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Review Article

Implementation of PjBL-field study to improve science process skills and environmental awareness: A review

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Abstract: Science education continues to face persistent challenges due to the limited application of contextual instructional approaches and insufficient integration with students' real-life experiences. This study employed a Systematic Literature Review guided by the PRISMA framework. Data were retrieved from the Scopus database using Publish or Perish with five query combinations, yielding 134 records after duplicate removal, of which 19 met the criteria for in-depth synthesis. Bibliometric analysis using VOSviewer was conducted to map research trends and thematic relationships. Across the included studies, Project-Based Learning (PjBL) was the more frequently represented approach and was commonly associated with reported gains in Science Process Skills (SPS), whereas outdoor or field-based learning was associated with contextual engagement and environmental-awareness outcomes. However, the evidence base was heterogeneous in research design, participants, and outcomes, and most studies examined these strands separately. The bibliometric maps likewise indicated limited thematic proximity between PjBL and outdoor learning, while SPS did not emerge as a dominant keyword. Accordingly, this review does not estimate pooled causal effectiveness; instead, it identifies a fragmented evidence base and a design opportunity to investigate PjBL-field study integration supported by digital scaffolds such as E-LKPD, particularly in biodiversity learning. This proposition requires empirical validation.

Keywords: Project-Based Learning; Field Study; Outdoor Learning; Science Process Skills; Environmental Awareness

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INTRODUCTION

The transformation of competency standards in schools now places scientific analysis skills and environmental sensitivity as the top priorities for student learning outcomes. In order to achieve this, mastery of Science Process Skills (SPS) is one of the important prerequisites because of its strategic function in facilitating the exploration of scientific phenomena, starting from the observation stage to data interpretation and communicating research results (Restiana & Djukri, 2021).

Several studies show that students' science process skills are still relatively low due to the dominance of learning oriented to cognitive aspects, less use of the environment to support learning and less involvement in direct scientific activities (Aulia et al., 2018; Pintubatu, 2023; Restiana & Djukri, 2021). This condition shows the need to develop a

learning approach that is able to train science process skills through contextual and meaningful learning experiences.

On the other hand, global environmental problems such as climate change, ecosystem damage, and biodiversity loss increasingly demand the strengthening of environmental education in learning. Education has a strategic role in shaping environmental care attitude (Environmental Awareness) as the basis for students' pro-environmental behavior (Ghazali et al., 2025). Environmental awareness is not only related to knowledge, but also includes attitudes, values, and concrete actions in maintaining environmental sustainability (A. M. Wibowo et al., 2024). The implementation of environmental edu-cation in schools still faces various obstacles, such as the limitations of contextual learning methods and the lack of integration with the real experience of students (Ghazali et al., 2025). This emphasizes the importance of learning innovations that are able to integrate direct experience with the context of students' lives.

One of the learning approaches that is considered effective in answering these challenges is Project-Based Learning (PjBL**)**. PjBL is a constructivism-based learning model that emphasizes the active involvement of students in solving real problems through projects, so as to improve critical thinking, collaboration, and science process skills (Bhakti et al., 2020).

Project-Based Learning (PjBL**)** is a model that is relevant to 21st century learning applied through the implementation of the Merdeka curriculum. This learning model provides opportunities for students to be able to collaborate and have the ability to plan and provide solutions related to a problem through a project-based learning program (Alhayat et al., 2023). In another study, PjBL also had a positive and significant effect on the creativity of fifth grade students in science learning (Siswandari et al., 2025).

Various studies have shown that PjBL has been proven to be effective in improving psychomotor skills and concept understanding through project-based activities and practicums (Sumarni et al., 2016). PjBL can significantly improve SPS, learning outcomes, and student motivation because it provides an authentic and meaningful learning experience (Andriyani et al., 2019). PjBL has also been proven to be able to increase students' environmental awareness through involvement in projects related to real environmental problems (Xi & Wang, 2022).

In addition to PjBL, Outdoor Learning or Field Study also has substantial potential to improve the quality of science learning. The school environment is a learning resource that can be utilized through hands-on experience. There are many potential objects that can be observed and used as a learning resource outside the classroom so that learning can be more meaningful and thus it is hoped that students can achieve better learning outcomes (Sari & Paidi, 2018).

Environment-based learning provides opportunities for students to interact directly with real objects, so that they can strengthen their understanding of concepts while forming an attitude of caring for the environment. An out-of-classroom environment provides learning experiences that cannot be obtained in the classroom, such as exploration, hands-on observation, and experiential learning (Trina et al., 2026).

