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INTEGRATING INDIGENOUS KNOWLEDGE IN SCIENCE EDUCATION: A SYSTEMATIC REVIEW OF CURRICULUM DESIGN AND TEACHING STRATEGIES

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ABSTRACT

This systematic literature review seeks to investigate in a structured manner how the appropriate curriculum design and teaching strategies are used to integrate indigenous knowledge into science education. The method used is the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The phases are carried out from identification, screening to included. Several inclusion and exclusion criteria are used for the screening stage. The resulting articles were 21 studies. The findings of the study reveal that by integrating indigenous knowledge with science education, learning becomes more contextual. In addition, the right curriculum and strategy also determine the success of this integration. Local teachers are also more confident in explaining learning topics by being integrated into local culture in a multicultural manner, this is because teachers already know a little more about local culture in daily life in society. In addition, the concept of relationships in this integration is not just about transferring knowledge but building a close relationship between the environment and the community. The development of a new paradigm is not aimed at dominating, but rather to open a dialogue between knowledge systems so that it can enrich science education without sacrificing cultural identity.

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INTRODUCTION

Integrating indigenous knowledge into subjects has become a common thing in every school around the world. In the field of education, this integration is always related to the curriculum used in a subject, especially in science education (United Nations Department of Economic and Social Affairs, 2019). According to Rankoana (2017), indigenous knowledge can be defined as the knowledge of local communities collected through observation, experimentation, or daily interaction with the surrounding environment. According to Okpokwasili & Oladipupo (2019), indigenous knowledge can be used as a foundation in various fields such as education, agriculture, or health. Therefore, it is true that what was conveyed by Zidny and Eilks (2018) is that this type of knowledge is very important for the life and survival of the local community. This knowledge is also inherited from generation to generation so that it becomes a culture (Senanayake, 2006). This culture is a potential in itself that must always be preserved, one of which can be through the learning process.

Integrating indigenous knowledge with science education makes learning more contextual and can increase participation and deeper understanding of topics. As well as students being given the space and voice to be able to express critical and independent views by integrating indigenous knowledge into the science curriculum, this discovery was found in South Africa after being applied for two decades (Sefoka & Chuene, 2025). With this integration, it can also increase love for the existing culture (Handayani et al., 2018). The findings of Rahmawati & Ridwan (2017) state that such an approach can provide a meaningful learning experience and can foster critical self-awareness of cultural identity and character development in a context relevant to the curriculum. Integration also has a role in a sustainable way for students (Demssie et al., 2020). And it can be easier to contextualize science, especially at the junior high school level (Fakoyede and Otulaja, 2019). However, the integration process is not easy to implement, this is due to the lack of appropriate strategies and methods that are compatible with the culture introduced (Diwu & Ogunniyi, 2011; Mothwa, 2011).

According to Naidoo & Vithal (2014), the right way to integrate indigenous knowledge into science education is to embed elements of knowledge into the learning material, combining different aspects of indigenous knowledge and science to form new concepts as separate but equally true and valuable forms of understanding. Because in this case, integrated indigenous knowledge has a special relationship with science education, especially in scientific concepts such as physics, biology, and chemistry (Imaduddin et al., 2020; Parmin et al., 2022). Scientific concepts are also used as a learning resource in developing knowledge about the relationship between science and indigenous knowledge. After a deeper exploration of these studies, the key to success in integrating indigenous knowledge is by planning and implementing the right curriculum to be used. Because the right curriculum can provide a good strategy for learning outcomes. Ogegbo & Ramnarain (2024) stated that there is a need for an in-depth and systematic study to integrate indigenous knowledge in science education. As well as a study that explains how the impact of the right indigenous knowledge-based curriculum on effective learning strategies on learning with the model. Although numerous studies have highlighted the importance of integrating

indigenous knowledge into science education, previous reviews have primarily focused on its philosophical foundations, cultural relevance, or general benefits. Limited attention has been paid to systematically examining how indigenous knowledge is translated into curriculum design and classroom instructional strategies across diverse educational contexts. Furthermore, existing reviews often address curriculum and pedagogy in isolation, making it difficult to identify coherent patterns for effective implementation in science education. Therefore, this systematic review addresses these research gaps by synthesizing empirical evidence on the curriculum design approaches and teaching strategies used to integrate indigenous knowledge into science education. The uniqueness of this review lies in its comprehensive analysis of both curricular and pedagogical dimensions within a single framework. This study contributes to science education by identifying dominant integration models, instructional practices, implementation challenges, and opportunities that can inform future curriculum development, teacher preparation programs, and culturally responsive science learning environments. This study is guided by the following research questions:

