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Trends in the Use of Project-Based Learning Model LKPD to Improve Learners' Science Literacy: A Bibliometric Analysis (2015-2025)

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Abstract: This study presents a bibliometric analysis of the trend in the use of Learner Worksheets (LKPD) based on the Project-Based Learning (PjBL) model to improve students' science literacy. The main objective of this research is to identify and analyze annual publication trends, disciplinary focus, and major thematic clusters in this research domain from 2015 to 2025. Data was collected from Google Scholar via Publish or Perish and Dimension.ai, with procedures adapted from PRISMA guidelines, and analyzed using VOSviewer software. The results showed a significant increase in the number of publications, signaling the field as a rapidly growing research frontier. The dominance of the 'Education' category was complemented by substantial contributions from 'Information and Computer Science' and 'Engineering,' indicating a shift towards technology integration. Thematic clusters confirmed the close relationship between PjBL, LKPD, and science literacy, with an emphasis on problem-solving and STEM-based development. PjBL proved effective in improving science literacy and collaborative skills, although implementation challenges such as time management and teacher competence still exist. The findings provide valuable insights for educators, curriculum developers, and policymakers to optimize the implementation of PjBL in science education.

Keywords: LKPD; Project-Based Learning; Science Literacy; Bibliometrics; VOSviewer; Dimensions.ai

Introduction

Science literacy is a crucial competency in the 21st century, enabling individuals to understand complex scientific issues, make informed decisions, and actively participate in a science-driven society. The PISA framework defines science literacy through three key competencies: explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting scientific data and evidence (Aulia, 2021; Fadhila, 2022; Rizalia & Wuriani, 2023). However, recent research shows that learners' science literacy levels are still relatively low, often due to traditional educational approaches that tend to emphasize memorization over critical thinking and application in real-world contexts (Cahyanto et al., 2024; Khikmah & Susantini, 2019; Susanti et al., 2019). Conventional approaches often fail to equip learners with critical thinking and problem-solving skills essential for effective engagement with scientific issues (Amelia & Nur, 2023; Asma & Muchlis, 2018; Zahroh & Yuliani, 2021).

To address this challenge, innovative learning models such as Project-Based Learning (PjBL) offer a solution. PjBL is a learner-centered pedagogical approach, where they engage in extended authentic projects to solve real-world problems. This approach inherently encourages critical thinking, collaboration, and independent inquiry (Karmana, 2024; Putri, 2024; Sakti et. al., 2021). Based on the context of PjBL, the Learner Worksheet (LKPD) serves as a facilitation tool

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that guides learners through project stages and learning activities (Pratiwi, 2024; Rosyida et al., 2023). PjBL, especially when supported by well-designed LKPD, can provide a dynamic and active learning environment, overcoming the shortcomings of traditional, passive methods (Sulastri et al., 2025; Vebrianti et al., 2019).

Given the importance of PjBL in improving science literacy, a systematic and quantitative review of the existing literature is needed to map the intellectual landscape and identify trends in this specific research area. Bibliometric analysis, with the help of tools such as VOSviewer and Dimension.ai, allows the visualization of research patterns, influential works, and thematic evolution. This approach provides a comprehensive picture that traditional literature reviews may miss (Aulia, 2021; Fadhila, 2022; Rizalia & Wuriani, 2023). By quantitatively analyzing publication data, this research can identify evolving focus areas, collaborations between researchers, and the underlying knowledge structure of this field of study.

Method

This research adopts a descriptive and analytical bibliometric approach. Bibliometric analysis is a quantitative method used to analyze academic literature, identify trends, and map the intellectual structure of a research field (Aulia, 2021; Fadhila, 2022). This approach enables the systematic identification of patterns and relationships in publication data.

Data was collected primarily from Google Scholar, accessed through Publish or Perish software, and supplemented with Dimension.ai. The search time span was set from 2015 to 2025 to capture recent trends. The use of Google Scholar through Publish or Perish provides extensive coverage, including grey literature and regional publications, while Dimension.ai offers a highly connected and structured database with advanced analytical capabilities (Jaya et al., 2023; Prakoso & Rusnilawati, 2024). The combination of these two sources provides a robust and comprehensive data set, minimizing the risk of missing relevant publications and ensuring a more holistic view of the research landscape. The main search terms used were 'LKPD,' 'Project Based Learning,' and 'Science Literacy'.