Environment-based learning can significantly increase student involvement, scientific thinking skills, and ecological awareness. Research shows that science learning carried out outside the classroom allows students to observe natural phenomena directly so that they can support the understanding of science concepts in a more real and fun way. Outdoor learning has been reported to enrich learning experiences and

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support students' science skills (Sisi & Parisu, 2025). In addition, environment-based learning has also been reported to connect science concepts with real-life contexts and support science process skills (Rahimanisa et al., 2025).

Conceptually, PjBL and Outdoor Learning (Field Study) provide complementary learning affordances. PjBL structures inquiry around authentic problems and projects that require planning, observation or experimentation, data interpretation, problem solving, and communication, processes that align closely with SPS (Andriyani et al., 2019; Bhakti et al., 2020). Field study, in contrast, places those inquiry processes in direct contact with environmental phenomena and real settings, creating contextual expe-riences that can support environmental awareness and pro-environmental mean-ing-making (Rahmawati et al., 2020a; Sari & Paidi, 2018; A. M. Wibowo et al., 2024). Their integration is therefore not merely the combination of two teaching strategies: the project structure can organize the scientific inquiry process, while the outdoor context can provide authentic objects of investigation and environmental relevance.

Digital or worksheet-based scaffolds may help operationalize this integration by sequencing project tasks, field observations, data recording, interpretation, and ref-lection. Existing LKPD studies have reported support for students' science process skills, including in biodiversity learning (Izzaturrohmah et al., 2018; Pramaditya & Ambarwati, 2020). Nevertheless, these studies do not by themselves establish the effectiveness of an E-LKPD that integrates PjBL with field study and environmental-awareness outcomes.

Taken together, the literature suggests a plausible conceptual connection among project-based inquiry, authentic environmental experience, SPS, and environmental awareness; however, the available evidence is dispersed across different research strands and methodological designs.

A systematic review is therefore needed because the evidence is fragmented: studies of PjBL commonly emphasize SPS or other cognitive-process outcomes, whereas out-door or field-based studies more often emphasize contextual experience, engagement, or environmental outcomes. Without a structured synthesis, it remains unclear how often these strands intersect, what methodological patterns characterize the evidence, and whether digital scaffolds such as E-LKPD have been used to support their integration. The review is thus intended to map and synthesize the evidence base rather than to produce a pooled estimate of causal effectiveness.

Therefore, this study aims to conduct a Systematic Literature Review (SLR) to map publication and thematic trends, synthesize the reported learning outcomes associated with PjBL and outdoor learning (field study), examine how the two approaches have been connected in science education, and identify evidence gaps relevant to future learning-design research. The review also considers whether the literature provides a defensible basis for proposing digital support such as E-LKPD as a future design direction, without treating that proposal as evidence of effectiveness.

In particular, this study is directed to answer the following research questions: (1) What publication and thematic trends characterize the literature on PjBL and outdoor learning in science education?; (2) What patterns of reported SPS outcomes are asso-ciated with PjBL in the included studies?; (3) What patterns of reported environmental-awareness outcomes are associated with outdoor learning or field study?; (4) How, and to what extent, have PjBL and outdoor or field-based learning been integrated in the included literature?; and (5) What evidence gaps and learning-design implications, including the possible role of E-LKPD, emerge from the synthesis?

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METHODS

This study uses the Systematic Literature Review (SLR) method to identify, organize, and synthesize research related to Outdoor Learning (field study), Project-Based Learning, science process skills, and environmental awareness. The purpose of the SLR is evidence mapping and narrative synthesis; it is not a meta-analysis and does not estimate a pooled effect size. The research data were obtained from the Scopus database through the Publish or Perish (PoP) application using five keyword combinations designed to cover the main variables of the review. The term “outdoor learning” was used as a broad retrieval term and was subsequently interpreted in relation to field-study activities within science and biology education.

The combination of keywords used are as follows: (1) "science process skills" AND "project-based learning"; (2) "project-based learning" AND "environmental awareness" AND "education"; (3) "field study" AND "science education"; (4) "outdoor learning" AND "science learning"; (5) "project-based learning" AND "field study" OR "outdoor learning". The search covered publications from 2016 through the database-retrieval period in 2026. Because 2026 was an incomplete publication year at the time of retrieval, records from 2026 are treated as partial-year data rather than as a complete annual output.

The determination of articles to be analyzed in this study is carried out through the systematic application of inclusion and exclusion criteria presented in Table 1.