RQ1: how is indigenous knowledge integrated into science education?

RQ2: what roles do curriculum design and instructional strategies play in facilitating the integration of indigenous knowledge into science education?

METHOD

The approach used in this systematic review is with the framework of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) by Moher et al. (2015). This framework includes several phases such as identification, screening for eligibility criteria and exclusions, as well as abstraction and analysis of report data that is used as final data for systematic review. According to Gough et al., (2019) this approach aims to obtain data and descriptions of a research variable in a transparent manner and other important issues in the research. It provides a comprehensive and structured overview of a particular topic. The results of this study can be a picture for future study updates, by being used as a reference for research (Higgins et al., 2019). The topic of this systematic study on the integration of indigenous knowledge in science education is reviewed in terms of curriculum and teaching strategies.

Identification & Selection Criteria

The article selection process followed the PRISMA 2020 guidelines. An initial search across Scopus and ScienceDirect databases using the keywords "Indigenous Knowledge" and "Science Education" yielded 956 records. After removing duplicates (n = 27) and records excluded for other reasons (n = 10), 919 records underwent title and abstract screening based on predefined criteria. Of these, 877 were excluded as they focused broadly on social sciences, environmental studies, or cultural studies without a direct link to science pedagogy.

The remaining 42 records were further screened through title, abstract, and keyword assessment, resulting in the exclusion of 18 irrelevant articles. The full texts of the remaining 24 articles were rigorously evaluated for eligibility. Three systematic literature reviews were excluded to retain only empirical studies. Ultimately, 21 articles met all eligibility criteria and were included in the final qualitative synthesis. Eligible studies comprised peer-reviewed, English-language journal articles explicitly addressing Indigenous Knowledge integration in science education through curriculum development, instructional practices, or classroom implementation. Non-science disciplines, non-empirical papers (e.g., reviews, conference proceedings, editorials), and studies lacking adequate methodological information were excluded. The identification of the article was carried out on May 14, 2025 at around 08.38 WIB.

Data Abstraction and Analysis

This process is carried out after reviewing duplicate studies, assessing the suitability of abstracts, titles and content of

studies. 24 articles were produced that still need further analysis. The articles are thoroughly examined, related to the theme and sub-theme of the article. The stage is to read the article in full. Then the extraction results are entered in excel. The variables recorded in each study included the identity of the author, the country where the study was conducted, the methods used, the main findings as well as what conclusions the study reached. Therefore, 21 articles were obtained from the study. Then the results and discussion were compiled based on the research questions in this systematic study. This is done by looking for slices that match the research questions. Then categorize the similarities (Adams et al., 2021). The following are the inclusion and exclusion criteria used in this systematic study.

Table 1: Selection Criteria

Inclusion Criteria	Exclusion Criteria
Studies published last 15 years from 2011-2025	Studies published beyond the last 15 years
Studies are limited to the subjects of science education, social sciences and environmental science.	Studies that are not related to science education, social sciences and environmental science.
Studies published in the form of articles	Published studies are in the form of books & journal proceedings.
Studies conducted in English	Studies not conducted in English
Studies are opened to public access or reading	Studies are closed to public access or reading

Based on the above criteria, a study flow diagram with the PRISMA framework is also attached in the process of reviewing the article.

