Journal of Turkish Science Education, 2024, *21*(4), 651-667
DOI no: 10.36681/tused.2024.035

Local and indigenous knowledge (LIK) in science learning: A systematic literature review

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ABSTRACT
This research aimed to analyse the literature regarding Local and Indigenous Knowledge (LIK) in science teaching and learning. This research uses a Systematic Literature Review (SLR) to identify articles focusing on studies regarding LIK in science education. This research explores 52 articles from Scopus and Web of Science published between 2014 and 2023 from various countries. The SLR results show that the number of publications increased yearly. LIK is a recognised research topic in various countries, such as Indonesia, the United States, Canada, Australia, and African countries. The SLR results also show types of LIK consisting of daily lifestyle behaviour, system development in society, and knowledge and practice of investigation by the community. These types related to issues in science issue of climate, ecology, medicinal plants, and astronomy. These issues are studied from the perspective of indigenous knowledge, which is harmonised with modern scientific knowledge. LIK implementation strategies in science learning include community-based and place-based education learning development strategies. Implementation of different strategies is the development of a formal curriculum that accommodates LIK, such as Cross-Curriculum Cultural Priorities, Integration of medicinal plants as important content in K-12 curriculum subjects in the USA, Development of chemistry and physics practicums based on knowledge of indigenous communities and culture, and curriculum development in Traditional Ecological Knowledge (TEK).

REVIEW ARTICLE

ARTICLE INFORMATION
Received: 08.06.2023
Accepted: 13.02.2024
Available Online: 27.11.2024

KEYWORDS:
Local, indigineous knowldege, science education.

To cite this article: Latip, A., Hernani, & Kadarohman, A. (2024). Local and indigenous knowledge (LIK) in science learning: A systematic literature review. *Journal of Turkish Science Education, 21*(4), 651-667. http://doi.org/10.36681/tused.2024.035

Introduction

Local and Indigenous Knowledge (LIK) comes about as an understanding and philosophy developed by society through a long process of interaction with nature, which is then used to make decisions on fundamental matters (UNESCO, 2018). LIK includes knowledge and practices contextualised by local communities in everyday experiences interacting with nature (Druker-Ibáñez & Cáceres-Jensen, 2022; Sharma & Kumari, 2021). LIK is a comprehensive system of society that

includes views, practices, knowledge and guidelines for interacting with nature and can be used as a learning tool and source of knowledge regarding environmental conservation (Demssie et al., 2020).

LIK has an essential role in responding to global challenges through the participation of local communities in the development and application of knowledge in various contexts of challenges that occur in society, such as in the context of climate change challenges (Greenall & Bailey, 2022), ecological issues (Magni, 2017; Nesterova, 2020; Sandoval-Rivera, 2020), overcoming the water crisis and water management (Shahraki et al., 2023), and in the context of conservation of medicinal plant diversity (Ridwan et al., 2023). The participation of local communities in developing their knowledge aims to make the LIK owned by the community relevant to knowledge in modern and formal education. However, the integration of LIK into the education curriculum has yet to be fully implemented. In fact, LIK has not been integrated at all in the education curriculum in several African countries (Njoh et al., 2022), even though LIK in education has benefits and an important role for teachers, students and society.

The integration of LIK in the education curriculum has various benefits, namely helping learners understand their regional context, increasing the sensitivity of pupils, teachers and the community to surrounding environmental problems (Njoh et al., 2022). Integrating LIK can eliminate the gap between LIK and scientific knowledge about the environment in education. It can build collaboration between LIK and scientific knowledge in environmental conservation efforts (Nesterova, 2020). The integration of LIK in education also has an essential role in building and improving sustainable competence in learners (Demssie et al., 2020; Magni, 2017).

LIK has a specific relationship with scientific concepts: physics, biology and chemistry (Imaduddin et al., 2020; Parmin et al., 2022; Sumarni et al., 2016). In science education, LIK related to scientific concepts is used as a learning resource in developing knowledge regarding the relationship between science and societal knowledge (Parmin et al., 2022; Parmin et al., 2019). Furthermore, integrating LIK in science education aims to increase more meaningful science learning (Greenall & Bailey, 2022; R. D. Handayani et al., 2019; Mustafaoglu, 2022). Even LIK in science education becomes a means of developing readiness and improving the skills of prospective science teachers, such as improving science lesson planning skills, reconstruction skills for science teaching materials by paying attention to LIK (Parmin et al., 2022), development of experimental design skills (Parmin, et al., 2019), as well as increasing the skills of prospective teachers in identifying STEM in LIK (Imaduddin et al., 2020).