Table 1. Inclusion-Exclusion Criteria

Aspects	Inclusion Criteria	Exclusion Criteria
Year of Publication	2016–2026 (2026 partial at search date)	Under 2016
Publication Type	Scopus indexed scientific journal articles	Books, book chapters, non-indexed proceedings, conceptual articles, conference reviews
Field of Study	Science, biology, or environmental education	Pure biology, ecology, or non-educational fields
Research Topics	Discussing PjBL, outdoor learning or field study, science process skills, environmental care attitude	Not discussing the main variables of the study
Research Subject	Students (elementary, junior high, high school, or equivalent), students	Non-educational or irrelevant subjects
Language	English	Other than English
Research Methods	Empirical research (experimental, quasi-experimental, mixed methods, survey), R&D, SLR	Articles with no obvious method or only conceptual
Data Availability	Full-text available	Full-text not available

The article selection process was carried out using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach, including identification, screening, eligibility, and inclusion. At identification, 136 records were obtained from Scopus. After removing 2 duplicates, 134 records remained. Screening of title, document type, and data availability excluded 79 records, leaving 55 full-text articles for eligibility assessment. At full-text review, 36 articles were excluded because they met one or more exclusion conditions, including absence of a clear method, absence of empirical results, topic mismatch with the review variables, or lack of direct relevance to the research questions. The original screening record retained the aggregate full-text exclusion total (n=36) but did not retain mutually exclusive counts for each individual reason; therefore, per-reason counts were not reconstructed retrospectively. Nine-

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teen articles met all criteria and were included in the narrative synthesis. The selection process is visualized in Figure 1.

Data analysis was carried out through structured descriptive coding and narrative synthesis. Articles were grouped by learning approach (PjBL, field study, outdoor learning), research design, participant group, outcome variable (including SPS and environmental awareness), and reported findings. Cross-study similarities and differences were then compared to identify recurring evidence patterns and research gaps. Because the included studies were heterogeneous in design, participants, outcome measures, and analytical procedures, no pooled effect size or statistical meta-analysis was performed; consequently, the synthesis concerns patterns of reported findings rather than a single causal estimate.

In addition to the SLR, bibliometric mapping was conducted using VOSviewer to display (1) network visualization, (2) density visualization, and (3) overlay visualization of topic development. The maps were interpreted descriptively in terms of node prominence, link patterns, cluster proximity, density, and average publication-year color. Because numerical centrality or total-link-strength values were not exported for this manuscript, the visualization is not treated as a statistical test of dominance.

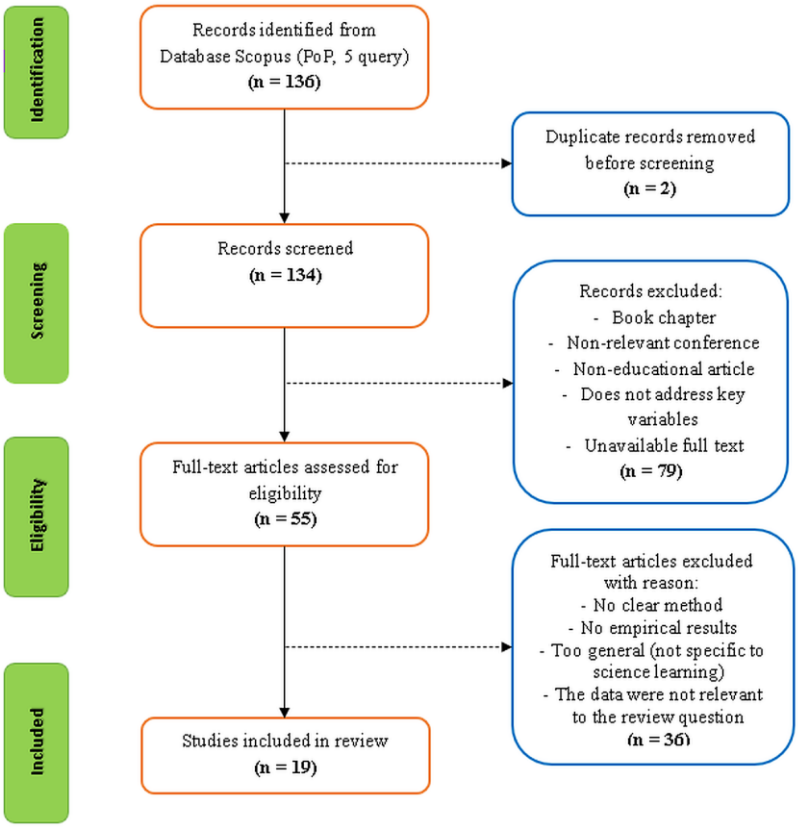


Figure 1. PRISMA Flowchart

RESULTS AND DISCUSSION

Results

Research Trends and Topic Development

Based on the 134 records retrieved through the defined search strategy after duplicate removal, the publication-year distribution fluctuated across the search window. Publications were relatively stable in 2016–2017, increased through 2020, fluctuated thereafter, and reached the highest retrieved count in 2025. These values describe the

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records captured by this review strategy and should not be interpreted as the total global production of research on PjBL or outdoor learning.