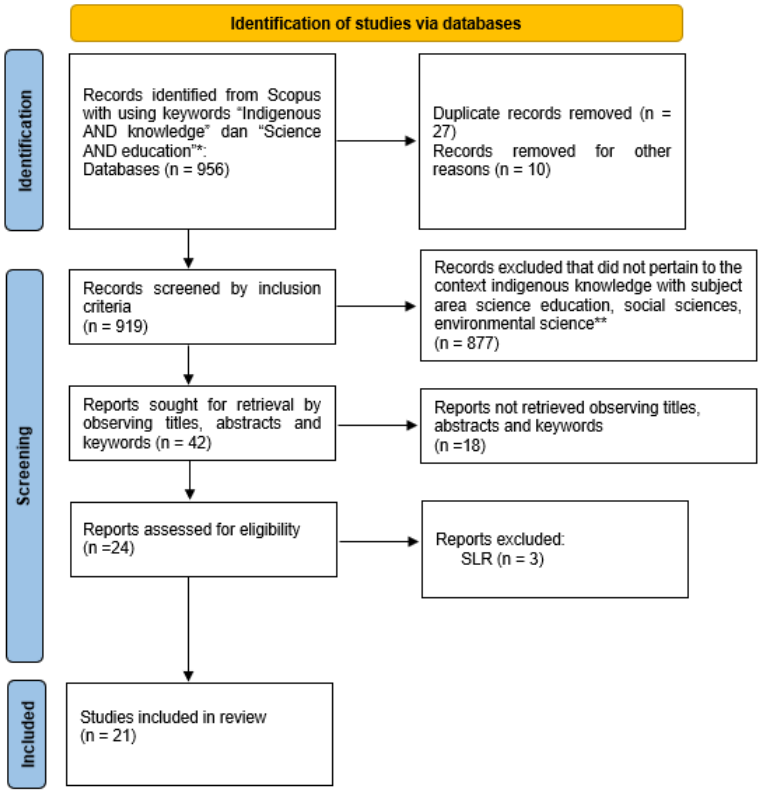

Figure 1: Study Flow Diagram

In this systematic study, 21 articles were obtained to be studied in more depth in a structured and transparent manner. The articles obtained have been adjusted based

on the inclusion and exclusion criteria that have been set. Where there are 17 countries that are the subject of the research. The study of the methodological studies used, articles using a qualitative approach were 14 articles, quantitative approach was 1 article, mixed methods was 3 articles and conceptual review was 3 articles. The focus of indigenous knowledge of each study varies according to the customs or culture in each country, with it being tailored to science education at each level. The following table below explains the results obtained in this systematic study.

Table 2: Article Based on Indexing

Journal Indexing	Name of Journal (number of article)	Total of Article (%)
Scopus Q1	● Education Sciences (n = 2) ● Conservation Science and Practice (n = 1) ● Social Sciences and Humanities Open (n = 1) ● Cultural Studies of Science Education (n = 1) ● Global Ecology and Conservation (n = 1) ● Nurse Education Today (n = 1) ● Ambio (n = 1) ● Australian Journal of Indigenous Education (n = 1)	42,86 %
Scopus Q2	● London Review of Education (n = 2) ● Social Sciences (n = 1) ● International Journal of Science Education (n=1) ● Curriculum Perspectives (n = 1) ● Australian Academic & Research Libraries (n = 1) ● International Journal of Science Education (n=1) ● Acta Scientiae (n = 1) ● Educational Research for Social Change (n = 1) ● Eurasia Journal of Mathematics, Science and Technology Education (n = 1)	47,62 %
Scopus Q3	● International Journal of Evaluation and Research in Education (n = 1) ● Education as Change (n = 1)	9,52 %

The articles that are used as a systematic study indexed by Scopus are Q1 to Q3. This is done because the article that is used as a study material has been proven to be reputable. It also points to a higher standard quality of articles.