LIK has a role and benefits in science learning. However, the introduction, exploration and use of indigenous knowledge in learning still need more attention as an essential part of the education system (Demssie et al., 2020). Transmitting local community knowledge through formal schools is rarely implemented because the context presented in class is less relevant to the pupil's situation and local community knowledge (Magni, 2017). Another opinion states that in science education, indigenous knowledge contradicts with scientific knowledge, which needs to be given more attention in the science education curriculum (Kim, 2022; Saputra et al., 2016). The lack of integration of LIK in science learning is due to the lack of teacher ability to align LIK with the learning process in the classroom (Fasasi, 2017).

In its implementation, it is necessary to pay attention to the the curriculum that needs to emphasise the use of local resources by involving local communities (Demssie et al., 2020), strategies learning must emphasise local problem-based learning which is a source of knowledge (Fabra, 2019), and learning must be carried out collaboratively in solving problems and creating projects (Datta, 2018; Demssie et al., 2020). Based on this explanation, science learning that integrates LIK can be carried out using learning models, such as problem-based learning, project-based learning, place-based education, and other models that are relevant according to these aspects. However, using these learning models depends on the form and type of LIK in areas relevant to scientific concepts.

Each region and country have different characteristics according to the local potential in that region and country. Local potential includes regional natural resources, human resources, culture, geographical location and history (Jumriani & Prasetyo, 2022). The local potential of the area is related

to the flora and fauna as well as sociocultural aspects of the area (Wilujeng et al., 2020). The diversity of local potential in each country results the differences of local community knowledge. Thus, the type of LIK integration in science learning will vary according to the country's local potential. Based on this, a systematic literature review was conducted on various research results regarding local potential, local community knowledge, and their integration into science learning. This research aims to map the types of LIK in various countries and the integration of LIK in science learning in various countries. The problem formulation studied in this SLR is:

1) What are the research trends on local and indigenous knowledge topics in science learning in various countries in 2014-2023?
2) What types and issues of local and indigenous knowledge are integrated into science concept?
3) What implementation types are local and indigenous knowledge in science teaching and learning?

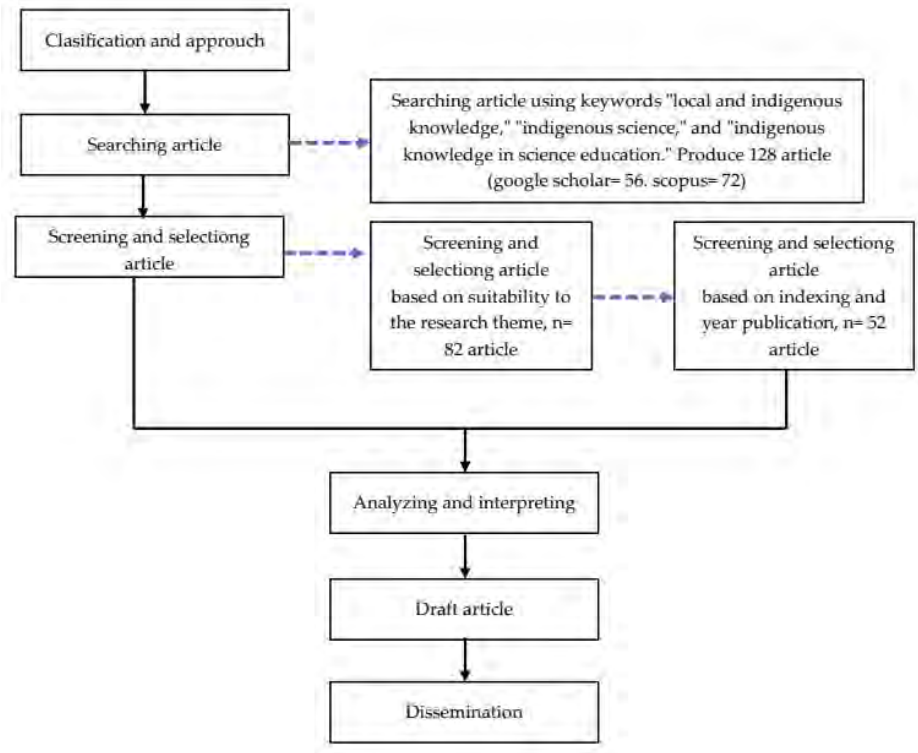
Methods

The research approach used was a systematic literature review (SLR) which aims to obtain data and a description of a variable research explicitly and other esential issues in research (Gough et al., 2019). In a literature review that focuses on the results of research regarding the Local and Indigenous Knowledge (LIK), and the implementation of LIK in science education. A search for articles was carried out using the keywords "local and indigenous knowledge," "indigenous science," “ethnoscience”, and "indigenous knowledge in science education."

