



DEVELOPMENT TRENDS IN LOCAL WISDOM-BASED PROBLEM-BASED LEARNING FOR PHYSICS EDUCATION: A SYSTEMATIC LITERATURE REVIEW AND BIBLIOMETRIC ANALYSIS

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Abstract

This study examines the development of local wisdom-based Problem-Based Learning (PBL) in physics education through a systematic literature review and bibliometric analysis. The systematic review identified 13 eligible full-text studies, while the bibliometric analysis examined 300 deduplicated records retrieved from OpenAlex. The review synthesized the forms of local wisdom integration, learning outcomes, and research characteristics, while bibliometric analysis examined publication trends and author patterns. The findings indicate that local wisdom has been integrated into physics PBL through traditional games, transportation, cultural architecture, traditional practices, and local environmental phenomena. The reviewed studies primarily focused on conceptual understanding, learning achievement, critical and creative thinking, and scientific literacy. In contrast, problem-solving skills and scientific attitudes were less frequently investigated as explicit outcomes. Bibliometric findings indicate substantial growth in research activity, particularly after 2022, with 2025 representing the peak publication year. Overall, local wisdom-based PBL represents an emerging approach for connecting culturally meaningful contexts with physics learning. Future research should provide stronger empirical evidence concerning its effects on specific scientific competencies, particularly problem-solving skills and scientific attitudes.

Keywords: local wisdom; problem-based learning; physics education; problem-solving skills; scientific attitude.

1. INTRODUCTION

Physics education requires students not only to understand scientific concepts but also to apply those concepts to problems situated in meaningful real-world contexts. However, physics is frequently perceived as a difficult subject because students are required to connect abstract principles, mathematical representations, and physical phenomena. Problem-Based Learning (PBL) provides an instructional approach that addresses this challenge by placing students in authentic problems that require investigation, collaboration, self-directed learning, and the construction of solutions (Hmelo-Silver, 2004; Savery, 2006). Rather than presenting knowledge



as a set of isolated facts, PBL encourages students to develop knowledge through active engagement with problems and reflection on their learning processes (Barrows, 1986; Hmelo-Silver, 2004).

The potential of PBL for science and physics education has been supported by previous research. Meta-analytic evidence indicates that PBL can provide advantages in skill development and knowledge application compared with conventional instructional approaches (Dochy et al., 2003; Strobel & van Barneveld, 2009). In physics education specifically, systematic reviews have reported that PBL has been associated with improvements in learning achievement, problem-solving, critical and creative thinking, attitudes toward physics, and science-process skills (Nicholus et al., 2023; Sabarrini et al., 2023). These findings indicate that PBL is particularly relevant to physics because learning physics requires students to interpret phenomena, identify relevant principles, construct representations, and apply scientific knowledge to solve problems.

Nevertheless, the effectiveness of PBL can depend on the meaningfulness of the problems presented to students. Problems that are disconnected from students' experiences may reduce the relevance of learning and make it difficult for students to recognize the relationship between physics concepts and everyday phenomena. Science education research has therefore emphasized the importance of connecting scientific knowledge with students' cultural and everyday experiences. Aikenhead argues that science learning involves movement between students' everyday cultural worlds and the subculture of formal science (Aikenhead, 1996, 2006). Similarly, research on Indigenous science highlights the educational value of recognizing culturally situated knowledge and experiences in science education (Snively & Corsiglia, 2001). Culturally relevant pedagogy further emphasizes the importance of using students' cultural backgrounds as meaningful resources for learning rather than treating culture as separate from academic knowledge (Gay, 2018; Ladson-Billings, 1995).

In this context, local wisdom and ethnophysics provide promising foundations for contextualizing PBL in physics education. Local wisdom can provide authentic phenomena, practices, technologies, and cultural artifacts that can be transformed into physics problems. When these phenomena are incorporated into PBL, students may encounter physics concepts through situations that are familiar within their cultural environment. Recent studies have demonstrated the potential of this integration. Sunarti et al. (2025), for example, examined ethnophysics-integrated PBL and explicitly connected the approach with scientific literacy and problem-solving skills. Other studies have combined local wisdom with PBL and STEM or digital learning materials to support learning outcomes, scientific literacy, and science-process skills (Siahaan et al., 2025; Zainuri et al., 2024). These developments suggest a shift from using local wisdom merely as an illustration toward integrating cultural phenomena into the structure of physics learning.



One important issue concerns the specific competencies targeted by local wisdom-based PBL. Previous research on problem-solving in physics has demonstrated the importance of students' abilities to understand problems, identify appropriate physics principles, construct solutions, and evaluate their reasoning (Docktor et al., 2016; Maries & Singh, 2023). Recent systematic reviews also indicate that problem-solving remains an important and increasingly investigated competency in physics education (Heldalia et al., 2025; Kiraga, 2023; Sukma et al., 2025). However, the existing literature on local wisdom-based PBL appears to emphasize conceptual understanding, learning outcomes, critical thinking, creative thinking, and scientific literacy more frequently than explicit measures of problem-solving skills.

A similar gap can be observed regarding scientific attitude. Scientific attitude represents an important dimension of science learning because scientific knowledge development involves dispositions toward evidence, inquiry, objectivity, curiosity, and scientific reasoning (Gauld, 1982). Previous research has demonstrated that PBL can contribute to the development of students' scientific attitudes (Wibawa et al., 2023), while recent research has begun to map broader trends in scientific-attitude studies in science education (Arifin et al., 2026). Nevertheless, the specific integration of scientific attitude within local wisdom-based PBL in physics education remains insufficiently synthesized.

Furthermore, although several studies have investigated PBL, local wisdom, ethnophysics, and related learning outcomes, the research landscape itself has not been comprehensively mapped through the combination of systematic literature review and bibliometric analysis using an open scholarly database. OpenAlex provides an openly accessible index of scholarly works, authors, venues, institutions, and concepts, making it suitable for identifying publication patterns and research structures in an open-data research framework (Priem et al., 2022). Bibliometric analysis can complement systematic review by revealing publication trends, author patterns, and research themes across a broader literature corpus (Aria & Cuccurullo, 2017; Donthu et al., 2021). VOSviewer further enables the visualization of bibliometric relationships and research networks (van Eck & Waltman, 2010, 2011).

Therefore, this study aims to examine the development trends of local wisdom-based Problem-Based Learning in physics education through a systematic literature review and bibliometric analysis. Specifically, the study investigates how local wisdom has been integrated into PBL, which physics learning outcomes have been examined, how the research landscape has developed over time, and which areas remain insufficiently explored. By combining systematic synthesis of eligible studies with bibliometric mapping of the broader literature, this study seeks to provide a comprehensive overview of the development of local wisdom-based PBL and identify future research opportunities, particularly concerning problem-solving skills and scientific attitudes.