Table 3: Identify of Articles

Title	Authors	Year	Participants	Methodology	Subject	Publisher
Building Science Teacher Leaders for Indigenous Schools: Lessons from a Science Professional Development	Bhaskar Upadhyay and Saule Sadykova	2024	Elementary, junior high and high school teachers and principals	Qualitative Case Studies	Science Education	Multidisciplinary Digital Publishing Institute (MDPI)

Workshop in Nepal						
"Totemic species" can be an effective lens for engaging students with Indigenous knowledge and biodiversity conservation	Natasha M. Ward, Georgia Garrard, Emily A. Gregg, Benjamin May, Dave Wandin, Micheal Harrison, Marnie Pascoe, Fiona Mc Conachie, Bradley Moggridge, Alex Kusman, Sarah A. Bekessy.	2023	Elementary students, teachers, parents, and cultural collaborators	Mixed Methods	Environmental Science	John Wiley and Sons Ltd
Dialogue between epistemologies as quality education. Integrating knowledges in Sub-Saharan African classrooms to foster sustainability learning and contextually relevant education	Maren Seehawer & Anders Breidlid	2021	Primary and secondary school teachers	Reflective qualitative studies	Science Education	Elsevier Ltd
Expanding the conversation: further explorations into Indigenous environmental science education theory, research, and practice	Greg Lowan	2012	Students, teachers and practitioners of indigenous cultures	Conceptual Overview	Cultural Studies	Springer Netherlands

Generative AI for Culturally Responsive Science Assessment: A Conceptual Framework	Matthew Nyaaba, Xiaoming Zhai & Morgan Z. Faison	2024	Students, teachers and educational researchers	Conceptual Overview	Science Education	Multidisciplinary Digital Publishing Institute (MDPI)
Hunting skills and ethnobiological knowledge among the young, educated Papua New Guineans: Implications for conservation	Alfred Kika, Pavel Duda, Jarmila Bajzekova, Nigel Baro, Redley Opasa, Gibson Sosanika, Leonardo R. Jorge, Paige West, Katerina Sam, Jan Zrzavy & Vojtech Novotny.	2023	Student	Qualitative – descriptive case studies	Environmental Science	Elsevier B.V.
Indigenous students' experiences of being taught indigenous health	Tamara Power, Christine Catling, Chris Rossiter & Danielle Manton	2024	Student	Qualitative – Narrative	Science Education	Churchill Livingstone
Social and knowledge diversity in forest education: Vital for the world's forests	Mika Rekola, Andrew B. Taber, Terry L. Sharik, John A. Parrotta, Michael J. Dockry, Folaranmi D. Babalola, Tara L.	2025	Students and Indigenous Peoples	Qualitative Case Studies	Environmental Science	Springer Science and Business Media B.V.

	Bal, David Ganz, Marta Gruca, Manuel R. Guariguata, James Kungu, Pipiet Larasatie, Anne Nevgi, Sandra Rodriguez-Pin˜eros, Sirichai Saengcharnchai, Niclas Sandstro¨m, Khalil Walji					
Teachers' Attitudes to Including Indigenous Knowledges in the Australian Science Curriculum	Renee Baynes	2015	Teachers	Quantitative	Science Education	Aboriginal and Torres Strait Islander Studies Unit, The University of Queensland
Culturally responsive teaching through primary science in Aotearoa New Zealand	Steven S. Sexton	2024	Teachers and students in primary schools	Qualitative – descriptive case studies	Science Education	UCL Press
Indigenous Education in Brazil—The Case of the Bare People in Nova Esperança: Transition to Work and Sustainability	Giovanna Campani	2024	Indigenous	Qualitative case studies	Social Science	Multidisciplinary Digital Publishing Institute (MDPI)
Epistemic agency, Indigenous knowledge, and	Sara Tolbert, Rosemary Hipkins,	2024	Teachers, students and school	Reflective Qualitative Studies	Science Education	Taylor and Francis Ltd.