The articles collected were sourced from Scopus, WoS, Elsevier, and SINTA. In the process, 52 articles were selected that were appropriate and relevant to the focus of the research study. The SLR process stages were adopted from (Martín-Páez et al., 2019). The SLR stage consists of five stages: classification and approach, searching, screening and selecting, analyzing and interpreting, and the last is dissemination. The following is an explanation of the five stages of SLR.

Figure 1

Stages of the SLR process



In the clarification and approach stages, the researcher determined the focus of the literature review to finding articles related to Local and Indigenous Knowledge (LIK) in science education. The criteria for the specified articles are conformity with the focus of the study (type of the LIK issues context and LIK implementation), and Scopus indexing Q1/Q2/Q3/Q4/internasional indexing/ sinta indexing (grade 1 and 2) with the year of publication 2014-2023.

At the searching, screening and selecting stages, articles about Local and Indigenous Knowledge in science learning were searched through journals in websites such as Scopus, Google Scholar, and Sinta. At this stage, 128 articles were produced based on search results using the publish or perish application. The articles obtained were filtered based on the suitability criteria of the focus of the study, so 85 articles were obtained from the screening results. To ensure the quality and novelty of the articles obtained, the researcher carried out a second screening with indexing criteria and the year of publication so that 52 articles were obtained. The following is a database of the 52 articles analysed in this research.

Table 1

Article database based on indexing

Journal indexing	Name of journal (number of article)	Total of article (%)
Scopus Q1	• Journal of forestry (n= 1) • Cultural studies of science education (n= 5) • Environmental education research (n =1) • Sustainability (n =1) • Research in science education (n= 1) • MAI Journal (n= 1) • Sustainable chemistry and pharmacy (n= 1) • International journal of educational research open (n= 1) • CBE Life sciences education (n= 1) • International journal of science education (n= 1) • Journal of philosophy of education (n= 1) • International journal of disaster risk reduction (n= 1)	16 (30,76%)
Scopus Q2	• Australian journal of indigenous education (n= 3) • Journal of chemical education (n= 1) • Eurasia journal of mathematics, science and technology education (n= 1) • Sage open (n= 1) • Journal of turkish science education (n= 1) • Education sciences (n= 2) • Ecoscience (n= 1) • Acta scienta (n= 1) • Journal of teacher education for sustainability (n= 1) • Diaspora, indigenous, and minority education (n= 1)	13 (25%)
Scopus Q3	• Journal of education (n= 1) • Educational research for social change (n= 1) • Pharmacognosy journal (n= 1) • Chemistry teacher international (n= 2) • Perspectives in education (n= 1) • Case studies in the environment (n= 1) • Universal journal of educational research (n= 2) • African journal of research in mathematics, science and technology education (n= 3) • Waikato journal of education (n= 1) • International journal of innovation in science and mathematics education (n= 1)	14 (26,92%)

Journal indexing	Name of journal (number of article)	Total of article (%)
Scopus Q4	• Ubiquitous learning (n= 1) • Pegem journal of education and instruction (n= 1) • International e-journal of educational studies (n= 1)	3 (5,76%)
Other international indexing*	• Oriental anthropologist (n= 1) • Journal for the education of gifted young scientists (n= 1) • International journal of academic research and reflection (n= 1) • Electronic journal of science education (n= 1)	4 (7,69%)
Sinta indexing**	• Jurnal penelitian dan pembelajaran ipa (n= 1) • Journal of science learning (n= 1)	2 (3,84%)

Note. *articles from these journals are very relevant to the theme. **Indonesian indexing.

In the next stage, researchers analyzed and interpreted data and meaningful information from 58 articles. The data and information analyzed are focused on the research question to obtain conclusions according to the research focus. The analysis and interpretation stage are carried out by providing codes according to the problem formulation, namely types of local and indigenous knowledge and strategies for implementing local and indigenous knowledge in science learning.

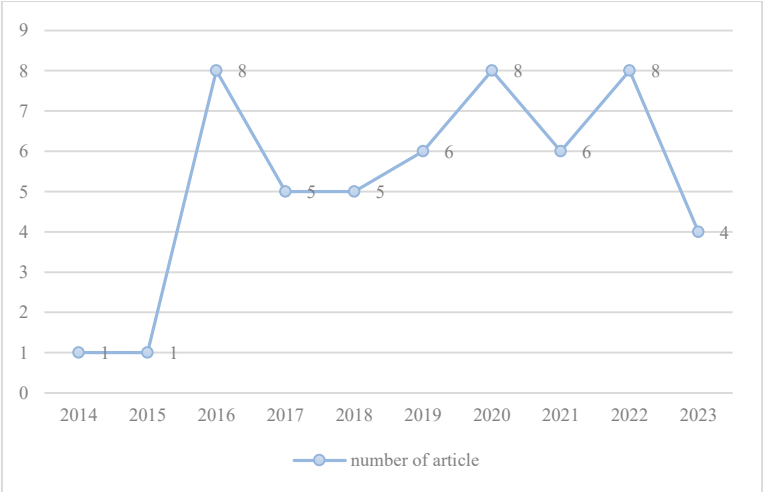
Findings and Discussion

Local and Indigenous Knowledge Research Trends in Science Education

The following representation of literature based on the year of publication within the range of 2014 to 2023 is presented in Figure 2:

Figure 2

Literature representation based on year of publication



Based on Figure 2, research about Local and Indigenous Knowledge in science education over the last ten years has been occurring albeit at a low level. Local and Indigenous Knowledge in each region and country have yet to be fully explored. Furthermore, Local and Indigenous Knowledge has the potential to provide learning that leads to sustainable development so that issues regarding Local and Indigenous Knowledge are still relevant to SDG issues (Demssie et al., 2020). One example of Local and Indigenous Knowledge contributing to ecological challenges includes local community knowledge regarding climate system (Datta, 2018; Magni, 2017).

In another aspect, Local and Indigenous Knowledge research in science education will continue to be an essential study for preparing future generations to face the challenges of global

issues. Integrating Local and Indigenous Knowledge in formal education can help develop sustainable skills to face global challenges (Greenall & Bailey, 2022; Sandoval-Rivera, 2020). The diversity of natural resources is one of the essential factors that will make research on Local and Indigenous Knowledge continue to develop. Local community knowledge about the diversity of medicinal plants, the existence of various types of plants, and knowledge about preserving nature and its ecosystems have relevance to science learning in the classroom (Ridwan et al., 2023).

In another aspect, Local and Indigenous Knowledge research in science education will continue to be an essential study in preparing future generations to face the challenges of global issues. Integrating Local and Indigenous Knowledge in formal education can help develop sustainable skills to face global challenges (Greenall & Bailey, 2022; Sandoval-Rivera, 2020). The diversity of natural resources is one of the essential factors that will make research on Local and Indigenous Knowledge continue to develop. Local community knowledge about the diversity of medicinal plants, the existence of various types of plants, and knowledge about preserving nature and its ecosystems have relevance to science learning in the classroom (Ridwan et al., 2023).

The representation of literature based on the researcher's country that studies and implements Local and Indigenous Knowledge in learning is presented in Table 2:

Table 2

Literature representation by country

No	Country	N	%
1	Indonesia	12	23%
2	Sout Africa	6	12%
3	Canada	10	18%
4	Ghana	3	6%
5	USA	7	13%
7	Australia	6	12%
9	Mexico	1	2%
10	Argentina	1	2%
11	Taiwan	1	2%
12	Philippines	2	4%
13	New Zealand	3	6%
	Total	52	100%

The mapping results in Table 2 show that Indonesia has the most number of studies examining local and indigenous knowledge in science education (N= 12). Indonesia is a country that has a diversity of local potential, both natural and cultural resources, which can be a source of learning (Sumarni et al., 2022). The diversity found in Indonesia produces various traditions, local wisdom and local knowledge that have been passed down from generation to generation (Diliarosta et al., 2021). This condition makes research on local and indigenous knowledge in Indonesia a widely researched topic in the last ten years, especially in science learning. Several local and indigenous knowledge topics studied in Indonesia include the use of various traditional plants as medicine (Parmin, Nuangchalerm, et al., 2019; Sumarni et al., 2016), traditional scientific processes, such as tradition in making salt manually (Imaduddin et al., 2020), community traditions regarding use bitter melon for breast milk stimulus (Parmin et al., 2022), and use of traditional and natural pesticides (Zidny, 2022).

Canada and the USA are the second and third countries with the most research topics on LIK based on Table 2 (Canada= 10, USA= 7). Several local and indigenous knowledge research topics in the USA are related to environmental issues, such as the principles of indigenous knowledge applied in ecological systems (Verma et al., 2016). Apart from ecological issues, other studies regarding local and indigenous knowledge in the USA relate to local community projects based on STEM about simple

technology in ethnomedicine project (Alkholy, 2017). Several African studies are based on the lack of a formal school curriculum that accommodates local and indigenous knowledge (Njoh et al., 2022). In this way, research on local and indigenous knowledge continues to develop, thus strengthening the relevance between local knowledge and modern scientific knowledge.