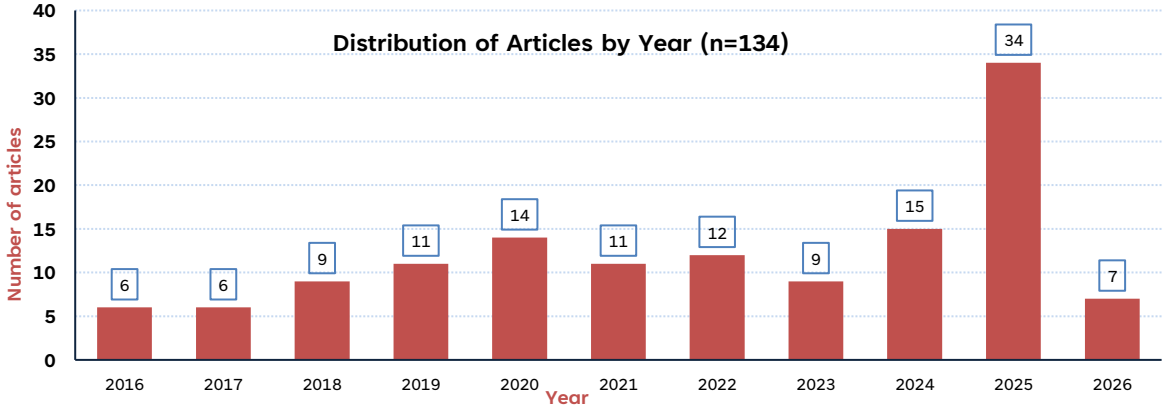


Figure 2. Distribution of records retrieved through the review search strategy by publication year (n=134)

Within the retrieved dataset, 2025 contained the highest number of records (n=34), compared with 15 records in 2024. The 2026 bar (n=7) represents only records available up to the retrieval period and is therefore partial-year coverage. The pattern suggests increasing representation of project-based and environment-related learning within this search set, but it does not establish a global publication trend.

In addition to publication counts, topic development was examined through VOS-viewer overlay visualization. The color scale represents the average publication year of each term rather than the full temporal span of all retrieved records. Terms such as environmental awareness and project-based learning appear toward the more recent end of the mapped keyword spectrum, indicating relatively recent attention within the network.

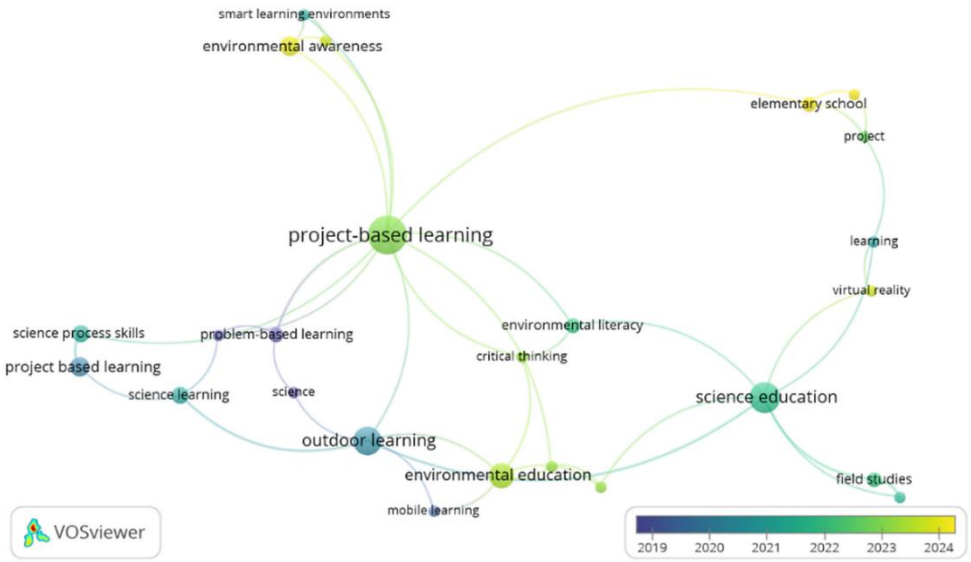


Figure 3. Research trend visualization overlay

As shown in Figure 3, warmer colors identify terms with more recent average publication years in the VOSviewer map. Environmental awareness appears among the relatively recent terms and is connected to project-based learning. This pattern is interpreted as a thematic-development signal within the retrieved corpus, not as proof that these topics dominate all contemporary science-education research (Wibowo et al., 2024).