the school science curriculum: reflections from Aotearoa New Zealand	Bronwen Cowie & Pauline Waiti		curriculum policymakers			
Investigating indigenous knowledge awareness among South African science teachers for developing a guideline	Patricia Photo & Marcell McKnight	2024	Primary and secondary school science teachers	Interpretive qualitative studies	Science Education	Springer International Publishing AG
Islamic Scientific Critical Consciousness as a theoretical framework for Muslim science educators	Usama Javed Mirza	2024	Muslim science teacher	Conceptual Overview	Science Education	UCL Press
Kia whai taki: Implementing Indigenous Knowledge in the Aotearoa New Zealand Library and Information Management Curriculum	Spencer Lilley & Te Paea Paringatai	2014	Students & curriculum policymakers	Descriptive and reflective case studies	Social Science	Routledge, Taylor & Francis Group
Science communication across cultures: design and delivery of a graduate science communication program in South Africa	Susan M. Stocklmayer, Tom Netshisaulu, Annelize Potgieter and Graham J. Walker	2024	Graduate Students	Descriptive and reflective case studies	Science Education	Taylor and Francis Ltd.
Science Education and Indigenous Knowledge in a Decolonial Perspective: An Argentine Case	Tatiana Edith Vergara & Veronica Albanese	2022	Science teachers, students and indigenous communities	Qualitative case studies	Science Education	Lutheran University of Brazil

South African Science Teachers' Strategies for Integrating Indigenous and Western Knowledges in Their Classes: Practical Lessons in Decolonisation	Maren Seehawer	2018	Science teacher	Qualitative with Participatory Action Research	Science Education	Nelson Mandela University,Faculty of Education
Life sciences learners' views on the integration of indigenous knowledge into indigenous knowledge-related topics using a cooperative learning approach: A case of South African grade 10 classroom	Thabelang Segopotse Sefoka & Karabo Justice Chuene	2025	Student	Qualitative case studies	Science Education	Modestum LTD
Ethnoscience education: how do teacher implementing to increase scientific literacy in junior high school	Jufrida, Wawan Kurniawan, Fibrika Rahmat Basuki.	2024	High school students and teachers	Mixed methods	Science Education	Institute of Advanced Engineering and Science
It Matters Who You Are: Indigenous Knowledge Research and Researchers	Moyra Keane, Constance Khupe & Blessings Muza	2016	Researcher in the field of education	Conceptual overview	Science Education	UNISA Press

The table above explains in detail the participants and the methodology used. As well as other identities that include authors, years, research subjects and article publishers.

RESULT AND DISCUSSION

With respect to the research questions, there are several representations of approaches used in integrating indigenous knowledge in science education. Some of the main themes that will be identified from the reviewed articles are as follows: (a) research trends by integrating indigenous knowledge in Science Education; (b) the integration of indigenous knowledge in science education; (c) the role of the curriculum in Integration and its impact on

science education; (d) strategies, challenges and gaps in implementation; (e) contribution to science education innovation; (f) key findings.

Research Trends by Integrating Indigenous knowledge in Science Education. The figure below represents research trends by integrating indigenous knowledge in science education year over year (over the last 15 years) that meet the established inclusion and exclusion criteria.

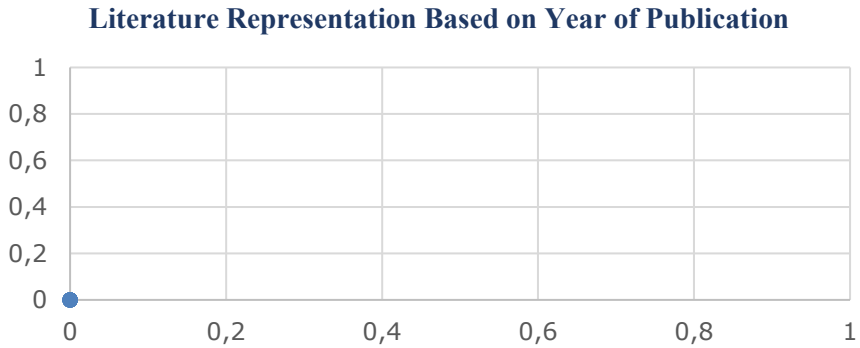

Figure 2: Literature Representation Based on Year of Publication

Based on figure 2, it shows that over the past 15 years research on integrating indigenous knowledge in science education has continued, although it has not developed significantly. However, it is shown that in 2024, the increase is very significant, this is an interest in itself so that local culture can still be a local potential that can be studied by all groups, so that it can lead to sustainable development that is relevant to the culture in the community (Demssie et al., 2020). Science education considers that studies related to integrating indigenous knowledge with science education are very important to prepare future generations who love culture and can face global challenges. In addition, the study also has a good impact on the optimal outcomes of science education (Ridwan et al., 2023). The representation of articles by research country that integrates indigenous knowledge in science education is presented in figure 3 below:

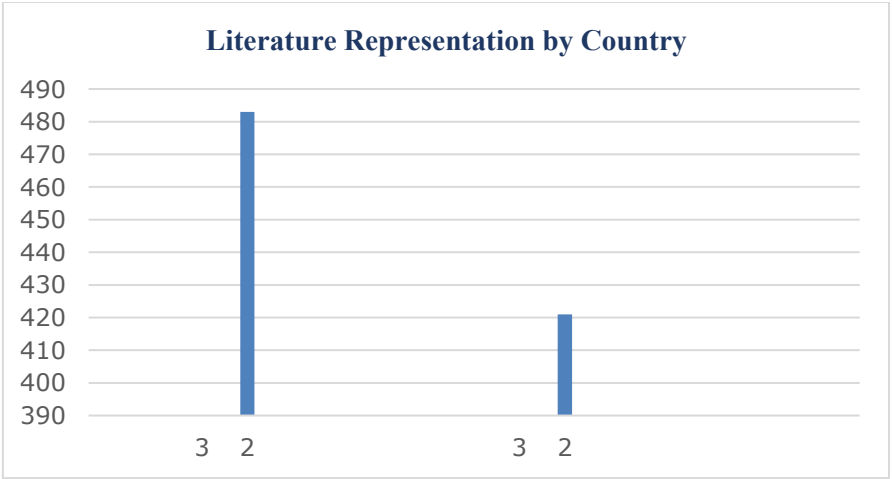

Figure 3: Literature Representation by Country

Based on Figure 3, the topic of integrating indigenous knowledge into science education has been widely applied. For example, in this study, it is proven that 17 countries consistently conduct research on this topic and apply it in the country's education system.

Integration of Indigenous knowledge in Science Education

Indigenous knowledge is closely related to the indigenous knowledge of the community about traditions or phenomena in their area that are passed down from ancestors to the next generation. This indigenous knowledge can also be used to overcome problems that occur in society. According to UNESCO (2018), indigenous knowledge can occur in 3 ways, namely the daily lifestyle of the community, the community system itself and how the process of investigation by the community with scientific methods. In this case this integration is applied to science education, which is presented in table 4 below:

Table 4: Issues of Indigenous Knowledge in Science Education

No	Issues of IK	Scientific Field	Description of IK	Concept in Science Education
1	Ecology	Environmental Science	Explain how indigenous knowledge of the community is used to overcome environmental problems, combined with scientific knowledge. An example in this case is the traditional irrigation system by the Thru people, Nepal. In addition, there is also a conservation system traditionally by the community of Bare, Brazil.	Ecosystem
2	Agriculture	Environmental Science	Explain how certain techniques are traditionally used by the community in farming so that the results obtained are optimal and sustainable. Examples occur in indigenous peoples in the states of Amazonas and Mato Grosso, Brazil.	Genetics & Breeding
3	Herbal plants	Sciences	Explain how people believe in a plant to cure a certain disease. An example that occurs in the majority of Indonesian people who use medicinal plants.	Plant Physiology, Botany, Ecology, Ethnobotany
4	Technology	Social Sciences	Methods of building, hunting, farming, or creating locally developed tools. In this case, handicrafts or media also apply as learning. An example of what happened to the community is South Africa.	Simple Aircraft

Based on table 4 above, indigenous knowledge can be integrated in science education in many issues, namely ecology, medicinal plants, agriculture and local technology. These issues are then presented to students in a learning process, by being integrated into science education, for example in ecosystem material, genetics and breeding, plant physiology and even simple planes (Upadhyay & Sadykova, 2024; Campan, 2024; Seehawer & Breidlid, 2021; Jufrida et al., 2024; Stocklmayer et al., 2024).