Issues and Type of Local and Indigenous Knowledge in Science

Local and Indigenous Knowledge (LIK) is closely related to community knowledge about a tradition or phenomenon in their region that is firmly held by the community. This community knowledge is used to solve various problems that occur or as a way of survival and is related to scientific concepts of science. Local and indigenous knowledge consists of 3 types, namely daily lifestyle behaviour, society system, knowledge and practice of investigation by the community with scientific method. Local and indigenous knowledge consists of understanding, skills, and philosophy developed by society (UNESCO, 2018), knowledge and practices contextualised by local communities in everyday experiences (Druker-Ibáñez & Cáceres-Jensen, 2022), and system of society (Demssie et al., 2020). The following is a mapping of the issues and type of Local and Indigenous Knowledge (LIK) in various field of science.

Table 3

Issues and type of local and indigenous knowledge (LIK)

No	Issues of LIK	Scientific field	Description of local and indigenous knowledge	Type of local and indigenous knowledge
1	Climate system	Science education	Indigenous people's style and way of life in maintaining climate stability (McGinty & Bang, 2016),	Daily lifestyle behaviour
			Local people's understanding of land use and the George River as an effort to prevent the negative impacts of climate change (Gérin-Lajoie et al., 2018), community knowledge about forms of adaptation and mitigation disasters in maintaining social-ecological resilience systems as a response to climate change (Tanyanyiwa, 2019), traditional practices and technology of local communities in anticipating climate change (Zinyeka et al., 2016), local community knowledge in seasonal forecasting systems and adaptation to climate change (Mafongoya, 2021), local community knowledge about how to anticipate the impacts of climate change on their communities (Littrell et al., 2020).	System in society
2	Ecology	Environmental education	Understanding of Elders from the Dene First Nation community regarding land-based education (Datta, 2018), local community practices and culture that uphold respect for others and loving the environment (Sandoval-Rivera, 2020), local community ways of life and systems in anticipating environmental degradation (Nesterova, 2020)	System in society
		Science education	Local community knowledge regarding natural resource processing, which focuses on the harmonization of art, science and technology (Govender & Mudzamiri, 2022), local community knowledge regarding river watershed management (Engels et al., 2019), local community knowledge regarding land-based education, both water and land while still prioritising local culture (Jacobs et al., 2021)	System in society
3	Diversity of medicinal plants	Biology education	Research results regarding this type consist of: kind of indigenous traditional medicinal plants to treat wounds, hypertension, anaemia, coughs and colds, and asthma (Bibon, 2022), investigation of indigenous knowledge and values of the traditional martial arts of the Betawi tribe (Indonesia) "silat beksi" is associated with the system motion (Elvianasti et al., 2023).	Knowledge and practice of investigation by the community with scientific value

No	Issues of LIK	Scientific field	Description of local and indigenous knowledge	Type of local and indigenous knowledge
		Science education	Local knowledge about yellow root plant (*Arcangelisia flava Merr*.) contains bioactive compounds which act as antibacterials, thereby inhibiting bacterial growth (Diliarosta et al., 2021), use of bitter melon by local communities as a breast milk stimulus (Parmin et al., 2022), use of various kind of plants in the northern coastal area of Java to treat various diseases (Parmin, Nuangchalerm, et al., 2019), community knowledge about plants used as herbal medicines (Sumarni et al., 2022).	Knowledge and practice of investigation by the community with scientific method
		Chemistry education	Indigenous chemical knowledge in the fields of agriculture, food preservation, food processing, health care and environmental conservation (TAWANDA & MUDAU, 2022), the use of traditional pesticides in maintaining agricultural systems (Zidny, 2022), local community knowledge regarding traditional chemicals used as medicine in aboriginal tribes (Ziebell et al., 2021)	System in society
4	Earth science	Science education	The knowledge of Mäori and other ethnicities in Aotearoa, New Zealand, relates with horoscopes and weather based on people's experience and traditional direct monitoring (Fonua, 2020)	System in society

Based on Table 3, the issues in local and indigenous knowledge generally consists of 4 main issues, namely climate system, ecology, medicinal plants and earth science. The issue of climate change is a global issue. The worldwide community is discussing this issue because everyone worldwide feels the impacts of climate change. Local communities already know the issue of climate system, namely daily lifestyle behaviour and system development in society. The everyday behaviour type is a community lifestyle that has been firmly adhered to and passed down from generation to generation. Research on the issue of climate system states that local communities have knowledge and behaviour that reflect a style and way of life to maintain the stability of climate system (McGinty & Bang, 2016). This community's style and way of life need to be known and reconstructed in the science education curriculum in schools and universities so that the relevance of LIK is established with modern scientific knowledge. Another type of LIK on the issue of climate is system knowledge in society. This type is related to developing systems, tools, and technology by local communities to face and anticipate issue about climate. This type of LIK consists of community knowledge about adaptation systems to face climate issues and the development of simple technology to deal with climate system (Cajete, 2020; José Gérin-Lajoie et al., 2018; Tanyanyiwa, 2019). Another type of system knowledge in society is local community knowledge regarding climate forecasting and mitigation systems in climate (Mafongoya, 2021; Zinyeka et al., 2016). This system in local communities has been proven to maintain regional stability, so it needs to be integrated into modern science learning to be studied scientifically.