Data collection procedures followed an adapted version of the PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) guidelines to ensure transparency, reproducibility, and comprehensive data collection (Rosyida et al., 2023; Sahril et al., 2022). Although PRISMA is primarily intended for systematic reviews and meta-analyses, its principles for systematic search strategies, inclusion/exclusion criteria, and reporting can be effectively adapted for bibliometric studies to improve methodological rigor (Safitri et al., 2021). This strategic adaptation of the PRISMA guidelines for bibliometric studies demonstrates a commitment to high methodological transparency and reproducibility, which are crucial for academic credibility and future research utility. It goes beyond the mere presentation of data to ensure that the foundations of research are strong.

Publish or Perish is used to extract bibliographic data from Google Scholar, including publication details, citation counts, and author information (Aulia, 2021; Fadhila, 2022). The extracted data is stored in RIS format for compatibility with VOSviewer (Hidayati & Rachmadiarti, 2024). Dimension.ai was utilized for initial trend identification, disciplinary categorization, and overall publication volume analysis, providing a high-level overview and visualization (as seen in Table 1 and Figure 1) (Jaya et al., 2023; Prakoso & Rusnilawati, 2024). VOSviewer is used for bibliometric mapping and visualization of co-occurrence networks, overlay visualization, and density visualization (as seen in Figure 2, Figure 3, and Figure 4). VOSviewer's capabilities include analyses of co-authorship, keyword co-occurrence, and citation patterns to build and view bibliometric maps (Aristawati, 2022; Setyowati et al., 2023). The 'full count' method was used for keyword co-occurrence, and a minimum threshold (e.g., 10 occurrences) was set for keywords to be included in the mapping to focus on salient themes (Zuliyanti et al., 2024). The specific methodological choice to use 'full counting' for keyword co-occurrences in VOSviewer, as distinct from binary counting, indicates a deliberate attempt to capture the intensity and frequency of thematic discussions, providing a more detailed and accurate representation of the focus of the research landscape. This detail reveals a deeper level of analytical precision.

Result and Discussion

Table 1. Number of Annual Publications (2015-2025)

Year	Number of Publications (total)
2015	0
2016	2
2017	8
2018	10
2019	30
2020	53
2021	100
2022	193
2023	345
2024	365
2025	79

Table 1 presents the annual publication volume from 2015 to 2025. There is clearly a significant and consistent increase in publications from 2016 to 2024,

indicating a rapidly growing interest and research activity in the area of PjBL Model LKPD for science literacy. The number of publications jumped from a negligible number in 2016 to more than 350 in 2024. The sharp decline in 2025 is due to incomplete data for the current year. The steep and consistent increase in publications from 2016 to 2024 suggests that the topic of PjBL Model LKPD for science literacy is not just growing, but has become a rapidly emerging frontier of research. This indicates a convergence of factors, likely including increased policy emphasis on science literacy and empirical validation of the effectiveness of PjBL, that are driving the surge in academic inquiry.

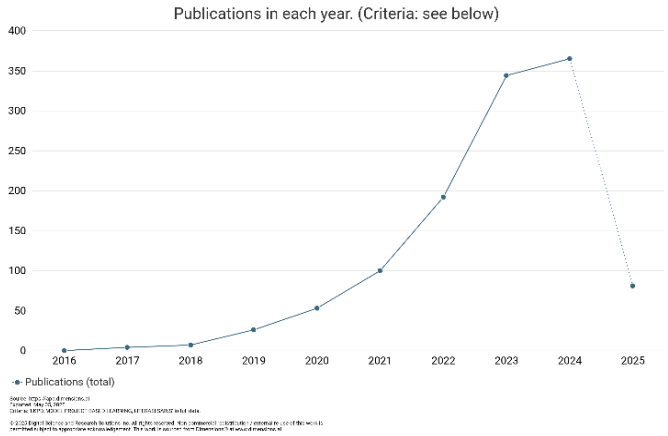

Figure 1. Research trends in the Use of Project-Based Learning Model LKPD to Improve Learners' Science Literacy

The exponential growth in publications (Figure 1) not only indicates an increase in the number of studies but also signals that this topic has become a rapidly growing research frontier. This can be explained by the increasing global emphasis on 21st-century skills and the importance of science literacy in meeting contemporary challenges. This growth also indicates the maturation of PjBL as a recognized and effective pedagogical approach in science education.