The Role of Curriculum in Integration and Its Impact on Science Education

The role of the curriculum is very crucial in integrating indigenous knowledge into science education, this is because it determines the success of a learning. A case study of a science professional development workshop in Nepal shows how indigenous knowledge can be considered in the curriculum to empower science teachers (Upadhyay & Sadykova, 2024). With this empowerment, it is hoped that science teachers can facilitate the learning process that takes place well. This kind of approach

not only makes learning more contextual but also upholds cultural love. Indigenous knowledge reflects knowledge that has been tested in the practice of community life that is inherited from generation to generation. When this knowledge is connected to topics in science such as ecology, medicinal plants, conservation, or simple engineering, students become more likely to understand and relate science concepts to their reality. This makes the curriculum more contextual, relevant, and meaningful (Baynes, 2015). Indigenous knowledge-based learning not only enhances the academic aspect, but also strengthens students' cultural identity and confidence. For example, students who engage in learning about traditional tools and practices show a deeper understanding because they can relate them to everyday experiences. This suggests that a curriculum that is open to local culture can be a tool for empowerment (Tolbert et al., 2024).

In fact, today's science curriculum is often oriented towards a western approach that lacks explicit space for indigenous knowledge. Although some studies mention the importance of Indigenous Knowledge, there are still no clear guidelines on how to integrate it. As a result, the responsibility for this integration is left entirely to the teacher, so it is true that it was conveyed in the previous paragraph that teachers need more empowerment (Photo & Mcknight, 2024). The curriculum should not only be normative, but be a tool of transformation that accommodates the diversity and equity of science education. The integration of indigenous knowledge in the science curriculum has a significant impact on students' perceptions and how they interact with science. With this, students will not see science as something foreign, but something that is in harmony with their own understanding of the world, namely the indigenous knowledge of the people in the surrounding environment. In addition, the positive impact obtained by student involvement in learning is higher so that this is a positive thing to continue to be implemented. The approach is not only about adding Indigenous content to the curriculum, but also about revisiting pedagogy and epistemology. Thus, science education becomes more inclusive and equitable and reflects the diversity of ways of thinking. So that the lens of science is not only for academic learning but also a tool for the empowerment of indigenous communities and cultural preservation. Therefore, the curriculum plays a very central role in the successful integration of indigenous knowledge into science education. This has an impact on the way teachers teach, students learn, and how people perceive the value of their own knowledge in a scientific context. Thoughtful implementation of this approach leads to science education that is more culturally relevant, pedagogically effective, and socially transformative (Vergara & Albanese, 2022; Lowan, 2012; Camppani, 2024, Latip et al., 2024).

Strategies, Challenges, Implementation Gaps & Contribution to Science Education Innovation

The strategy carried out in the implementation of the indigenous knowledge approach in science education is to conduct contextual learning based on the surrounding environment. This will make science education more relevant and meaningful for students by connecting it to their cultural context and indigenous knowledge (Sefoka & Chuene, 2025). In addition, it can also be done using interesting media and teaching materials, so that in this case, students' interest and motivation can increase. Therefore, teacher empowerment is very important because of the importance of integrating science from a decolonial perspective, not just as a surface addition (Vergara & Albanese, 2022). As explained earlier, that there are no clear guidelines on how to integrate indigenous knowledge into science education. As a result, the responsibility for this integration is left entirely to the teacher, so the teacher needs more empowerment (Photo & Mcknight, 2024). And the most important strategy is related to collaboration with indigenous peoples. This collaboration can be done by conveying their indigenous knowledge to the next generation or can be used as a facilitator or resource person to explain in more detail about the indigenous knowledge that they want to integrate. As well as

inviting the next generation, not only to know, but to be able to implement it in their daily lives (Upadhyay & Sadykova, 2024).

