5	General Science Education (including local contexts, community, and curriculum); Science Communication	de Jager (2019); El Islami & Nuangchalerm (2020); Stocklmayer et al. (2024); Tolbert et al. (2024); Vergara & Albanese (2022)
General Science (Multidisciplinary)	3	Biology, Chemistry, Physics, Ecology, Integrated Technology	Parmin & Trisnowati (2024); Wiyarsi et al. (2024); Zinyeka et al. (2016)
Biology/ Life Sciences	3	Ecology, Biodiversity, Conservation; Water Quality	de Beer (2019); Jackson et al. (2020); Ward et al. (2023)
Environment/ Ecology	4	Environmental Education, Water Ecology, Health, Agriculture	Izzah et al. (2024); Reihana et al. (2021); Seehawer (2018); Seehawer & Breidlid (2021)
Chemistry	2	Hydrocarbons & Petroleum; Chemical Processes (Pottery Making)	Chaijalearn et al. (2023); Dewi et al. (2021)
Physics	4	Gravitational Acceleration; Sound Waves; Properties of Materials; Solar System	Gumbo et al. (2021); Rahmawati et al. (2020); Rosa et al. (2020); Subali et al. (2023)

In contrast, despite having a significant number of articles, the disciplines of Physics (19%) and Chemistry (10%) show challenges in integration (Chaijalearn et al., 2023; Dewi et al., 2021; Gumbo et al., 2021; Rahmawati et al., 2020; Rosa et al., 2020; Subali et al., 2023). Research in these areas tends to be fragmented, struggling to connect specific technical topics (such as gravitational acceleration or hydrocarbons) with broader socio-cultural issues. Based on this mapping, identified research gaps include: (1) an imbalance in contextual integration across STEM disciplines; (2) a lack of contextual curriculum implementation studies at the formal (especially secondary) level; and (3) an urgent need to develop specific integration models of local wisdom for more abstract Biology concepts (e.g., molecular/cellular Biology) and in-depth exploration of ethnobotany for teaching functional Biology. Local wisdom may appear as a macroscopic concept, but its deepest roots lie in microscopic processes, from cells and molecules to the biological mechanisms that shape human behavior.

Table 5 presents an analysis of the distribution of research by educational level. The primary focus of the research is on higher education and junior high schools, reflecting the urgency of pedagogical aspects.

Table 5. Educational Levels

Educational Level	Number of Articles	Authors (Year)
Higher Education	7	Chaijalearn et al. (2023); de Jager (2019); Dewi et al. (2021); El Islami & Nuangchalerm (2020); Parmin & Trisnowati (2024); Stocklmayer et al. (2024); Wiyarsi et al. (2024)
Senior High School	5	de Beer (2019); Gumbo et al. (2021); Jackson et al. (2020); Reihana et al. (2021); Zinyeka et al. (2016)
Junior High School	6	Izzah et al. (2024); Rahmawati et al. (2020); Rosa et al. (2020); Subali et al. (2023); Seehawer & Breidlid (2021); Tolbert et al. (2024)
Elementary School	3	Seehawer (2018); Vergara & Albanese (2022); Ward et al. (2023)

Research distribution analysis shows that the primary focus is on higher education (33.3%), with the majority targeting prospective science teachers and junior high school students (28.6%), indicating a strong focus on pedagogical aspects (teacher preparation) and the foundations of scientific literacy during the transition phase. Meanwhile, high school only accounts for 23.8% of the total articles, with elementary school (SD) the least represented (14.3%). This lower concentration in high school creates a strategic gap that needs to be addressed. High school is crucial and strategic as a bridge to higher education, training complex skills such as scientific reasoning based on local contexts. By increasing exploration at this level, research can effectively strengthen SDGs 4 and the relevance of culture-based science learning from high school to university.

CONCLUSION

The trend of publications on the integration of STEM, Local Wisdom (LW), and science learning has increased sharply post-pandemic, underscoring global recognition of its relevance, particularly in the context of sustainability and climate change. Research is widely distributed geographically, with active collaboration between countries. Qualitative-exploratory and quantitative-experimental approaches dominate, with a disparate focus; research is predominantly conducted in universities and junior high schools, while research at the high school and elementary school levels remains limited. Significant gaps are also evident in the disciplines of Physics and Chemistry, which are difficult to contextualize, and there is a lack of research focused on epistemological integration and validation of LW as a scientific framework. Therefore, further research should focus on developing hybrid STEM-LW models (e.g., through DBR/R&D) at the high school level for complex science concepts, as well as conducting in-depth epistemological studies to build a truly decolonial science curriculum.

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