Knowledge of ecological issues is essential for society. Local communities already know ecological issues based on knowledge developed from community life practices. In general, research on ecological issues in LIK is a type of system knowledge in society. Systems that have developed in these communities include land-based education systems based on the understanding of Elders from the Dene First Nation community (Datta, 2018), local community systems in anticipating environmental degradation (Nesterova, 2020), local community practice and culture systems in a way that upholds respect and love for the environment (Sandoval-Rivera, 2020). Furthermore, system development in society regarding other ecological issues, namely natural resource processing systems which focus on harmonization of art, science and technology (Govender & Mudzamiri, 2022), river watershed management systems (Engels et al., 2019), systems land and water-based education that emphasizes local culture (Jacobs et al., 2021).

The system regarding ecological issues that have developed in local communities needs to be aligned with the modern science education curriculum. Aligning local community knowledge

regarding ecological issues to the science curriculum can develop critical thinking skills to overcome complex environmental problems and maintain environmental sustainability (Datta, 2018; Jacobs et al., 2021; Verma et al., 2016). Furthermore, harmonising indigenous knowledge and Western scientific knowledge about ecology in several research uses term "Traditional Ecological Knowledge" (TEK). Implementation of TEK in some research showed positively impacts to increasing student participation in classroom and enhance students understanding about problems in society (Greenall & Bailey, 2022). Other research shows that integrating TEK with Western ecological knowledge in science learning can contribute to developing sustainable educational paradigms and environmental preservation from the increasingly rapid impacts of climate change (Nesterova, 2020; Sandoval-Rivera, 2020).

Another issue studied in local and indigenous knowledge research is the issue of plant diversity, especially medicinal plants. On this issue, local people know medicinal plants and use them to cure various diseases. This issue of medicinal plant diversity includes the community's knowledge and practice of investigation with scientific value. Local people have searched for and investigated various plants that can be used as medicine for generations. Local people carried out repeated tests traditioally until they discovered the benefits of the plant. In this way, local community knowledge about the diversity and benefits of medicinal plants is used as a learning resource in science learning. In general, medicinal plants are used as exploration material in field project activities to find the relationship between the community's original knowledge about medicine and scientific knowledge (Bibon, 2022; Diliarosta et al., 2021; Parmin et al., 2022; Sumarni et al., 2016). More specifically, in other research, exploration of the benefits of medicinal plants was carried out through laboratory activities to study the content of chemical compounds in certain medicinal plants. Laboratory activities showed relationship between the community's original knowledge and scientific knowledge (Parmin et al., 2022; Ziebell et al., 2021).

Implementation of Local and Indigenous Knowledge in Science Learning

Local and Indigenous Knowledge (LIK) related to problematic issues faced by society can be integrated into formal education through various strategies. The results of a systematic literature review of the articles analyzed show that the LIK integration strategy in science learning uses various implementation strategies, such as developing a curriculum that accommodates LIK and Western science knowledge, developing learning strategies, developing teaching materials, and developing learning evaluation. The following is a mapping of the results of a literature review on articles published in 2014-2023 relating to LIK implementation strategies in science learning.

Table 4

Local and Indigenous Knowledge implementation in science learning

No	Strategy of LIK implementation	Types of implementations LIK and authors
1	Learning strategy development	• Community-based education: a strategy for developing learning and developing scientific knowledge that is based on the knowledge of the people in a community • Place-based education: a strategy for developing learning and developing scientific knowledge that is based on the problems and culture of a particular place (Achimugu et al., 2023a; Baynes, 2016; Bibon, 2022; Cajete, 2020; Cronje et al., 2015; Datta, 2018; Diliarosta et al., 2021; Edson & Nadaraj, 2021; Engels et al., 2019; Fasasi, 2017; Fonua, 2020; Gérin-Lajoie et al., 2018; Hiwasaki et al., 2014; Imaduddin et al., 2020; Jacobs et al., 2021; Mafongoya et al., 2021; Marker, 2019; Mavuru & Ramnarain, 2017; McGinty & Bang, 2016; Morales, 2017; Nesterova, 2020; Elvianasti et al., 2023; Parmin, Fibriana, et al., 2019; Parmin, Nuangchalerm, et al., 2019; Parmin et al., 2022; Rahmawati, 2020; Ruddell et al., 2016; Sandoval-Rivera, 2020; Maren Seehawer, 2018; Sumarni et al., 2022; TAWANDA & MUDAU, 2022; Ugwu, 2018; Vergara, 2022; Verma et al., 2016; R Zidny, 2020, 2022; Robby Zidny et al., 2021; Zinyeka et al., 2016)