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Analysis (VOSviewer)

The network visualization places project-based learning as a visually prominent node connected with terms such as science education, outdoor learning, and environmental awareness. This visual prominence is interpreted descriptively because numerical centrality metrics were not used in the present analysis.

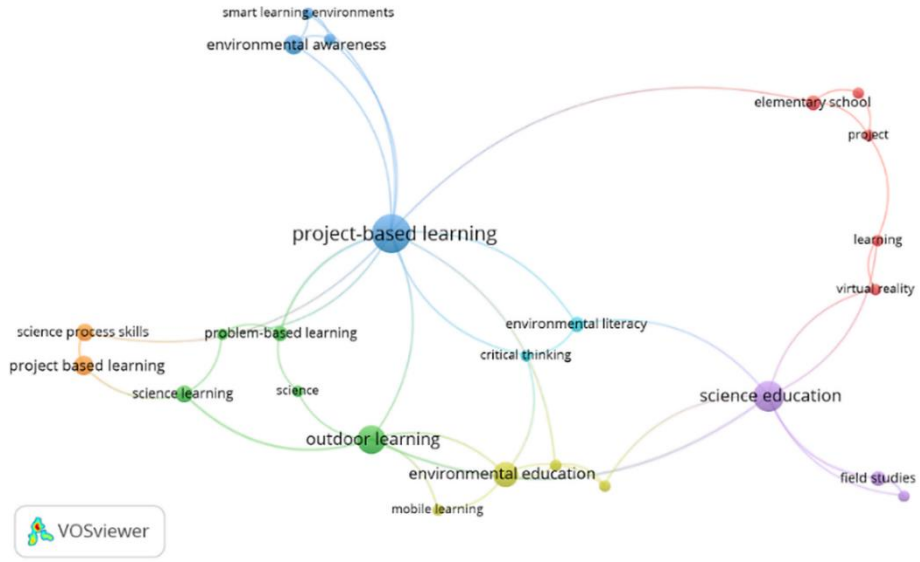


Figure 4. Network visualization of the relevance of research topics

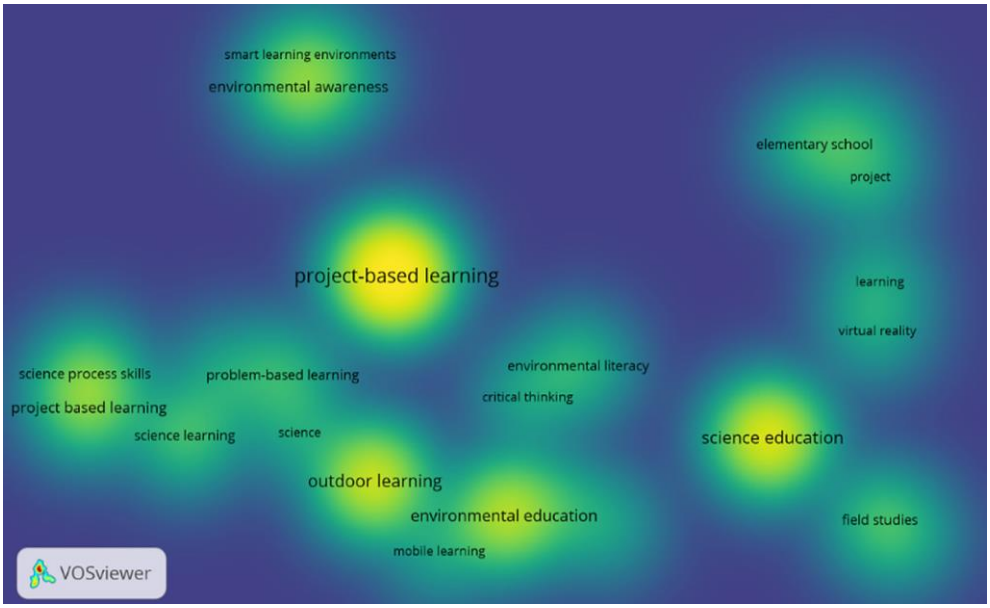


Figure 5. Density visualization of research topics

As shown in Figure 4, PjBL occupies a prominent position in the network and connects several thematic areas. This visual pattern is consistent with the structured SLR coding, in which 13 of the 19 included articles (68.4%) discussed PjBL as a principal or integrated approach. Accordingly, the manuscript refers to PjBL as prominent in this review corpus rather than claiming statistically quantified network dominance. The pattern is also conceptually compatible with PjBL characteristics that emphasize authentic problems, investigation, collaboration, and project activity (Firdausih & Aslan, 2024; Asmara et al., 2025).