2. LITERATURE REVIEW

2.1 Problem-Based Learning in Physics Education

Problem-Based Learning (PBL) is a learner-centered approach in which students learn through authentic and complex problems that require investigation, collaboration, and solution development (Hmelo-Silver, 2004; Savery, 2006). Unlike conventional instruction, problems in PBL function as the starting point for learning, encouraging students to construct knowledge through inquiry and reflection (Barrows, 1986).

PBL is particularly relevant to physics education because students are required to connect physical phenomena, scientific concepts, and mathematical representations. Previous research has shown that PBL can support academic achievement, problem-solving, critical and creative thinking, and science-process skills (*Dochy et al., 2003; Nicholus et al., 2023; Strobel & van Barneveld, 2009*). Problem solving is also an important competency in physics because students need to understand problems, select appropriate principles, construct solutions, and evaluate their reasoning (*Docktor et al., 2016; Mason & Singh, 2016*). Recent reviews further indicate that problem-solving remains an important research focus in physics education (*Heldalia2025; Sukma2025*).

2.2 Local Wisdom in Physics Learning

The integration of local wisdom provides an opportunity to make physics learning more meaningful by connecting scientific concepts with students' cultural and everyday experiences. Science education can involve interaction between students' everyday cultural knowledge and the formal culture of science (*Aikenhead, 1996, 2006*). Indigenous and local knowledge can also provide meaningful contexts for science learning because it reflects communities' experiences in observing and interacting with their environments (*Snively & Corsiglia, 2001*).

Within physics education, local wisdom can be incorporated through traditional games, transportation, architecture, cultural practices, and local environmental phenomena. When combined with PBL, these contexts can function as authentic problems rather than merely illustrations. Recent studies have reported the use of local wisdom with PBL to support scientific literacy, science-process skills, critical thinking, and other learning outcomes (*Siahaan et al., 2025; Sunarti et al., 2025; Zainuri et al., 2024*). This integration suggests that local wisdom can strengthen the contextual dimension of PBL in physics education.

2.3 Problem-Solving and Scientific Attitude

Problem-solving and scientific attitude represent two important dimensions of science learning. Problem-solving involves students' ability to understand and represent problems, apply



appropriate physics principles, and develop and evaluate solutions (*Docktor et al., 2016; Maries & Singh, 2023*). Although PBL is inherently problem-oriented, previous studies have more frequently examined general learning outcomes, critical thinking, creative thinking, and scientific literacy than explicitly measured problem-solving skills.

Scientific attitude is another important component of science education and involves dispositions related to scientific inquiry, evidence, curiosity, and scientific reasoning (Gauld, 1982). PBL has been reported to support students' scientific attitudes (Wibawa et al., 2023), while recent research has also highlighted the importance of systematic assessment of scientific attitudes (Arifin et al., 2026; Sharma & Tripathy, 2025). However, the combination of local wisdom-based PBL, problem-solving skills, and scientific attitude in physics education remains insufficiently synthesized.

Therefore, the present study combines systematic literature review and bibliometric analysis to examine the development of local wisdom-based PBL in physics education, with particular attention to research trends, learning outcomes, and the development of problem-solving and scientific-attitude research.

3. METHODOLOGY

3.1 Research Design

This study employed a systematic literature review (SLR) combined with bibliometric analysis to examine the development of local wisdom-based Problem-Based Learning (PBL) in physics education. The systematic review was used to identify, screen, and synthesize eligible studies, whereas bibliometric analysis was used to examine broader publication trends and research patterns. The review process was reported following the PRISMA 2020 framework (Page et al., 2021), while the bibliometric component followed established principles of science mapping and bibliometric analysis (Aria & Cuccurullo, 2017; Donthu et al., 2021).

3.2 Data Source and Search Strategy

The literature search was conducted using OpenAlex, an open scholarly database containing metadata on scholarly works, authors, sources, institutions, and concepts (Priem et al., 2022). OpenAlex was selected to provide an openly accessible and reproducible bibliographic source for both the systematic review and bibliometric analysis.

The search strategy used combinations of keywords related to three main concepts: Problem-Based Learning, local wisdom or culturally situated knowledge, and physics education. Search terms included variations of “problem-based learning,” “PBL,” “local wisdom,” “local knowledge,” “indigenous knowledge,” “ethnoscience,” “ethnophysics,” and “physics education.” The retrieved records were exported and consolidated into a screening dataset before the selection process.



3.3 Eligibility and Study Selection

Studies were selected according to predefined inclusion and exclusion criteria. Studies were included when they addressed (1) Problem-Based Learning or a closely related PBL implementation, (2) local wisdom, local knowledge, indigenous knowledge, ethnoscience, or ethnophysics as part of the learning context, and (3) physics education or physics-related learning. Empirical studies, intervention studies, and relevant instructional development studies were considered eligible for the systematic synthesis.

Studies were excluded when they were unrelated to physics education, did not involve PBL, did not incorporate a local or culturally contextualized knowledge component, or did not provide sufficient information for the review. Review articles were also excluded from the primary empirical synthesis because the purpose of the review was to synthesize primary studies.

The selection process followed four stages: identification, screening, retrieval, and eligibility assessment. The initial OpenAlex search generated 349 records. After removing 49 duplicate records, 300 unique records remained for title and abstract screening. A total of 278 records were excluded during screening, leaving 22 potentially eligible records. Full texts were successfully retrieved for 15 records, while seven could not be retrieved. After full-text assessment, two review studies were excluded, resulting in 13 studies included in the final systematic literature review. The complete selection process is presented using the PRISMA 2020 flow diagram (Page et al., 2021).

3.4 Data Extraction and Synthesis

Data were extracted from the eligible studies using a structured coding framework. The extracted information included publication year, country, educational level, physics topic, local wisdom or ethnophysics context, form of PBL integration, research design, sample, learning outcomes, and major findings.

The extracted data were synthesized descriptively to identify recurring patterns in the literature. Particular attention was given to the forms through which local wisdom was integrated into PBL and to the learning outcomes investigated. The outcomes were grouped into broader categories, including conceptual understanding or learning achievement, critical and creative thinking, scientific literacy, problem-solving skills, and scientific attitudes.

Because the included studies employed heterogeneous research designs and outcome measures, the findings were synthesized narratively rather than combined through statistical meta-analysis. This approach enabled comparison of research characteristics and outcomes while maintaining the methodological distinctions among development, validation, experimental, quasi-experimental, and correlational studies.



3.5 Bibliometric Analysis

Bibliometric analysis was conducted using the broader set of 300 deduplicated OpenAlex records rather than only the 13 studies included in the systematic synthesis. This distinction was maintained because the SLR focuses on studies that met the full eligibility criteria, whereas the bibliometric analysis aims to describe the broader research landscape captured by the search strategy.

