



## Research Trends in Problem-Solving Skills within Science Learning: A Bibliometric Analysis Using the Scopus Database (2002-2026)

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DOI: <http://dx.doi.org/10.18592/tarbiyah.v15i1.20299>

### Key Words:

co-occurrence analysis  
bibliometric analysis  
problem-solving skills  
science learning  
scopus

### Abstract:

Research regarding problem-solving skills in science learning continues to expand, necessitating the mapping of publication trends on this topic. This study employed a bibliometric analysis designed to map research trends concerning problem-solving skills within science learning utilizing the Scopus database from 2002 to 2026. Data were gathered from Scopus export results on March 25, 2026, yielding 65 relevant documents. The analysis focused on the chronological development of annual publications, institutional affiliations, contributing countries, publication venues, author prominence based on citations and document counts, and keyword clustering visualized through the VOSviewer approach. The findings indicated that publications initially emerged in 2002 and exhibited an upward trend from 2018 onward, reaching a peak of 10 documents in 2025. Keyword co-occurrence analysis revealed seven primary clusters centered on problem-solving skills, science learning, students, education computing, learning systems, and problem-based learning. These findings demonstrate that research into problem-solving skills within science learning is evolving toward innovative instruction, technology integration, and the reinforcement of 21st-century skills. Theoretically, this study contributes to mapping the structure of knowledge, while practically providing guidance for researchers, educators, and curriculum developers in defining future research agendas and instructional practices in science education. This study serves as a bibliometric mapping spanning from the inception of publication until the year 2026 using the Scopus database, executed through a selection process adhering to the PRISMA protocol.

*Received* : 02-04-2026  
*Revised* : 04-05-2026  
*Accepted* : 01-06-2026  
*Published* : 11-06-2026

**To cite this article:** Misbah, Haryandi, S., Hakam, A.B., Qamariah, Oktavianty, E. (2026). Research Trends in Problem-Solving Skills within Science Learning: A Bibliometric Analysis Using the Scopus Database (2002-2026). *Tarbiyah: Jurnal Ilmiah Kependidikan*. 15 (1), 1-20.

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## Introduction

Problem-solving skills represent one of the 21st-century core competencies demanded by the workforce and modern life (Sholikhan *et al.*, 2020; Agustoni *et al.*, 2021; Nigussie *et al.*, 2025). These skills pertain to the capacity to identify problems, select resolution strategies, apply knowledge, and evaluate outcomes. Within science instruction, these skills hold a paramount position because science demands not only conceptual mastery but also the ability to investigate phenomena, reason scientifically, and make evidence-based decisions (OECD, 2023; Taufiq *et al.*, 2021; Zafeer *et al.*, 2025). Various studies affirm the significance of problem-solving skills for learner development. Learners who possess proficient problem-solving skills tend to enhance their employability in the 21st century (Jamil & Khairuddin, 2017). Moreover, problem-solving skills can support the science learning process, enabling students to overcome difficulties and resolve issues in daily life (Fauziah *et al.*, 2024; Martaningsih *et al.*, 2022; Nursaadah *et al.*, 2025; Pantiwati *et al.*, 2025).

Despite the recognized importance of problem-solving skills, research indicates that these skills remain low among students. Franestian *et al.* (2020) discovered that the performance metrics for each dimension of problem-solving skills were 5.20% in problem identification, 57.60% in correlating cause and effect, 47.10% in planning solutions, 37.60% in determining relevant solutions, and 39.10% in analyzing the impact of solutions. This condition has triggered an increasing volume of research aimed at enhancing problem-solving skills, causing the number of publications on this topic to grow annually.

The rapid growth of publications creates a necessity to map them systematically. Without a clear roadmap, researchers risk replicating identical studies or overlooking critical research gaps. Bibliometric analysis serves as an approach based on publication metadata capable of revealing patterns in document growth trends, citations, authors, affiliations, countries, publication sources, and inter-keyword relationships (Aria & Cuccurullo, 2017; Donthu *et al.*, 2021; Zupic & Čater, 2015). In bibliometric analysis, network visualization is commonly performed using VOSviewer, as this software is effective for displaying bibliometric maps and keyword co-occurrences (van Eck & Waltman, 2010).

Several bibliometric studies have been conducted on the topic of problem-solving skills in science learning, such as that by Misbah *et al.*, (2025), which analyzed publications from 2018 to 2023. Their study utilized broader keywords: “science learning” or “science education” without additional filters or screening. Consequently, it yielded only three thematic clusters and analyzed authors solely based on document counts without examining citations. This research gap serves as the primary justification for the study presented in this article.