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Furthermore, the density visualization presented in Figure 5 shows the level of research density on a particular topic. In the VOSviewer density display (Figure 5), project-based learning and science education are located in the visually denser areas of the map, whereas outdoor learning and environmental awareness appear in less dense but connected areas. This result should be read as a visualization of the retrieved corpus, not as a population-level measure of research importance. It is consistent with the review matrix showing greater representation of PjBL-oriented studies than outdoor-learning studies.

Analysis of 19 articles with the PRISMA Approach

The results of data analysis of 19 articles obtained through the selection process using the PRISMA approach can be seen in Table 2. Analysis of the 19 articles in Table 2 shows that PjBL is the most frequently represented approach in the included synthesis. Thirteen of 19 articles (68.4%) discussed PjBL either as the principal model or in combination with another element.

Outdoor learning or field-study topics were represented in 5 of 19 articles (26.3%), while one additional article (5.3%) reviewed several learning models for SPS, including PjBL (Restiana & Djukri, 2021). These proportions are descriptive characteristics of the included set and do not represent prevalence in the entire international literature.

Discussion

RQ 1: Publication and thematic trends in PjBL and Outdoor Learning (Field Study)

The retrieved records show a fluctuating publication pattern with a marked concentration in 2025, while 2026 is only partially covered. This pattern should be interpreted as a characteristic of the review search results rather than as a census of global research production. When read together with the overlay map, it suggests that contextual, experiential, and environment-related themes have become increasingly visible within the corpus (Ghazali et al., 2025; R. A. Wibowo et al., 2020).

The overlay visualization (Figure 3) adds a thematic dimension to the year-count pattern: environmental awareness and project-based learning are located toward the relatively recent end of the average-publication-year scale. This does not establish causation or universal research priority, but it indicates that sustainability-related and project-oriented terms are temporally salient within the mapped dataset (Xi & Wang, 2022).

Across the corpus, PjBL and environmental-awareness themes intersect because projects can situate scientific inquiry in authentic environmental problems. However, the review distinguishes conceptual complementarity from empirical integration: many PjBL studies primarily report SPS, creativity, or learning outcomes, whereas environmental-awareness outcomes are more often linked to environmental or contextual learning. This separation is central to the research gap identified by the review.

Figure 4 places project-based learning as a visually prominent node linked with science education, outdoor learning, and environmental awareness. This pattern is interpreted descriptively rather than as a formal centrality test. It is consistent with the review matrix, in which 13 of 19 included articles are PjBL-oriented, and it suggests that PjBL functions as a thematic bridge within this retrieved corpus (Baran et al., 2021; Bhakti et al., 2020).

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Table 2. Matrix of Results Analysis 19 articles