Table 2 shows the distribution of publications across different research categories. 'Education' dominantly leads the research landscape with 662 publications, as expected. However, 'Information and Computer Science' (63 publications) is the second most prominent category, followed by 'Language, Communication and Culture' (46) and 'Engineering' (43). The significant presence of 'Information and Computer Science' and 'Engineering' next to 'Education' indicates an important interdisciplinary trend. This suggests that research on PjBL Model LKPD for science literacy is increasingly exploring the integration of digital tools, computational thinking, and technological design, moving beyond purely pedagogical considerations to encompass technological innovation in educational practice.

Table 2. Top Research Categories by Number of Publications

Research Category	Number of Publications
Education	662
Information and Computing Sciences	63
Language, Communication, and Culture	46
Engineering	43
Philosophy and Religious Studies	24
Creative Arts and Writing	23
Physical Sciences	18
Built Environment and Design	10
Human Society	9
Law and Legal Studies	8
Commerce, Management, Tourism, and...	7
History, Heritage, and Archaeology	4
Biological Sciences	2
Psychology	2
Biomedical and Clinical Sciences	1
Chemical Sciences	1
Earth Sciences	1

The interdisciplinary nature of the field, particularly the strong presence of 'Information and Computer Science' and 'Engineering' (Table 2), indicates an important shift in the way PjBL is implemented and researched. This suggests that research on PjBL-modelled LPDs for science literacy is not just limited to traditional pedagogical considerations. Instead, there is a growing focus on the integration of digital tools, computational thinking, and technology design. This leads to the development of digital LKPD (e-LKPD), virtual simulations, data analysis tools, or even robotics/coding projects within a PjBL framework to improve science literacy (Akbar, 2024; Buana, 2022; Fadhila, 2022; Ikhlas, 2023; Pratiwi, 2024; Prihastuti & Sukaesih, 2024; Roliati, 2024; Rohmaya et al, 2023; Rosyida et al., 2023; Sabila et al., 2023; Safitri et al., 2021; Shaleha et al., 2020; Tri, 2024; Wafi, 2024; Zahroh & Yuliani, 2021). This shift represents a significant evolution from purely pedagogical concerns to deep technology integration.

Figure 2 displays a network of keywords that frequently co-occur, forming distinct clusters. Key terms such as 'project learning,' 'liked,' 'scientific literacy,' 'model problem,' 'pbl,' 'research,' 'development,' 'student,' 'learning,' 'effect,' 'science,' 'stem,' 'engineering,' 'technology,' 'ability,' 'participant,' 'literacy-based,' 'SMP,' 'public sma,' and 'science learner' are prominent. The co-occurrence network (Figure 2) reveals a strong conceptual integration where 'Project-Based Learning' and 'LKPD' are often studied in direct relationship with 'Scientific Literacy.' The prominent clustering of 'problem models' with 'project learning' indicates significant overlap or fundamental reliance on Problem-Based Learning (PBL) principles in the

implementation of PjBL, suggesting that problem-solving is a key driver for promoting scientific literacy in these studies. The presence of 'research' and 'development' indicates that most of the studies focussed on the development and validation of PjBL-based LKPD or interventions. The association with 'STEM,' 'engineering,' and 'technology' further reinforces the interdisciplinary nature identified in Figure 2, suggesting that PjBL is often applied in STEM contexts to improve science literacy.

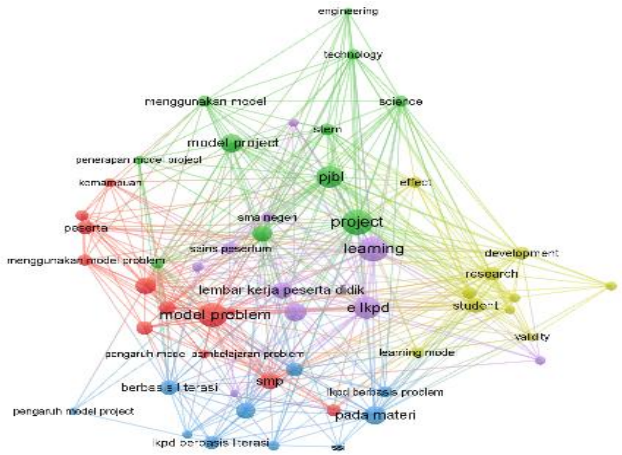

Figure 2. Network visualization of frequently co-occurring keywords in the research trends in the use of project-based learning model liked to improve learners' science literacy