This study is a bibliometric analysis aimed at mapping research trends regarding problem-solving skills in science learning using Scopus data from the 2002–2026 period. This study addressed the following research questions:

- (1) What is the trend in the annual number of publications regarding the topic of problem-solving skills in science learning?
- (2) Which affiliations or institutions have published the most literature on problem-solving skills in science learning?

- (3) Which countries have the highest publication contributions regarding problem-solving skills in science learning?
- (4) Which journals or proceedings have published the most research on problem-solving skills in science learning?
- (5) Who are the most influential authors on the topic of problem-solving skills based on document count and citations?
- (6) What is the thematic structure and research focus based on keyword cluster analysis on the topic of problem-solving skills in science learning?

The findings of this study are expected to provide an empirical foundation for formulating research agendas on the topic of problem-solving skills in science learning. This information is valuable for researchers, lecturers, teachers, and curriculum developers to comprehend the positioning of this field of study and to determine subsequent research directions.

## **Research Method**

### ***Research Design***

This study employed a bibliometric analysis research design. Bibliometric analysis is a quantitative method used to measure and map scientific output based on publication metadata, such as authors, citations, affiliations, countries, journal sources, and keywords (Donthu *et al.*, 2021; Zupic & Čater, 2015). This approach was selected because it can reveal the developmental patterns of a scientific field systematically without evaluating the methodological quality of individual articles.

### ***Data Source and Search Strategy***

Data were retrieved from the Scopus database, which constitutes one of the largest and most widely utilized bibliometric databases in bibliometric studies (Mongeon & Paul-Hus, 2016). The search was executed on March 25, 2026, through several stages. The document selection process adhered to the PRISMA 2020 method (Page *et al.*, 2021), which comprised four stages:

At the identification stage, data retrieval was performed as follows: (1) Keywords: “problem-solving skills” AND “science learning”; (2) Search fields: Article title, abstract, and keyword (TITLE-ABS-KEY); (3) Boolean operator: AND to connect the two main concepts; (4) Time span: all available years up to March 2026; this yielded 74 documents. All available years were selected to determine publication trends, such as when the first publication was issued and how publications progressed annually.

Subsequently, at the screening stage, the following data extraction criteria were applied: (1) Filter criteria: Publication stage: final; (2) Source type: Journal and Conference Proceeding.

At the eligibility stage, the criterion applied was: all languages. Finally, at the included stage, a total of 65 documents met the requirements and were analyzed as the final dataset.

### ***Inclusion and Exclusion Criteria***

The document selection process was conducted using the inclusion and exclusion criteria outlined in Table 1.

**Table 1. Inclusion and Exclusion Criteria for Document Selection**

Criterion	Inclusion	Exclusion
Database	<i>Scopus</i>	<i>Web of Science, ERIC, Google Scholar</i>
Document type	Journal articles, conference proceedings (final/published)	Book chapters, editorials, letters, preprints
Language	All languages	-
Keywords	“problem solving skills” and “science learning” in the title, abstract, and keywords (TITLE-ABS-KEY)	Articles not containing both concepts
Topic	Problem-solving skills within the context of science learning	Problem solving outside the context of science education (e.g., medicine, industrial engineering)
Year range	All available years up to March 2026	-

### Data Analysis Techniques

Analysis was carried out in two primary stages in accordance with the bibliometric framework proposed by [Donthu et al., \(2021\)](#):

1. **Performance analysis:** This stage identified publication productivity and impact based on annual document trends, top 10 affiliations, top 10 countries, top 10 publication sources, and top 10 authors based on total citations and document counts. Analysis at this stage utilized the built-in analytics features of Scopus and data exported in CSV format.
2. **Science mapping:** This was conducted through keyword co-occurrence analysis. The mapping of research thematic clusters utilized VOSviewer software ([van Eck & Waltman, 2010](#)) with the following parameters: type of analysis: co-occurrence; unit of analysis: all keywords; counting method: full counting; minimum number of occurrences of a keyword: 2. Out of 350 identified keywords, 46 keywords met the threshold and were analyzed further.

Research findings were presented in the form of figures, tables, and interpretive narratives. The research focus was not to assess the methodological quality of each article, but rather to map the developmental patterns of publications and research themes on the topic of problem-solving skills within science learning. The visualization workflow is depicted in Figure 1.