Following established bibliometric procedures (Aria & Cuccurullo, 2017; Donthu et al., 2021), the analysis examined publication trends and author-related patterns. Annual publication trends were calculated by counting records according to publication year. Author productivity was assessed based on the number of records associated with each author. Where applicable, bibliometric relationships were visualized using VOSviewer, a software tool designed for constructing and visualizing bibliometric maps (van Eck & Waltman, 2010).

The bibliometric analysis was therefore used as a complementary component of the systematic review. While the SLR provided a detailed synthesis of the 13 eligible studies, bibliometric analysis provided a broader overview of how research related to PBL, local wisdom, and physics or science education has developed over time.

4. RESULTS

4.1 Study Selection

The study selection process followed the PRISMA 2020 framework to systematically identify, screen, assess, and include relevant studies. The literature search was conducted using the OpenAlex database with combinations of keywords related to Problem-Based Learning, local wisdom, local knowledge, indigenous knowledge, ethnoscience, ethnophysics, and physics education. The initial search identified 349 records. Since OpenAlex was the only bibliographic database used in this review, no records were obtained from registers or other databases.

Before screening, 49 duplicate records were removed, resulting in 300 unique records for title and abstract screening. No records were removed through automation tools or for other reasons. During the screening stage, 278 records were excluded because they did not meet the predefined relevance criteria, particularly the requirement to address Problem-Based Learning, local wisdom or related cultural knowledge, and physics education.

Following the screening process, 22 reports were sought for retrieval. Full texts were successfully retrieved for 15 reports, while 7 reports could not be retrieved. The 15 available full-text reports were subsequently assessed for eligibility. Two reports were excluded because they were systematic or literature review studies rather than primary empirical or development studies. Consequently, 13 studies were included in the final systematic literature review. The corresponding 13 reports constituted the final corpus for data extraction and synthesis. The complete study selection process is presented in Figure 1.

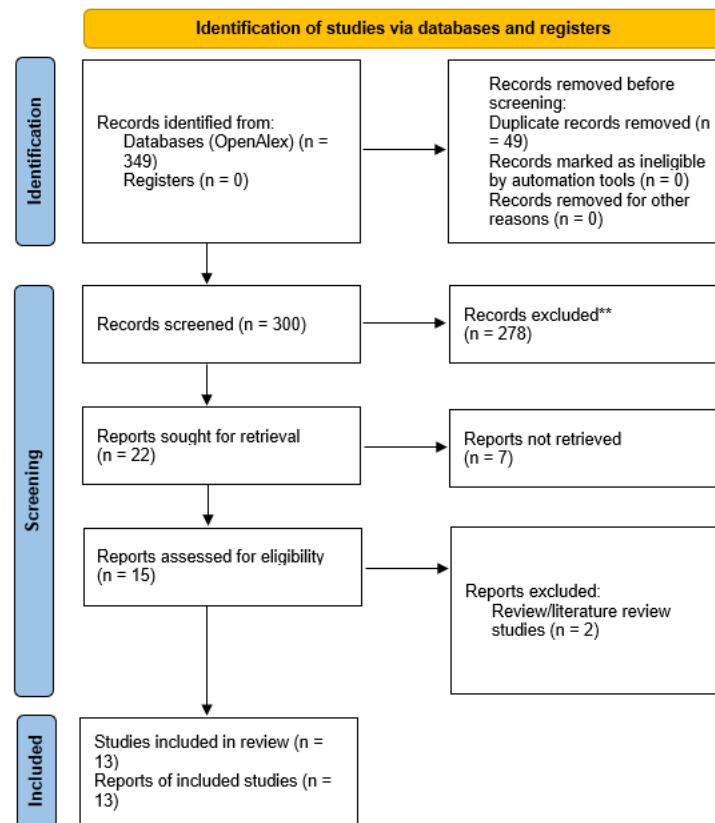


Figure 1. PRISMA 2020 flow diagram

4.2 Characteristics of the Included Studies

The 13 studies included in the final systematic review corpus demonstrate a relatively recent and predominantly Indonesian research landscape concerning the integration of local wisdom, ethnophysics, and Problem-Based Learning (PBL) in physics education. The studies were published between 2019 and 2026, with a marked increase in publications during the most recent years. The earliest study in the corpus was published in 2019 and examined the effectiveness of physics learning materials using a PBL model integrated with local wisdom. The study employed a one-group pretest–posttest design involving 33 Grade X students.

The distribution of publications indicates that 2025 was the most productive year, accounting for seven of the 13 included studies. Three studies were published in 2026, while one study was published in each of 2019, 2023, and 2024. This pattern indicates that research on local wisdom-based PBL in physics education has gained increasing attention in recent years, particularly from 2025 onward.



Table 2. Distribution of Included Studies by Publication Year

Publication year	Number of studies	Percentage
2019	1	7.7%
2023	1	7.7%
2024	1	7.7%
2025	7	53.8%
2026	3	23.1%
Total	13	100%

The characteristics of the included studies are summarized in Table 3. Most studies were conducted in Indonesia, reflecting the strong relevance of local cultural contexts to this research area. The local wisdom incorporated into physics learning varied considerably, including traditional games, traditional transportation, architecture, cultural practices, and locally relevant natural phenomena. For example, Becak Lawu was used to contextualize Newton's Laws, while Engklek was incorporated into learning about rigid-body equilibrium. The latter study employed a quasi-experimental non-equivalent control-group design and reported a higher N-Gain in the experimental group (0.661) than in the control group (0.293), with a very large effect size (Cohen's $d = 1.858$).

Table 3. Characteristics of the Included Studies

No.	Year	Physics context/topic	Local wisdom / ethnophysics context	PBL integration	Research design	Main outcome
1	2019	Physics learning	Local wisdom	PBL-integrated teaching materials	One-group pretest–posttest	Knowledge, skills, attitudes
2	2023	Physics learning	Local wisdom of catapults	PBL pocketbook + AR	Effectiveness study	Mathematical and graphical representation
3	2024	Physics	Local wisdom	PBL-integrated e-module	R&D, Four-D	Student preparedness
4	2025	Work and Energy	Ethnophysics/local cultural context	PBL + ethnophysics	PLS-SEM	Problem-solving, scientific literacy, engagement



5	2025	Temperature and Heat	Local thermal phenomena	Local-wisdom-based PBL	Quantitative experiment	Learning outcomes/conceptual competence
6	2025	Physics learning	Local wisdom	PBL physics e-module	Development/ effectiveness	Analytical thinking, scientific attitude
7	2025	Newton's Third Law	Balogo and Jukung Barenteng	PBL + modeling cycle	Quasi-experimental	Mental model
8	2025	Potential and Kinetic Energy	Palembang local wisdom	PBL + PhET	R&D, 4-D	Validity and practicality
9	2025	Physics learning	Local wisdom	PBL-integrated learning materials	Quasi-experimental	Knowledge, skills, attitudes
10	2025	Newton's Laws	Becak Lawu	Ethnophysics-based PBL	Quasi-experimental	Scientific literacy
11	2025	Heat	Ethnoscience/local context	ETHNO-PBL ICT materials	Needs analysis	Critical and creative thinking needs
12	2026	Temperature and Heat	Perang Ketupat	PBL science e-module + ethnophysics	R&D, Four-D	Science process skills, critical thinking
13	2026	Rigid Body Equilibrium	Engklek	Ethnophysics-based PBL	Quasi-experimental	Conceptual understanding