The core clusters identified by VOSviewer (Figure 2, Table 3) underscore the strong relationship between 'Project-Based Learning,' 'LKPD,' and 'Scientific Literacy,' confirming the central theme of this study. The close relationship between 'model problem' and 'project learning' suggests that problem-solving is a fundamental driver for PjBL applications in this context (Cahyanto et al., 2024; Pratiwi & Lestari, 2024). This indicates that PjBL is often implemented to address authentic scientific problems in the real world, which inherently promotes science literacy

Table 3. Major Thematic Clusters and Representative Keywords

Cluster (Colour)	Main Theme	Representative Keywords
Red	Problem-Based Learning & Learners	problem model, participants, ability, public high school, science students, using problem model
Purple	Learning Validity & Development	validity, development, research, student, and learning model
Blue	Literacy & junior high school-based LKPD	literacy-based liked, SMP, problem-based liked, on material, the effect of the project model, the effect of problem learning model
Green	PjBL, Sains, STEM & Teknologi	project, learning, PjBL, science, stem, engineering, technology, effect, using model, project model
Yellow	General Concepts & Research	research, development, student, validity, learning model

Notes: The determination of representative clusters and keywords is based on the visual interpretation of Figure 2.

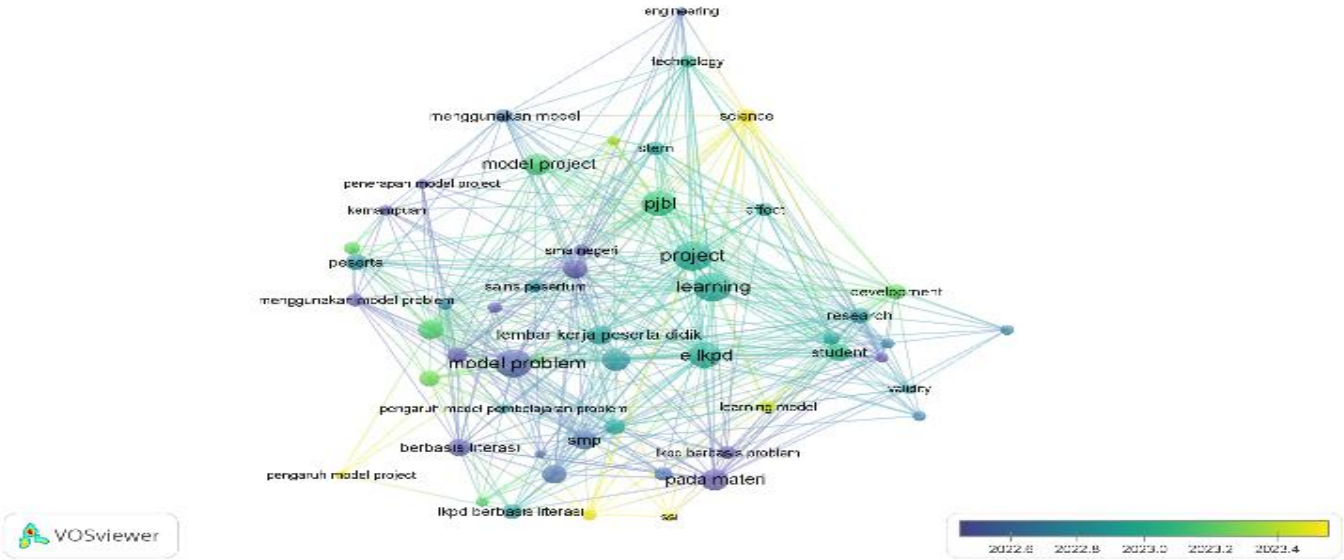

Figure 3. Overlay visualization on the use of project-based learning lkpd model to improve students' science literacy

Figure 3 displays a temporal overlay, where colors indicate the average publication year of documents associated with the keywords. Newer terms (e.g., yellow-green) seem to be more concentrated around

'stem,' 'engineering,' 'technology,' 'development,' and 'research', while some older terms (e.g., dark blue) may be closer to core concepts such as 'problem model' or 'literacy-based.' The temporal overlay map (Figure 3) shows a subtle but significant evolution in research focus. While the core concepts of 'PjBL,' 'LKPD,' and 'science literacy' remain central, more recent studies (greenish-yellow nodes) increasingly lean towards the integration of PjBL/LKPD in the context of 'STEM,' 'engineering,' and 'technology,' alongside a stronger emphasis on 'development' and rigorous 'research' methodologies. This indicates the maturation of the field, moving from basic effectiveness studies to more complex interdisciplinary applications and systematic development of educational resources.