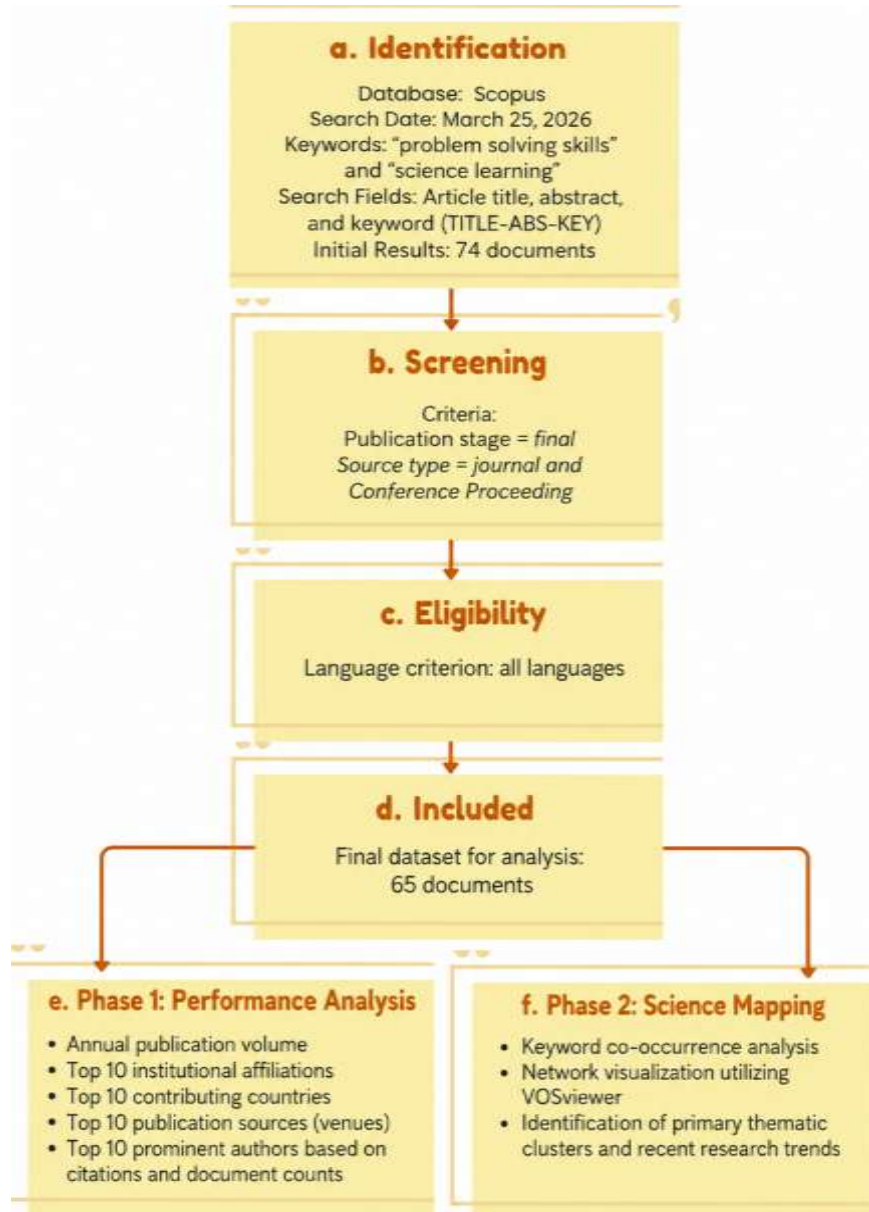


Figure 1. Bibliometric Analysis Research Flow

## Results and Discussion

### *Annual Publication Trends*

Based on the 65 analyzed documents, publications regarding problem-solving skills in science learning were fairly fluctuating. The number of documents published within the 2002–2026 period is shown in Figure 2.