The included studies also demonstrate substantial variation in the type of local wisdom integrated into PBL. Rather than being restricted to a single cultural practice, local wisdom was represented through traditional games, cultural traditions, local architecture, transportation, and everyday phenomena. For instance, the Perang Ketupat tradition was used as an ethnophysical context for temperature and heat, while Palembang local wisdom, including the Ampera Bridge, Musi River, and falling coconut phenomena, was incorporated into a physics module on potential and kinetic energy.



The studies also varied substantially in their methodological approaches. Experimental and quasi-experimental studies were used to examine learning effectiveness, while several studies employed research and development approaches to produce PBL-based instructional materials. For example, the Palembang study used the Four-D development model and involved three expert validators and six students in limited trials; however, the study explicitly positioned the validation as preparation for a subsequent classroom-scale effectiveness trial. Similarly, the ethnophysics e-module study on temperature and heat was conducted using the Four-D model and focused on establishing the validity of the instructional package before classroom implementation.

An important characteristic of the corpus is therefore the heterogeneity of research designs and outcome measures. Some studies provide direct evidence of learning effectiveness, whereas others primarily provide evidence concerning product validity, practicality, or development needs. This distinction is important for interpreting the overall evidence because development and validation studies cannot be treated as equivalent to controlled effectiveness studies.

The most direct evidence concerning problem-solving skills comes from the study by Sunarti et al. (2025), which involved 100 junior high school students and employed PLS-SEM. Four constructs were examined: PBL tools integrated with ethnophysics, student engagement, problem-solving skills, and scientific literacy. The model explained 56.9% of the variance in problem-solving skills and 47.7% of the variance in scientific literacy.

In contrast, scientific attitude was considerably less frequently examined as a specific outcome. Although some studies assessed attitudes more generally, such as spiritual and social attitudes, these constructs should not be treated as equivalent to scientific attitude. This distinction becomes important in the subsequent synthesis of learning outcomes.

4.3 Trends in Local Wisdom-Based Problem-Based Learning

The synthesis of the 13 included studies indicates that the integration of local wisdom into Problem-Based Learning (PBL) in physics education has developed through several forms of contextualization. Rather than functioning merely as additional cultural information, local wisdom is increasingly positioned as a source of authentic phenomena, problems, learning scenarios, or representations through which physics concepts can be investigated. This pattern is particularly evident in studies employing ethnophysics-based PBL, where cultural phenomena are explicitly connected to physics concepts and problem-solving activities.

A prominent trend is the use of local everyday phenomena as authentic problem contexts. For example, the Becak Lawu phenomenon was used to contextualize Newton's Laws and motion concepts. Students were encouraged to connect the characteristics of the traditional vehicle with scientific concepts and subsequently investigate and solve physics problems. The study reported



that the integration of the local phenomenon into PBL enabled students to relate local phenomena to scientific concepts and construct more logical experimental procedures.

A second trend is the use of traditional cultural practices and games as sources of physics problems. The Engklek traditional game, for example, was integrated into ethnophysics-based PBL for teaching rigid-body equilibrium. The study explicitly positioned the traditional game as the contextual basis of the learning intervention and compared ethnophysics-based PBL with conventional PBL. The experimental group obtained a higher normalized gain than the control group, indicating the potential of culturally contextualized problems to support conceptual understanding.

A third trend concerns the integration of local architecture and cultural artifacts as organizing contexts for physics concepts. The Ethno-STEM PBL e-module using Rumah Gadang, for example, did not treat the cultural object merely as an illustration. Its architectural characteristics were used as an organizing principle for connecting physics concepts such as work, potential energy, kinetic energy, conservation of energy, and power with creative-thinking indicators. This represents a deeper form of integration because the cultural context becomes part of the structure through which students explore the physics content.

A fourth trend is the incorporation of local environmental and geographical phenomena into digital PBL materials. In the Palembang-based module, phenomena associated with the Ampera Bridge, Musi River, and falling coconut were incorporated into learning activities involving potential and kinetic energy. The learning module combined local wisdom, PBL activities, and PhET simulations, thereby connecting cultural context with digital representations of physics concepts.

These patterns demonstrate that local wisdom is being integrated at different levels of the PBL learning process. The integration ranges from simply providing contextual examples to using cultural phenomena as the initial problem, investigation context, source of data, and basis for developing solutions.



Table 4. Forms of Local Wisdom Integration in PBL-Based Physics Education

Integration form	Description	Examples identified in the corpus	Function in PBL
Local everyday phenomena	Everyday phenomena familiar to students are transformed into physics problems	Becak Lawu, local thermal phenomena	Problem orientation and contextual investigation
Traditional games	Traditional games are connected with measurable physical principles	Engklek	Authentic problem and experimental context
Traditional transportation	Local transportation technology is analyzed using physics principles	Becak Lawu, Jukung Barenteng	Real-world problem solving and conceptual analysis
Cultural architecture	Local buildings or structures become physical systems for analysis	Rumah Gadang	Organizing context for physics concepts
Traditional cultural practices	Cultural activities/practices provide phenomena related to physics	Perang Ketupat and other local practices	Problem orientation and contextual learning
Local environmental phenomena	Geographical or environmental characteristics are incorporated into learning problems	Musi River, Ampera Bridge, local thermal phenomena	Investigation, simulation, and application
Digital representation of local context	Local wisdom is combined with e-modules, simulations, AR, or other digital media	PhET + Palembang local wisdom; PBL e-modules	Visualization, investigation, and independent learning

The synthesis also indicates a movement from surface contextualization toward deeper cultural integration. In surface contextualization, a local cultural object is introduced primarily as an example before students learn the physics concept. In deeper integration, the cultural phenomenon becomes inseparable from the problem-solving process. This distinction is particularly visible in the Rumah Gadang study, where the local architecture was treated as an organizing principle rather than merely an illustration.

The same tendency can be observed in the Becak Lawu study. The local phenomenon was not simply presented in the introduction; students were expected to observe, investigate, process information, and develop explanations based on the phenomenon. The reported N-Gain for scientific literacy was 0.53 in the experimental group compared with 0.24 in the control group.