The 'development' and 'research' clusters indicate a strong academic effort to systematically design, test, and refine PjBL-based LKPD. In addition, the emergence of the themes 'STEM,' 'engineering,' and 'technology' (Figure 3) indicates a growing trend to implement PjBL in the context of interdisciplinary STEM to improve science literacy (Arrohman et al., 2022; Fatmawati et al., 2022; Izzania, 2022; Kamal, 2021; Ramadhan, 2023; Sabila et al., 2023; Safitri et al., 2021; Zahirah & Sulistina, 2023). This is in line with the global education reform movement that emphasizes an integrated approach to science education.

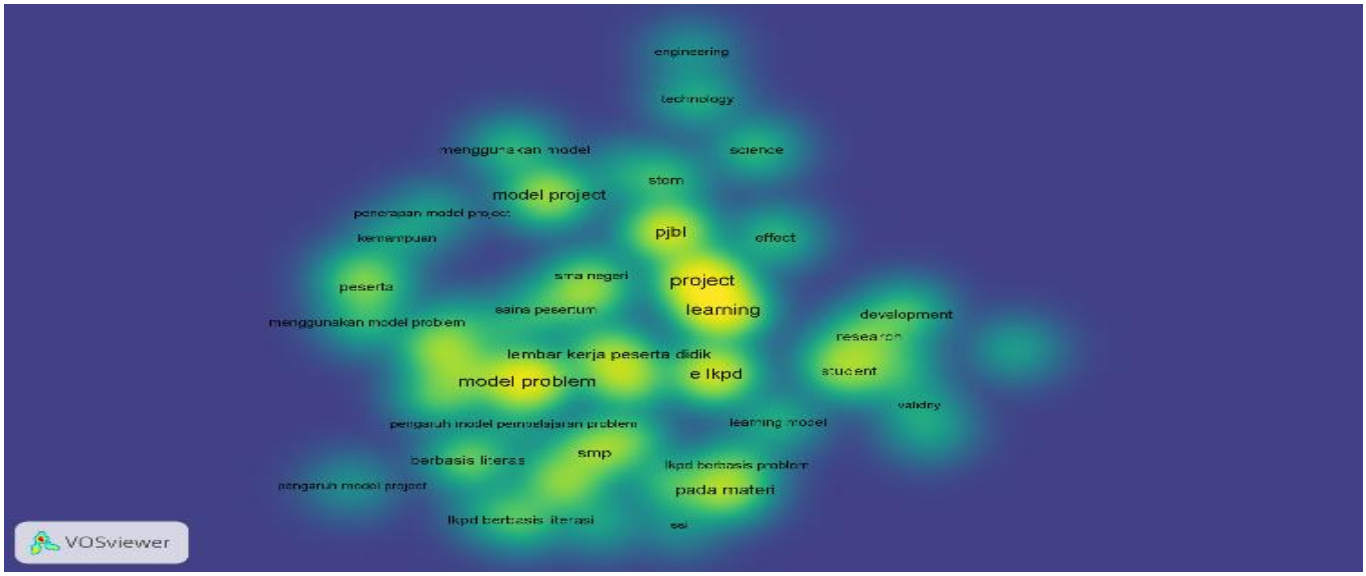

Figure 4. Density visualization on the use of project-based learning lkpd model to improve students' science literacy

Figure 4 shows high-density areas (lighter yellow/green) around terms such as 'project learning,' 'lkpd,' 'scientific literacy,' 'model problem,' 'pbl,' 'learning,' and 'project.' Areas of lower density (darker blue) are around more peripheral or novel terms. The density visualization (Figure 4) provides strong confirmation of the core conceptual focus of the research field. The high-density areas clearly show that the intersection of 'Project-Based Learning,' 'LKPD,' and 'Scientific Literacy' forms the intellectual epicenter of this domain, indicating a strong and established research agenda around these interconnected themes. This density also highlights the strong conceptual link between 'project learning' and 'problem modeling,' reaffirming that problem-solving is a highly inherent aspect of the PjBL approach in this context.