Num	Author (Year)	Country	Research Design	Sample	Variable	Key Results
1.	Baran et al. (2021)	Turkey	Pre-experiment	24 high school students	PjBL-STEM → skills	Improving 21st century skills & awareness
2.	Rusmini et al. (2021)	Indonesia	Pre-experiment	94 students	PjBL → SPS	SPS good category, positive response
3.	Rohman et al. (2019)	Indonesia	Experiments (practical observations)	Physics students	PjBL + technology → SPS	Tracker-based PjBL improves SPS & innovation skills
4.	Sekarini & Arty (2019)	Indonesia	Experiments	Students	Outdoor learning → curiosity	Outdoor learning increases students' curiosity
5.	Bhakti et al. (2020)	Indonesia	Experiments	Students	STEM-PjBL → SPS	PjBL-STEM increases SPS
6.	Cotič et al. (2020)	Slovenia	Experiments	192 elementary school students	Outdoor learning → learning outcomes	Outdoor learning significantly improves learning outcomes
7.	Putri & Wulandari (2024)	Indonesia	Quasi experiment	±61 elementary school students	Outdoor-PjBL	Significantly improve school well-being
8.	Riyanti et al. (2025)	Indonesia	Quasi experiment	High School Students	PjBL → SPS & awareness	PjBL significantly increases SPS & awareness
9.	Agustira et al. (2025)	Indonesia	R&D + experiments	Junior High School Students	PjBL → environmental literacy	PjBL improves environmental literacy & HOTS
10.	Tarigan et al. (2025)	Indonesia	R&D + quasi-experiment	College Students	PjBL+ technology	Increase creativity & contextual learning
11.	Nuraini & Muliawan (2020)	Indonesia	R&D (needs analysis)	Junior High School Teacher	PjBL → SPS	Project-based learning design required for SPS
12.	Ariffin et al. (2022)	Malaysia	R&D (ADDIE)	Members & learners	PjBL Module	Modules are valid (92–97%) & support SPS
13.	Giyono et al. (2026)	Indonesia	Qualitative study (case study)	Students & community	Local wisdom → awareness	Raising environmental awareness through local culture
14.	Rahmawati et al. (2020)	Indonesia	Case study	70 students	Outdoor learning	Field trips enhance learning & interaction experience
15.	(Amalia et al. 2024)	Indonesia	Literature review	Article	PjBL → Creative Thinking and Collaboration Skills	Students' Creative Thinking and Collaboration Skills can develop through the application of PjBL
16.	Andriyani et al. (2019)	Indonesia/ Japan	Literature review	Article	PjBL → SPS	PjBL is effective in increasing SPS
17.	Sari & Paidi (2018)	Indonesia	Meta-analysis	Literature	Outdoor learning	Potential school environment as a source of hands-on learning
18.	Restiana & Djukri (2021)	Indonesia	Meta-analysis	Article	learning model → SPS	PjBL is an effective model for increasing SPS
19.	Wibowo et al. (2024)	Indonesia	Correlation	114 college students	PjBL → awareness	Collaboration & critical thinking affects awareness

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Density visualization (Figure 5) likewise shows greater visual concentration around project-based learning and science education than around outdoor learning and environmental awareness. The difference in density is treated as a descriptive feature of the mapped corpus, not as proof of greater effectiveness or global research dominance. Together with the article counts, it reinforces the conclusion that PjBL is more frequently represented, while environment-oriented themes remain less densely connected and are still developing (Kurniawan & Wahyuningsih, 2025; Rahimanisa et al., 2025).

Environmental-awareness terms nevertheless appear as a developing area, indicating increasing attention to affective and sustainability-oriented outcomes. The important point for this review is not that one strand is superior to another, but that the two strands address complementary learning outcomes and are not yet consistently studied within the same instructional design.

RQ 2: Reported SPS outcomes associated with PjBL

Table 2 shows that PjBL is frequently examined in relation to SPS and related process outcomes. The included evidence spans pre-experimental, experimental, quasi-experimental, R&D, correlational, and review designs; therefore, the studies do not provide a single comparable effect estimate. Instead, the narrative synthesis examines whether reported findings converge across differing designs.

Several included studies report improvement in SPS-related activities such as observation, experimentation, problem solving, and scientific inquiry under PjBL conditions (Bhakti et al., 2020; Rusmini et al., 2021). Technology-supported PjBL studies also report gains in creativity or innovation-related outcomes (Fajaruddin et al., 2024; Rohman et al., 2019; Tarigan et al., 2025). These findings indicate a recurring positive pattern, but the present review does not pool effect sizes and therefore does not quantify the magnitude of PjBL effectiveness.

The recurring mechanism proposed across studies is that authentic project tasks require students to formulate problems, plan procedures, observe or test phenomena, interpret evidence, and communicate products or conclusions. These activities are conceptually aligned with SPS and help explain why SPS-related outcomes recur in PjBL studies (Baran et al., 2021; Sumarni et al., 2016).

RQ 3: Reported environmental-awareness outcomes associated with Outdoor Learning (Field Study)

The included outdoor-learning and field-study literature reports that direct interaction with environmental settings can support curiosity, contextual engagement, and environmental meaning-making. Field experiences allow learners to observe real phenomena and connect scientific concepts with places and environmental conditions that are difficult to reproduce in the classroom (Rahmawati et al., 2020a; Sekarini & Arty, 2019).

Some studies in the corpus report positive environmental-awareness outcomes when project or environmental contexts are used (A. M. Wibowo et al., 2024). Nevertheless, field-based learning also involves implementation constraints, including time, logistics, and teacher readiness (Cotič et al., 2020). Thus, the evidence supports a plausible contextual contribution of outdoor learning, but it should not be interpreted as a pooled causal estimate of its effect on environmental awareness.

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RQ 4: Integration between PjBL and Field Study

Although PjBL and outdoor learning share an emphasis on active and authentic learning, explicit integration of the two approaches remains limited in the included corpus. Figure 4 and Figure 5 show related but not tightly overlapping thematic areas, and the review matrix likewise contains relatively few studies in which project structure and outdoor or field-based experience are examined together.