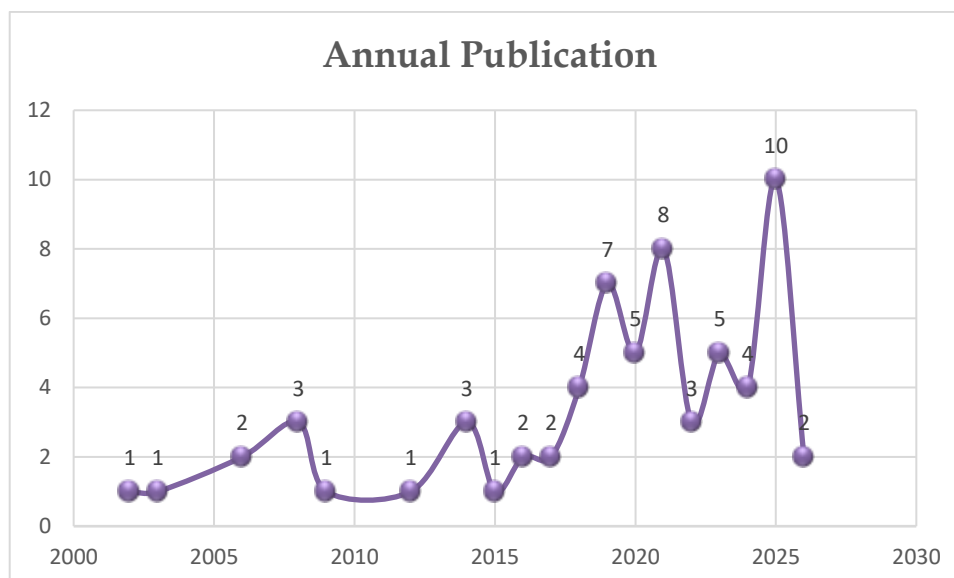


Figure 2. Number of Annual Publications on Problem-Solving Skills in Science Learning

Figure 2 illustrates that the initial publication in this database appeared in 2002. During 2002–2017, the volume of publications remained low. A more consistent increase in publications began to emerge during the 2018–2025 period. The year 2021 yielded 8 publications, whereas 2025 represented the year with the highest number of publications, totaling 10 documents. Data for the year 2026 exhibited a decline because data collection occurred in March 2026; hence, it remains unknown whether it will surpass the previous year, given that annual publication data fluctuate considerably. This trend aligns with research on problem-solving skills in mathematics education, which has also demonstrated a consistent annual increase (Wahyuni *et al.*, 2024).

The upward trajectory in publications since 2018 indicates that the study of problem-solving skills in science instruction has gained increasing traction. This growth can be attributed to several factors. First, there has been a reinforcement of competency-based education policies in various nations, including the implementation of the *Kurikulum Merdeka* (Independent Curriculum) in Indonesia, which emphasizes the cultivation of 21st-century skills (Lubis *et al.*, 2023). Second, the expanding integration of STEM approaches and problem-based learning has occurred as a response to the demands of Industry 4.0 (OECD, 2023).

The first publication was authored by Hsu & Thomas (2002), who investigated the influence of web-aided instructional simulation characteristics on learners' conceptual change, problem-solving, and knowledge transfer in science learning. Their findings indicated that simulation and multimedia environments rendered the learning environment more realistic. This helped learners connect what they learned within computer simulations to real-life situations. This baseline study established that computer-based simulations had been integrated to develop problem-solving skills, thereby serving as an early reference for subsequent research to leverage technology for enhancing problem-solving capabilities.

Conversely, the latest publication was conducted by Bashri *et al.*, (2026), who examined the efficacy of the SACPS (Seeking, Acquiring, and Knowledge Synthesis) Blended Learning model in enhancing students' spatial thinking and problem-solving skills. This recent literature demonstrates that the topic of problem-solving skills has

been merged with various other competencies, such as spatial thinking abilities. Diversified innovative instructional models have also been widely deployed to enhance problem-solving skills (see discussion under Cluster 4).

**Top 10 Affiliations**

The list of affiliations heavily engaged in research within the field of problem-solving skills can be observed in Figure 3.