Table 5. Level of Local Wisdom Integration in PBL

Level	Characteristics	Evidence from the corpus
Level 1 – Contextual illustration	Local culture is mainly used as an example or introductory context	Local wisdom integrated into physics learning materials
Level 2 – Problem contextualization	Local phenomena become the basis for the PBL problem	Becak Lawu, local thermal phenomena
Level 3 – Investigation context	Students investigate a cultural phenomenon using physics concepts	Traditional games, transportation, and local environmental phenomena
Level 4 – Organizing principle	Local wisdom structures the learning content and problem-solving process	Rumah Gadang as an organizing context for Work and Energy
Level 5 – Integrated digital-cultural environment	Local wisdom, PBL syntax, and digital tools are systematically combined	Ethnophysics e-modules, PhET-supported PBL, AR-supported materials

Overall, the trend suggests that the most promising direction is not simply adding local wisdom to PBL, but embedding local wisdom within the problem-solving architecture of PBL. When cultural phenomena become the starting point for observation, questioning, investigation, data interpretation, and solution development, students have greater opportunities to connect abstract physics concepts with familiar real-world situations. This is consistent with the findings of Sunarti et al. (2025), in which PBL integrated with ethnophysics was associated with problem-solving skills, student engagement, and scientific literacy. The study reported that its model explained 56.9% of the variance in problem-solving skills and 47.7% of the variance in scientific literacy.

However, the synthesis also reveals that the depth of cultural integration is not consistently operationalized across studies. Some studies focus primarily on developing and validating instructional products, while others implement local wisdom directly within experimental learning. For example, the Palembang module study focused on establishing validity and practicality before a broader classroom effectiveness trial, with local-wisdom relevance receiving an Aiken's V of 0.93. Therefore, the presence of local wisdom in a learning product should not automatically be interpreted as evidence that deeper cultural integration produces stronger learning outcomes.

4.4 Bibliometric Analysis

4.4.1 Publication Trends

The bibliometric analysis was conducted using the 300 unique records obtained from OpenAlex after the removal of duplicate records. In contrast to the systematic literature review,



which focused on the 13 studies that satisfied the full-text eligibility criteria, the bibliometric analysis retained the broader deduplicated search corpus to identify the development and publication patterns of research related to Problem-Based Learning, local wisdom, and physics or science education.

The publication distribution indicates a substantial increase in research activity during the most recent years. The earliest record in the deduplicated corpus was published in 2000, while the latest records were published in 2026. However, publication activity remained relatively limited before 2018. A noticeable increase began in 2023, followed by a substantial expansion in 2024 and 2025.

The largest number of records was identified in 2025, with 105 publications, representing approximately 35.0% of the 300-record corpus. In 2026, 57 records were identified, representing approximately 19.0%. By comparison, 2024 contributed 52 records (17.3%), while 2023 contributed 32 records (10.7%).

This pattern demonstrates that research related to PBL and culturally contextualized science or physics education has experienced a strong acceleration in recent years. The increase is particularly pronounced after 2022, suggesting that the integration of local wisdom, ethnoscience, ethnophysics, and problem-based learning has become an increasingly active research area.

Table 6. Annual Distribution of the OpenAlex Bibliometric Corpus

Year	Records	Percentage
2000	1	0.3%
2002	1	0.3%
2006	1	0.3%
2007	1	0.3%
2012	1	0.3%
2013	1	0.3%
2015	1	0.3%
2016	2	0.7%
2017	1	0.3%
2018	7	2.3%
2019	12	4.0%
2020	7	2.3%
2021	6	2.0%
2022	11	3.7%
2023	32	10.7%
2024	52	17.3%
2025	105	35.0%
2026	57	19.0%
Total	300	100%



The publication trend provides an important distinction between the bibliometric landscape and the systematic review evidence. Although the broader OpenAlex corpus contains 300 unique records, only 13 studies met the criteria for the primary SLR synthesis. Therefore, the high publication volume observed in recent years should not be interpreted as meaning that 105 studies specifically examined the exact combination of local wisdom-based PBL in physics with problem-solving and scientific attitude outcomes. Rather, it indicates the rapid expansion of the broader research landscape captured by the search strategy.

4.4.2 Author Productivity

The author analysis indicates that research in this area is distributed among a relatively broad group of researchers rather than being dominated by a single author. Within the 300-record deduplicated corpus, Gunawan Gunawan had the highest number of records, appearing in eight publications. Jeni Jeni appeared in five records, while I Gede Margunayasa and Josef de Beer each appeared in four records. Several other researchers appeared in three records.

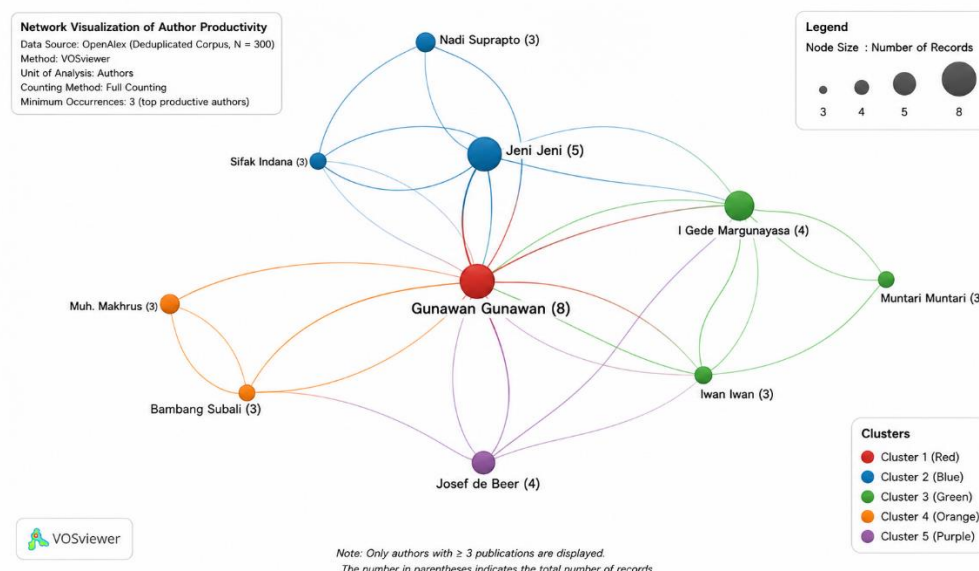


Figure 4. Most productive authors in the deduplicated OpenAlex corpus.

The author productivity pattern suggests that the field has not yet developed a single highly dominant research group. Instead, contributions appear to come from multiple researchers working across different educational and disciplinary contexts.



4.4.3 Citation Characteristics

The 300-record deduplicated corpus accumulated 1,029 citations based on the citation-count information available in the OpenAlex dataset. Citation counts were highly uneven, with a relatively small number of publications receiving substantially more citations than the majority of records.