The available integrated or environment-oriented project studies suggest a complementary mechanism: PjBL can structure the sequence of inquiry and production, while field contexts provide authentic objects, data, and environmental problems for investigation. Studies such as Hamdani et al. (2024); Rahimanisa et al. (2025); and Riyanti et al. (2025), report positive learning, SPS, or environmental-related outcomes in designs that connect projects with outdoor or environmental contexts. These results are promising but remain too heterogeneous for a pooled statement of simultaneous effectiveness.

Project-based learning linked to environmental issues has also been reported to increase student involvement with real environmental problems (Jumaidin et al., 2025). Taken together, this evidence supports the conceptual rationale for integration, while the small and methodologically varied integrated evidence base supports the need for further empirical testing rather than a definitive effectiveness claim.

Cross-study synthesis, heterogeneity, and evidence limitations

Across the 19 included studies, methodological heterogeneity was substantial: ten studies included experimental or quasi-experimental components (including R&D studies with intervention testing), four were literature reviews or meta-analyses, two were stand-alone R&D or needs-analysis studies, two were qualitative or case studies, and one was correlational. Participants also ranged from elementary-school pupils to university students and teachers across several national contexts. These differences in design, sample, outcome, and measurement preclude direct pooled comparison and weaken causal generalization across the corpus. The review therefore treats convergence of reported findings as an evidence pattern rather than as a pooled estimate of effect.

A formal risk-of-bias or critical-appraisal instrument was not applied to this methodologically diverse corpus. Accordingly, stronger causal interpretations are limited to the design of individual controlled studies, whereas findings from pre-experimental, correlational, R&D, qualitative, and review studies are treated as contextual or supportive evidence. This is a limitation of the present review and should be addressed in future updates with design-appropriate quality appraisal.

RQ 5: Research gap and implications for E-LKPD

Triangulation of the review matrix with the bibliometric maps identifies two defensible gaps. First, PjBL/SPS and outdoor-learning/environmental-awareness research are more often developed as separate strands than as a single integrated instructional design. Second, digital scaffolding is only weakly represented in the included evidence, even though project and field activities require structured guidance for task sequencing, observation, data recording, analysis, and reflection. These gaps are derived from the pattern of the included studies; they do not demonstrate that any specific digital medium is already effective.

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Existing LKPD studies show that worksheet-based designs can support structured SPS activities, including in biodiversity learning (Izzaturrohmah et al., 2018; Pramaditya & Ambarwati, 2020). However, the corpus does not provide direct evidence that an E-LKPD integrating PjBL, field study, SPS, and environmental awareness is effective. Therefore, E-LKPD is proposed here as a research-informed design implication and testable development direction, not as an established outcome of the review. The novelty of this review lies in connecting the two previously dispersed evidence strands and using their convergence to formulate an explicit, empirically testable integration proposition for future science-learning research.

CONCLUSION

Based on the systematic synthesis of 19 included articles from 134 retrieved records, PjBL was the most frequently represented approach and was repeatedly associated with reported SPS-related outcomes, whereas outdoor or field-based learning was associated with contextual engagement and environmental-awareness outcomes. The review also indicates that explicit integration of these two strands remains limited. Because the included studies are heterogeneous and no pooled effect-size analysis or formal risk-of-bias appraisal was conducted, these findings should be interpreted as patterns in the reported evidence rather than as a single estimate of causal effectiveness.

Digital scaffolds such as E-LKPD are not yet well represented in the integrated PjBL-field study evidence identified by this review. Accordingly, the principal contribution of the review is to identify a theoretically coherent but insufficiently tested intersection among project-based inquiry, authentic field experience, SPS, and environmental awareness, and to formulate E-LKPD-supported PjBL-field study as a design proposition for subsequent empirical validation. Future studies should test this proposition with clearly defined outcomes, stronger comparative designs, and explicit quality and effect-size reporting.

AUTHOR DECLARATION

Author Contribution. SNM served as the lead researcher, defining the research theme, developing the proposal, designing the research instruments, and conducting data analysis; SS contributed to drafting the article and conducting the theoretical review related to the research theme; Su & NRD contributed to data analysis and the interpretation of the research findings.

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Conflict of Interest. The authors declare no conflicts of interest in this study.

Declaration of AI and AI-assisted technologies in the writing process. The authors declare the use of technological tools throughout the research process. Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed for data management and analysis, while Mendeley was utilized for reference management. Additionally, artificial intelligence (AI) tools were used solely to refine academic language and assist in translating the manuscript from Indonesian into English.

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