No	Strategy of LIK implementation	Types of implementations LIK and authors
2	Curriculum development	• Cultures Cross-Curriculum Priority (Baynes, 2016) • Integration of medicinal plants as an essential content in five subjects in the K-12 curriculum in the USA (Bibon, 2022) • Development of chemistry and physics practicums based on the knowledge of indigenous communities and culture (Achimugu et al., 2023; Mashoko, 2022). • Development of the Traditional Ecological Knowledge (TEK) curriculum (Greenall & Bailey, 2022)
3	Learning material development	• Development of chemistry modules based on the practices of indigenous communities in Australia (Scholes, 2019) • Development of project-based learning modules based on the practices of urban communities and indigenous communities (Hsin & Wu, 2023)

Table 4 shows that LIK in science learning is integrated through the development of learning strategies, curriculum development, and modules or learning materials. The following is an explanation of the implementation of LIK in science learning.

Learning Strategy Development

In the development of learning strategies, the research focuses on developing and implementing learning models or methods by integrating local community knowledge that is harmonized and transformed into scientific knowledge. Based on the results of studies in various literature, the development of learning strategies that implement LIK, namely community-based education and place-based education.

Learning Strategy of Integration Local and Indigenous Knowledge: Community-Based Education

Local or indigenous people have knowledge that is passed down from one generation to the next. Local communities firmly hold this knowledge, known as Indigenous Knowledge or knowledge of native communities (Magni, 2017). Local community knowledge is essential as basic knowledge to preserve culture and pass it on to the next generation (Parmin et al., 2019). However, today, the knowledge of indigenous people needs to be remembered by hegemony and the increasing development of Western or modern knowledge (Greenall & Bailey, 2022; Handayani, 2018; Ruddell et al., 2016). Therefore, various efforts must be made to preserve local community knowledge and reconstruct it in modern science so that all levels of society can accept it.

Local and indigenous knowledge learning strategies that involve local communities are called community-based education (Cajete, 2020; Datta, 2018; Diliarosta et al., 2021; José Gérin-Lajoie et al., 2018; Tanyanyiwa, 2019). During the learning process, students explore the knowledge of indigenous communities related to science concepts to understand science concepts from the perspective of modern science and the community's traditional knowledge. In several studies, indigenous people's knowledge regarding natural science concept issues was reconstructed into scientific knowledge through laboratory activities to confirm the traditional knowledge of the community (Diliarosta et al., 2021; Parmin et al., 2022; Ziebell et al., 2021).

In other research, exploration activities in the traditional knowledge of indigenous people regarding natural science concepts were used as discussion material in class so that students could find harmony between indigenous knowledge and scientific or modern knowledge (Bibon, 2022; Elvianasti et al., 2023; Rahmawati, 2020; Woro Sumarni et al., 2016). More specifically, several studies show that the results of exploring indigenous people's traditional knowledge are used as material for developing STEM learning projects to train creativity and problem-solving (Imaduddin et al., 2020; Woro Sumarni et al., 2022).

Learning strategies that involve local communities are also carried out using community participation and local community leaders. In several studies, the exploration of indigenous knowledge was carried out by directly involving local communities in a participatory way in research projects so that researchers obtained a direct description of indigenous people's practices regarding a context related to the concept of science (Baynes, 2016; Gérin-Lajoie et al., 2018; Sandoval-Rivera, 2020; Seehawer, 2018). The strategy of involving the local community in a participatory manner makes the science concepts learned in class harmonize with the practices of indigenous peoples. Furthermore, the direct participation of local communities also reinforces solving environmental problems by combining traditional knowledge and scientific and modern knowledge.

In another strategy, indigenous people who become community leaders can provide material explanations in the research and learning projects carried out at schools or universities (Alkholy et al., 2017; Bibon, 2022; Datta, et al., 2018). Direct explanations about the practices and knowledge of indigenous peoples from community leaders make learning carried out in class more authentic because it directly presents the people who are considered to have qualified indigenous knowledge. In other settings, indigenous community leaders collaborate with academics in learning that provides traditional and modern perspectives on scientific knowledge and concept being studied to clarify the compatibility between traditional indigenous knowledge and more modern scientific knowledge (Seehawer, 2018; Seehawer & Breidlid, 2021).