This pattern is consistent with an emerging research field in which several foundational or broadly relevant PBL/local-wisdom studies attract greater scholarly attention, while many recent publications have had limited time to accumulate citations. This is particularly relevant because 105 records were published in 2025 and 57 in 2026; consequently, their citation counts should not be directly interpreted as indicators of research quality.

Table 7. Bibliometric Corpus Summary

Indicator	Result
Raw OpenAlex records	349
Unique records after deduplication	300
Publication period	2000–2026
Peak publication year	2025
Records in peak year	105
Total recorded citations	1,029

4.5 Summary of Findings

The systematic literature review of the 13 eligible studies demonstrates that local wisdom-based Problem-Based Learning (PBL) has been increasingly applied in physics education through diverse cultural contexts. Local wisdom was incorporated through traditional games, local transportation, cultural architecture, traditional practices, and local environmental phenomena. The reviewed studies predominantly focused on conceptual understanding, general learning outcomes, critical thinking, creative thinking, and scientific literacy, whereas explicit investigations of problem-solving skills and scientific attitudes were comparatively limited.

The bibliometric analysis of 300 deduplicated OpenAlex records further indicates a substantial increase in research activity in recent years. Publication activity increased particularly after 2022, with 2025 representing the peak year of the bibliometric corpus. The author analysis also indicates contributions from multiple researchers, suggesting that research on PBL and culturally contextualized physics or science education is expanding across different research groups.

Overall, the findings indicate that research on local wisdom-based PBL in physics education is developing rapidly, with increasing attention to culturally contextualized and digitally supported learning. The implications of these findings, including the interpretation of the observed trends, the position of problem-solving and scientific attitude within the existing literature, and potential directions for future research, are discussed in the following section.



5. Discussion

5.1 Development and Integration of Local Wisdom-Based Problem-Based Learning in Physics Education

The findings demonstrate that local wisdom-based Problem-Based Learning (PBL) has developed as a contextual approach for connecting physics concepts with students' cultural and everyday experiences. Across the reviewed studies, local wisdom was represented through traditional games, transportation, cultural architecture, environmental phenomena, and traditional practices. This pattern indicates that local wisdom is increasingly positioned as more than supplementary cultural information; it can function as a source of authentic problems through which students investigate and apply physics concepts. This perspective is consistent with culturally contextualized science education, which emphasizes the relationship between formal scientific knowledge and students' everyday cultural experiences (Aikenhead, 1996, 2006; Snively & Corsiglia, 2001).

This development is consistent with the broader literature on PBL in physics education. A systematic review of 36 empirical studies found that PBL in physics education was associated with improvements in academic achievement, problem-solving, critical and creative thinking, attitudes toward physics, and science-process skills (Nicholus et al., 2023). Previous meta-analytical research has likewise indicated that PBL can provide advantages in skill development and knowledge application (Dochy et al., 2003; Strobel & van Barneveld, 2009). The present review extends this perspective by showing that local wisdom can provide an additional contextual dimension to PBL, particularly by connecting physics problems with phenomena that are familiar to students.

The integration of local wisdom appears to be particularly meaningful when cultural phenomena become part of the problem situation itself. In the reviewed studies, examples such as *Becak Lawu*, *Engklek*, *Balogo*, *Jukung Barenteng*, and *Rumah Gadang* were connected to physics concepts and learning activities. The Sunarti et al. study, for example, found that students perceived ethnophysics-based learning as relevant to their social, cultural, and natural environments and reported greater confidence in applying physics to real-life problems (Sunarti et al., 2025). Similar integration has been reported in studies combining local wisdom with PBL, STEM, and digital learning materials (Siahaan et al., 2025; Zainuri et al., 2024).

The findings therefore suggest a distinction between surface contextualization and deep contextual integration. In surface contextualization, local wisdom is introduced as an example before students learn a physics concept. In deeper integration, the cultural phenomenon becomes the starting point for problem orientation, investigation, discussion, and solution development. The latter approach appears more consistent with the fundamental characteristics of PBL because students are required to construct and apply knowledge in response to an authentic problem (Barrows, 1986; Hmelo-Silver, 2004; Savery, 2006).



This direction is also visible in recent digital learning developments. The Ethno-STEM PBL e-module study integrated *Rumah Gadang* throughout the learning design and treated the cultural context as an organizing principle for connecting physics concepts with creative-thinking activities (Zainuri et al., 2024). Related research on local wisdom-based PBL has also demonstrated its potential for supporting scientific literacy and higher-order thinking (Berliana & Widiarti, 2026; Utami et al., 2026). Thus, the emerging trend is not simply PBL + local wisdom, but a more integrated combination of local culture, problem-based pedagogy, and digital learning resources.

5.2 Problem-Solving Skills and Scientific Attitudes as Emerging Outcomes

One of the most important findings of the present review is the uneven distribution of learning outcomes. The included studies predominantly examined conceptual understanding, general learning achievement, critical thinking, creative thinking, and scientific literacy. In comparison, problem-solving skills and scientific attitudes were considerably less frequently examined as explicit outcomes. This pattern is notable because problem solving represents one of the central competencies associated with PBL (Dochy et al., 2003; Nicholus et al., 2023).

The limited attention to problem-solving is noteworthy because problem solving is conceptually central to PBL. In physics education, effective problem solving requires students to understand and represent a problem, select an appropriate physics approach, apply relevant principles, and construct and evaluate solutions (Docktor et al., 2016). Students' attitudes and approaches toward problem solving may also influence how they engage with physics problems (Mason & Singh, 2016). More recent work emphasizes that becoming a proficient problem solver involves not only procedural knowledge but also appropriate reasoning, knowledge organization, and problem-solving strategies (Maries & Singh, 2023).

The broader physics education literature has also identified problem solving as an important and continuing research focus (Heldalia et al., 2025; Kiraga, 2023; Sukma et al., 2025). However, our review shows that problem-based learning activities and explicit measurement of problem-solving skills are not necessarily the same thing. Several studies in our corpus implemented PBL through problem orientation, investigation, discussion, and solution development but evaluated outcomes such as conceptual understanding or learning achievement instead of directly measuring problem-solving competency.

The study by Sunarti et al. (2025) provides particularly relevant evidence because problem-solving skills were explicitly operationalized as one of the principal constructs. The study examined the relationships among ethnophysics-integrated PBL tools, student engagement, problem-solving skills, and scientific literacy (Sunarti et al., 2025). The model explained 56.9%



of the variance in problem-solving skills and 47.7% of the variance in scientific literacy, suggesting that culturally contextualized PBL and student engagement have substantial explanatory potential.

The cultural component may be important because local wisdom provides students with a familiar context from which a physics problem can be represented. Students do not encounter physics exclusively as abstract equations; instead, they encounter physical principles through phenomena that have social or cultural meaning. This can potentially support the transition from understanding a physics concept to applying that concept in an authentic problem situation. This argument is consistent with culturally relevant approaches that position students' cultural experiences as meaningful resources for academic learning (Gay, 2018; Ladson-Billings, 1995).