Consistent empirical evidence from various studies confirms the positive impact of PjBL/PBL on science literacy. Research shows that PjBL effectively improves science literacy and collaborative skills, with higher mean scores reported than conventional learning (Amelia & Nur, 2023; Sa'adah & Pertiwi, 2022). The effectiveness of PjBL in improving science literacy is rooted in its inherent pedagogical design. The structured stages of PjBL directly foster critical thinking, problem-solving, and communication skills, thus establishing a clear causal path between the model and improved science literacy outcomes.

PjBL contributes to science literacy through the following stages:

a. Starting with Essential Questions: This stage encourages learners to identify and formulate problems from real-world environmental and social issues, connecting science to everyday life (Cahyanto et al., 2024; Rizalia & Wuriani, 2023). It directly addresses the 'explain phenomena scientifically' indicator of science literacy (Aulia, 2021).
b. Designing a Project Plan: Encourages creativity and problem-solving skills as learners plan activities and determine tools (Rizalia & Wuriani, 2023).
c. Investigating and Presenting Results: Directly trains learners in scientific investigation, data

interpretation, and communication, aligned with PISA indicators (Aulia, 2021; Cahyanto et al., 2024; Fadhila, 2022).

d. Collaborative Nature: Teamwork in PjBL enhances communication and collaboration, important 21st-century skills that support scientific discourse (Karmana, 2024; Putri, 2024; Sakti & Swistoro, 2021; Amelia & Nur, 2023; Sa'adah & Pertiwi, 2022).

In contrast to traditional educational approaches that often fail to equip learners with the critical thinking and problem-solving skills necessary for effective engagement with scientific issues (Amelia & Nur, 2023; Asma & Muchlis, 2018), PjBL provides a dynamic and learner-centered framework.

Despite its proven effectiveness, the implementation of PjBL faces several practical barriers that are recurrent and represent systemic obstacles to scaling the implementation of PjBL. These challenges suggest that while the pedagogical efficacy of PjBL is well established, its practical scalability is limited by institutional and teacher-level factors. Overcoming these challenges requires not only individual teacher training but also systemic support, policy adjustments, and resource allocation.

Key challenges include:

a. Limited Time Management: Teachers often struggle with the longer time required for PjBL projects within rigid curriculum schedules (Karmana, 2024; Putri, 2024).
b. Inadequate Infrastructure and Resources: Lack of appropriate materials, technology, or specialized spaces can hinder the effective implementation of PjBL (Karmana, 2024; Madi & Nida, 2023).
c. Lack of Teacher Competence/Training: Many teachers may not have the necessary pedagogical skills or confidence to effectively guide PjBL, which requires significant professional development (Karmana, 2024; Putri, 2024; Madi & Nida, 2023).
d. Meeting Accountability Requirements and State Standards: Integrating open-ended PjBL projects with standardized testing and curriculum mandates can be challenging for teachers (Putri, 2024).

The findings of this study have some important implications. For curriculum development, PjBL should be integrated more widely, especially in the science curriculum, to encourage science literacy and 21st-century skills. In terms of teacher training, there is an urgent need for targeted professional development programs to equip teachers with the skills and confidence to implement PjBL effectively. For education policymakers, these findings imply the need for policies that provide flexibility in curriculum delivery, allocate resources for PjBL implementation, and support teachers' professional development.

Conclusion

This study has identified a rapidly growing trend in research regarding the use of Project-Based Learning Model NPDs to improve learners' science literacy. There is a significant growth in publications, indicating the increasing recognition and importance of this approach in educational research. The field shows a strong interdisciplinary nature, with prominent contributions from Information and Computer Science and Engineering, indicating a trend towards the integration of technology in pedagogical design. The core thematic cluster confirmed strong conceptual links between PjBL, NPDs, and science literacy, driven by a problem-solving approach. Empirical evidence consistently supports the effectiveness of PjBL in improving various aspects of learners' science literacy and collaborative skills. The Project-Based Learning Model NPPD is a highly effective and increasingly researched pedagogical approach to foster science literacy among learners, which is critical to their development as science-literate citizens.

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Conceptualization, AD; methodology, SR; validation, FL; formal analysis, SA; investigation, AD; resources, SR; data curation, FL: writing-preparation of the original draft, SA; writing-review and editing, A. D; visualization, SR All authors have read and approved the published version of the manuscript.

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