Learning Strategy of Integration Local and Indigenous Knowledge: Place-Based Education

Developing other learning strategies as a form of LIK implementation in science learning is carried out by considering the location factor. Indigenous people's knowledge must be connected to where the community grows and develops. Each place has unique characteristics and problems; thus, the knowledge of indigenous peoples that develops also has specificities and uniqueness according to the place. In several studies, the implementation of LIK integration in science learning was carried out by paying attention to the place or known as place-based education.

The implementation of the place-based education strategy is carried out by using local environmental problems to understand science concepts contextually. The ecological problems raised include the quality and quantity of water in a river basin (DAS), used as a context for a group of students developing a water treatment project (Engels et al., 2019). Another problem that is used as a context for place-based education is the land problem. These problematic issues are used as context to understand real problems and bridge indigenous people's knowledge with Western knowledge (Jacobs et al., 2021; Marker, 2019). In general, several studies examining environmental problems around the area aimed to provide direct experience in understanding science concepts contextually, honing problem-solving skills directly, and raising awareness of the importance of ongoing environmental awareness and preservation.

Besides analysing surrounding environmental problems, place-based strategies also use an area's cultural context and local wisdom as one of the strategies for implementing LIK in developing the science concept. In a cultural context, people in one region of Indonesia (the Baduy tribe) can live by applying natural science concepts, such as renewable energy, agriculture, chemical dyes and household chemicals (Zidny, 2021). Other regional cultural contexts linked to the science concept include the movement system by studying the Beksi silat tradition as content and context in science learning (Elvianasti et al., 2023). In several other studies, local culture was explored and developed into science content studied in formal education environments (Bibon, 2022; Dupuis & Abrams, 2017; Sandoval-Rivera, 2020; Scholes, 2019; Vaughn, 2020).

Local and Indigenous Knowledge-Based Curriculum Development

In implementing LIK in science learning, curriculum development is an important part that has yet to be given much attention in several studies on Local and Indigenous Knowledge. In several

studies, the development carried out is more focused on preparing LIK to accommodate it in the formal education curriculum. The Australian national curriculum already contains Cultures Cross-Curriculum Priority; thus, in several states, a formal education curriculum has been developed which contains Indigenous Knowledge as a context for studying knowledge and modern science (Baynes, 2016).

In other curriculum developments, the context of medicinal plants is used as an important content in five subjects in the K-12 curriculum in the states of the USA, which were developed as an effort to increase conceptual understanding, metacognitive, science process skills, and increase appreciation of local culture (Bibon, 2022). Other studies have tried to develop a chemistry and physics practicum curriculum by paying attention to the knowledge-based practices of indigenous peoples and their culture (Achimugu et al., 2023b; Kibga et al., 2021; Mashoko, 2022). Furthermore, the LIK integration curriculum development produces a guide for teachers in the learning process that integrates Traditional Ecological Knowledge (TEK) when implementing classroom learning (Greenall & Bailey, 2022).

In general, curriculum development in the LIK implementation strategy is carried out to preserve the community's actual knowledge so that it remains in harmony and can be combined with modern knowledge (Fonua, 2020; Mashoko, 2022; Parmin et al., 2022; Ziebell et al., 2021). In addition, curriculum development related to LIK also aims to increase environmental and cultural awareness among students, teachers, and the community. Furthermore, developing this curriculum is expected to develop LIK as a continuing education effort based on participation and collaboration with the community (Gérin-Lajoie et al., 2018; Nesterova, 2020; Tasingwa, 2019).

Conclusion

The results of a systematic literature review of 52 articles on the topic of Local and Indigenous Knowledge (LIK) show that LIK from 2014-2023 was a viable research topic in science education, LIK issues integrated into science learning include climate system, ecology, diversity of medicinal plants, and earth sciences. These issues are categorised into three types of local and indigenous knowledge: daily lifestyle behaviour, system in society, and knowledge and practice of investigation by the community with scientific method. In each of these issues, local community knowledge is studied from a scientific perspective by reconstructing community knowledge into scientific knowledge. The strategy for implementing LIK in science learning consists of developing learning strategies, LIK curriculum, and LIK-based modules/teaching materials. These results show that LIK is one of the development topics in science education research with a focus on studies, the form of LIK on science education issues and strategies for implementing LIK in science learning. However, to strengthen the relevance of LIK with scientific and modern scientific knowledge, efforts are needed to increase the integration of LIK in science learning, especially in curriculum development for primary, secondary and higher education.

Acknowledge

We thank to Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia for supporting research funding through the LPDP and BPPT-BPI. We hope the results of this research will contribute ideas to advancing science education in Indonesia.

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