The findings of the challenges and gaps faced during implementation are that there are no specific guidelines from the curriculum regarding how to integrate, so the strategies carried out are fully charged to teachers. In addition, the teacher competency gap is not adequate for the integration of indigenous knowledge, so teacher empowerment is needed even higher in this regard. Because not all teachers understand culturally inclusive pedagogical methods. Another challenge is that there is no structured support from the government. So that although there are recommendations for the integration of local wisdom in education, there is no concrete policy, curriculum evaluation, or formal training that supports its systemic implementation. So that the implementation is only limited to being applied, for the results are still not very optimal. Therefore, there needs to be a good collaboration between the government, teachers, students and indigenous peoples (Vergara & Albanese, 2022). According to other research, another challenge is that there are many perceptions both in educational institutions and the community that indigenous knowledge is irrelevant when compared to science knowledge (Seehawer, 2018).

Approaches with learning models like this have an important contribution to science education. That is by emphasizing the need to shift the paradigm from a model dominated by western science to a more inclusive and epistemic approach (Tolbert et al., 2024). This integration as a strength is not a weakness, where this approach does not reduce the value of western science, but enriches learning to be more meaningful and relevant. This approach challenges the notion that indigenous knowledge and Western science cannot be combined. This dialogue between epistemologies can enrich science education without sacrificing cultural identity.

Key Findings

Some of the main findings of the systematic review are as follows:

a. Local teachers are more confident in explaining learning topics by integrating them into local culture in a multicultural manner, this is because teachers already know a little more about local culture in everyday life (Seehawer & Breidlid, 2021; Ward et al., 2022).
b. The concept of relationships in this integration is not just about transferring knowledge, but also building a close relationship between the environment and the community (Lowan, 2012; Kik, 2023; Rekola, 2025).
c. The development of a new paradigm is not aimed at dominating, but rather to open a dialogue between knowledge systems so that it can enrich science education without sacrificing cultural identity (Sexton, 2024; Keane et al., 2012).
d. Systemic support from governments and indigenous communities has a meaningful role in education, not just symbolic (Baynes, 2015).

CONCLUSION

The results of this systematic review indicate that the integration of indigenous knowledge into science education has become an emerging trend that contributes positively to more sustainable, contextualized, and culturally relevant learning. The findings show that curriculum design plays a crucial role in the success of this integration. Various approaches have been employed, including contextual learning, the use of culturally responsive teaching materials and media, and collaboration with Indigenous communities and local stakeholders in educational practices. The integration of Indigenous Knowledge strengthens science education by enriching students' understanding of scientific concepts while maintaining the value of Western science. Rather than positioning indigenous knowledge and western science as opposing perspectives, this approach promotes meaningful connections between multiple ways of knowing and supports the preservation of cultural identity.

The findings of this review have important implications for curriculum

developers and science educators. Curriculum developers should design learning experiences that systematically incorporate indigenous knowledge as an integral component of science education rather than as supplementary content. Science teachers are encouraged to adopt culturally responsive pedagogies, utilize local contexts as learning resources, and engage indigenous communities in the teaching and learning process. Such efforts can enhance students' scientific literacy, engagement, and appreciation of cultural diversity.

Despite these contributions, several limitations should be acknowledged. This review included only peer-reviewed journal articles and may have excluded relevant insights from books, conference proceedings, and other forms of grey literature. In addition, the studies reviewed were conducted in diverse educational and cultural contexts, which may limit the generalizability of the findings. The review was also restricted to articles indexed in selected databases and published in English, potentially overlooking valuable studies published in other languages.

Future research should explore the long-term effects of indigenous knowledge integration on students' scientific literacy, academic achievement, cultural identity, and environmental awareness. More empirical studies are needed to evaluate specific curriculum models and teaching strategies across different educational levels and cultural settings. Comparative and longitudinal studies may also provide deeper insights into the effectiveness and sustainability of indigenous knowledge integration in science education.

AUTHOR CONTRIBUTIONS

Imroatun Nadifah: Conceptualization, methodology, literature search, data curation, formal analysis, writing – original draft;
Yuni Anisa Widiyanti: Methodology support, screening articles (inclusion–exclusion criteria), data validation, writing – review & editing;
Nisa'ul Mutoharoh: Data extraction, quality assessment of studies, visualization (tables/figures), writing – review & editing;
Libna Sahlatul Mufidah: Supervision, project administration, validation, final review & editing.

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