Scientific attitude represents an even more evident gap. Although some studies in the corpus examined spiritual attitudes, social attitudes, curiosity, responsibility, collaboration, and other affective dimensions, these constructs should not automatically be classified as scientific attitude. Scientific attitude is a more specific construct related to students' dispositions toward scientific inquiry, evidence, and scientific reasoning (Gauld, 1982). Consequently, the current evidence does not yet establish a strong empirical relationship between local wisdom-based PBL and scientific attitude.

Nevertheless, evidence from the wider PBL literature suggests that PBL can influence students' attitudes toward science and learning (Nicholus et al., 2023). An experimental study specifically examining scientific attitude also reported improvements through PBL (Wibawa et al., 2023). In addition, recent research has emphasized the importance of systematic assessment and conceptual clarity when examining scientific attitudes among students (Sharma & Tripathy, 2025). These findings provide a theoretical and empirical basis for examining scientific attitude within local wisdom-based PBL, while our SLR indicates that this particular combination remains insufficiently investigated.

Therefore, the emerging research direction is to move from simply asking whether local wisdom-based PBL improves learning outcomes toward examining whether it develops specific scientific competencies, particularly problem-solving skills and scientific attitudes.

5.3 Methodological Implications and Future Research

The findings also reveal substantial methodological heterogeneity among the included studies. The corpus contains quasi-experimental studies, one-group pretest-posttest designs, PLS-SEM studies, research and development studies, validation studies, and needs analyses. This diversity reflects the developmental nature of the research field, but it also makes direct comparison of findings more difficult.



Development and validation studies are particularly useful for demonstrating the feasibility of local wisdom-based learning materials. However, evidence of validity or practicality should not be interpreted as evidence of effectiveness. This distinction is important because different research designs provide different levels and types of evidence. Consequently, the methodological diversity identified in the present review should be considered when interpreting the overall effectiveness of local wisdom-based PBL.

Future studies should therefore employ more rigorous and comparable designs when examining the effectiveness of local wisdom-based PBL. Quasi-experimental or experimental designs with control groups, clearly defined outcome constructs, validated instruments, and effect-size reporting would provide stronger evidence. This is particularly important for problem-solving and scientific attitude because both constructs require explicit operationalization rather than being inferred from general learning achievement (Docktor et al., 2016; Sharma & Tripathy, 2025). The future research direction can consequently be conceptualized as:

Local Wisdom → Authentic Physics Problem → PBL Investigation → Problem-Solving Skills + Scientific Attitude

In this framework, local wisdom functions as the culturally meaningful context for constructing authentic physics problems, while PBL provides the pedagogical process through which students investigate and solve those problems. Problem-solving represents the cognitive competency developed through the process, whereas scientific attitude represents the scientific disposition that may emerge through repeated engagement in inquiry, evidence-based reasoning, collaboration, and reflection.

However, this framework should be regarded as an emerging research direction rather than an established causal model. The present review provides evidence that local wisdom-based PBL can support various cognitive and affective outcomes, but the existing literature is not yet sufficient to establish that the approach simultaneously improves problem-solving skills and scientific attitudes. Future empirical studies should therefore test this relationship directly.

Overall, the contribution of the present review lies in identifying a shift in the field: from using local wisdom primarily to contextualize physics content toward using local wisdom as a structural component of problem-based scientific learning. This shift provides an opportunity for future research to investigate more specific and measurable scientific competencies rather than relying predominantly on general learning outcomes.



CONCLUSION

This systematic literature review and bibliometric analysis examined the development of local wisdom-based Problem-Based Learning (PBL) in physics education using OpenAlex as the bibliographic source. The systematic review identified 13 eligible full-text studies, while the bibliometric analysis examined 300 deduplicated records. The findings indicate a substantial increase in research activity in recent years, particularly from 2023 onward, demonstrating growing interest in the integration of PBL with local wisdom, ethnophysics, and culturally contextualized physics learning.

The systematic synthesis shows that local wisdom has been integrated into physics learning through diverse contexts, including traditional games, local transportation, cultural architecture, traditional practices, and local environmental phenomena. PBL combined with these contexts has been associated with improvements in conceptual understanding, learning outcomes, critical thinking, creative thinking, and scientific literacy. The findings also indicate an increasing movement toward deeper integration in which local wisdom functions not merely as an illustration but as an authentic context for identifying, investigating, and solving physics problems.

Despite these developments, the review identifies an uneven distribution of research outcomes. Problem-solving skills and scientific attitudes remain comparatively underexplored compared with conceptual understanding, higher-order thinking, and scientific literacy. In addition, the methodological heterogeneity of the existing studies—from development and validation research to quasi-experimental and structural modeling approaches—limits direct comparison across findings. Therefore, stronger empirical designs and explicit, validated measures of problem-solving and scientific attitude are needed.

Overall, local wisdom-based PBL represents a promising direction for physics education because it connects culturally meaningful experiences with scientific concepts and problem-oriented learning. Future research should move beyond demonstrating the feasibility of integrating local wisdom into PBL and investigate how different forms of cultural integration can systematically develop students' problem-solving skills and scientific attitudes. Such research may contribute to the development of physics learning that is not only conceptually meaningful but also culturally relevant and supportive of broader scientific competencies.



REFERENCES

- Aikenhead, G. S. (1996). Science Education: Border Crossing into the Subculture of Science. *Studies in Science Education*, 27(1), 1–52. <https://doi.org/10.1080/03057269608560077>
- Aikenhead, G. S. (2006). *Science Education for Everyday Life: Evidence-Based Practice*. Teachers College Press.
- Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11(4), 959–975. <https://doi.org/10.1016/j.joi.2017.08.007>
- Arifin, A. A., Ramdani, A., Jufri, A. W., & Rahayu, S. (2026). Trends in Scientific Attitude Research in Science Education, 2016–2025: A Bibliometric Analysis and Systematic Literature Review. *Lambda: Jurnal Ilmiah Pendidikan MIPA Dan Aplikasinya*, 6(1), 273–290. <https://doi.org/10.58218/lambda.v6i1.2767>
- Barrows, H. S. (1986). A Taxonomy of Problem-Based Learning Methods. *Medical Education*, 20(6), 481–486. <https://doi.org/10.1111/j.1365-2923.1986.tb01386.x>
- Berliana, H., & Widiarti, N. (2026). Pengembangan E-Modul Interaktif Berbasis Local Wisdom dan Problem Based Learning untuk Meningkatkan Berpikir Kritis Siswa SD. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 11(1), 32–51. <https://doi.org/10.23969/jp.v11i01.41539>
- Dochy, F., Segers, M., den Bossche, P., & Gijbels, D. (2003). Effects of Problem-Based Learning: A Meta-Analysis. *Learning and Instruction*, 13(5), 533–568. [https://doi.org/10.1016/S0959-4752\(02\)00025-7](https://doi.org/10.1016/S0959-4752(02)00025-7)
- Docktor, J. L., Dornfeld, J., Frodermann, E., Heller, K., Hsu, L., Jackson, K. A., Mason, A., Ryan, Q. X., & Yang, J. (2016). Assessing Student Written Problem Solutions: A Problem-Solving Rubric with Application to Introductory Physics. *Physical Review Physics Education Research*, 12(1), 10130. <https://doi.org/10.1103/PhysRevPhysEducRes.12.010130>
- Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133, 285–296. <https://doi.org/10.1016/j.jbusres.2021.04.070>
- Gauld, C. (1982). The Scientific Attitude and Science Education: A Critical Reappraisal. *Science Education*, 66(1), 109–121. <https://doi.org/10.1002/sce.3730660113>
- Gay, G. (2018). *Culturally Responsive Teaching: Theory, Research, and Practice* (3rd ed.). Teachers College Press.
- Heldalia, Kuswanto, H., & Salim, E. (2025). Systematic Literature Review: Problem-Solving Skills in Physics Learning. *Jurnal Penelitian Pendidikan IPA*, 11(3), 50–57. <https://doi.org/10.29303/jppipa.v11i3.10235>
- Hmelo-Silver, C. E. (2004). Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review*, 16(3), 235–266. <https://doi.org/10.1023/B:EDPR.0000034022.16470.f3>



- Kiraga, F. (2023). A Study of Problem Solving in Physics Learning: A Systematic Review. *EduFisika: Jurnal Pendidikan Fisika*, 8(3), 303–315. <https://doi.org/10.59052/edufisika.v8i3.29446>
- Ladson-Billings, G. (1995). Toward a Theory of Culturally Relevant Pedagogy. *American Educational Research Journal*, 32(3), 465–491. <https://doi.org/10.3102/00028312032003465>
- Maries, A., & Singh, C. (2023). Helping Students Become Proficient Problem Solvers Part I: A Brief Review. *Education Sciences*, 13(2), 156. <https://doi.org/10.3390/educsci13020156>
- Mason, A. J., & Singh, C. (2016). Surveying College Introductory Physics Students' Attitudes and Approaches to Problem Solving. *European Journal of Physics*, 37(5), 55704. <https://doi.org/10.1088/0143-0807/37/5/055704>
- Nicholus, G., Muwonge, C. M., & Nzabahimana, J. (2023). The Role of Problem-Based Learning Approach in Teaching and Learning Physics: A Systematic Literature Review. *F1000Research*, 12, 951. <https://doi.org/10.12688/f1000research.136339.2>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- Priem, J., Piwowar, H., & Orr, R. (2022). OpenAlex: A fully-open index of scholarly works, authors, venues, institutions, and concepts. *ArXiv*. <https://doi.org/10.48550/arXiv.2205.01833>
- Sabarrini, M. A., Sari, I., & Ramalis, T. R. (2023). Problem Based Learning in Physics Education: A Systematic Literature Review. *Prosiding Seminar Nasional Fisika Dan International Physics Seminar*.
- Savery, J. R. (2006). Overview of Problem-based Learning: Definitions and Distinctions. *Interdisciplinary Journal of Problem-Based Learning*, 1(1), 9–20. <https://doi.org/10.7771/1541-5015.1002>
- Sharma, A., & Tripathy, P. (2025). A Review on Assessment of Scientific Attitudes of School Students: A Case Study of Indonesia. *Journal of Scientific Temper*, 13(1), 5–24. <https://doi.org/10.56042/jst.v13i1.13975>
- Siahaan, A. A., Pathoni, H., & Nurhatmi, J. (2025). STEM-Integrated Problem-Based Learning with Local Wisdom (Gong Buleuh): Impact on Student Learning Outcomes. *Physics and Science Education Journal*, 5(1), 10–23. <https://doi.org/10.30631/psej.v5i1.3040>
- Snively, G., & Corsiglia, J. (2001). Discovering Indigenous Science: Implications for Science Education. *Science Education*, 85(1), 6–34. [https://doi.org/10.1002/1098-237X\(200101\)85:1<6::AID-SCE3>3.0.CO;2-R](https://doi.org/10.1002/1098-237X(200101)85:1<6::AID-SCE3>3.0.CO;2-R)
- Strobel, J., & van Barneveld, A. (2009). When Is PBL More Effective? A Meta-Synthesis of Meta-Analyses Comparing PBL to Conventional Classrooms. *Interdisciplinary Journal of Problem-Based Learning*, 3(1), 44–58. <https://doi.org/10.7771/1541-5015.1046>



- Sukma, M. D. A., Dhiarni, Y. I., Kusniati, R., Wiyatmo, Y., & Kuswanto, H. (2025). Systematic Literature Review: Analysis of Problem-Solving Skill Trends in Physics Education (2014–2024). *Jurnal Riset Dan Kajian Pendidikan Fisika*, 12(1), 41–49. <https://doi.org/10.12928/jrkpf.v12i1.1145>
- Sunarti, T., Suprpto, N., Hidaayatullaah, H. N., Suliyanah, Admoko, S., & Jauhariyah, M. N. R. (2025). Evaluating Student Responses to Ethnophysics Learning: Improving Scientific Literacy and Problem-Solving Skills Using a PLS-SEM Approach. *Multidisciplinary Science Journal*, 7(10), e2025454. <https://doi.org/10.31893/multiscience.2025454>
- Utami, H. C., Rahayu, Y. S., & Indana, S. (2026). The Effectiveness of Problem Based Learning Integrated with Local Wisdom in Enhancing Students' Scientific Literacy: A Systematic Literature Review. *Jurnal Penelitian Pendidikan IPA*, 12(5), 123–136. <https://doi.org/10.29303/jppipa.v12i5.14792>
- van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2), 523–538. <https://doi.org/10.1007/s11192-009-0146-3>
- van Eck, N. J., & Waltman, L. (2011). Text mining and visualization using VOSviewer. *ISSI Newsletter*, 7(3), 50–54.
- Wibawa, I. M. C., Susanta, I. W., Parmithi, N. N., & Mahendra, I. W. E. (2023). Improving the Scientific Attitude of Elementary School Students Through Problem-Based Learning. *MIMBAR PGSD Undiksha*, 11(1), 18–23. <https://doi.org/10.23887/jjpgsd.v11i1.61884>
- Zainuri, B. N. S., Gunawan, G., & Kosim, K. (2024). Local Wisdom Integration in Problem-Based Learning E-Modules: Impact on Science Literacy and Science Process Skills. *Indonesian Journal of STEM Education*, 6(1), 1–8.