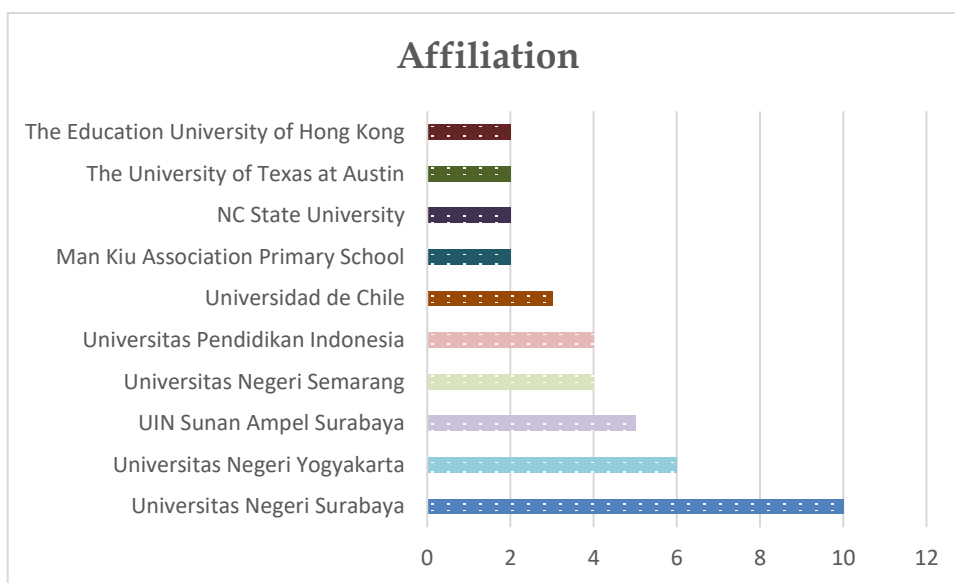


Figure 3. Top 10 Affiliations Conducting Research on Problem-Solving Skills in Science Learning

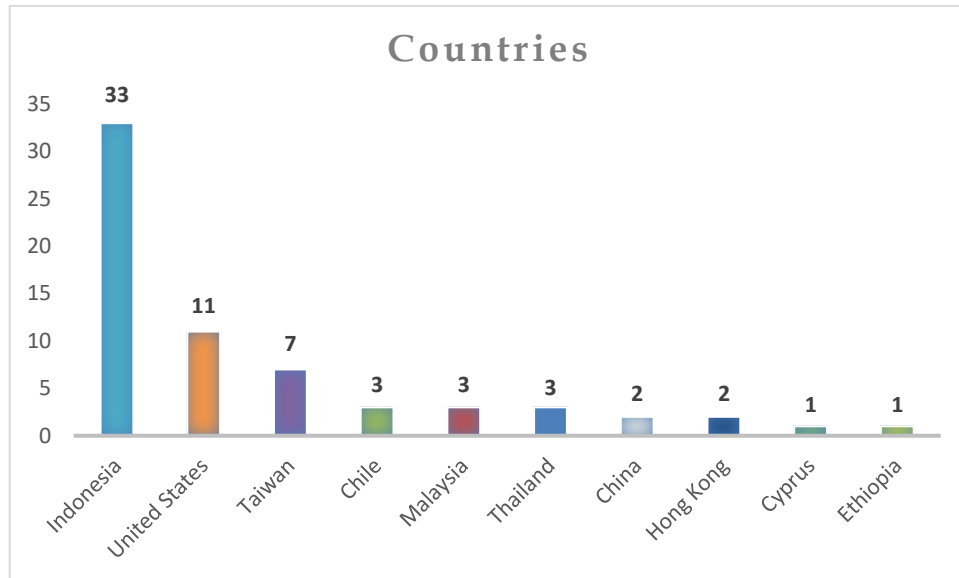
Figure 3 reveals that the most dominant affiliations in this database originated from Indonesia. Universitas Negeri Surabaya occupied the top position with 10 documents, followed by Universitas Negeri Yogyakarta with six documents. Eight out of the top 10 affiliations were Indonesian institutions, particularly teacher training universities.

The dominance of Indonesian affiliations within this dataset can be explained by several factors. First, there is an institutional drive for international publication productivity among lecturers in Indonesia, propelled by the policies of the Ministry of Education, Culture, Research, and Technology regarding mandatory research outputs. Second, there is a high volume of thesis and dissertation research within science education postgraduate programs that potentially culminates in publications in international proceedings indexed by Scopus. Third, proceedings such as the Journal of Physics: Conference Series and AIP Conference Proceedings provide publication channels that are relatively more accessible for Indonesian researchers. This third factor warrants critical attention as a potential source of institutional representation bias within the dataset.

Beyond Indonesian institutions, the presence of Universidad de Chile, Man Kiu Association Primary School, NC State University, The University of Texas at Austin, and The Education University of Hong Kong demonstrates that this topic has also garnered attention within the international research ecosystem. This uneven distribution indicates that cross-country research collaboration on the topic of problem-solving skills in science learning still possesses substantial room for development.

**Top 10 Countries**

Figure 4 displays the most productive countries in the domain of problem-solving skills.



**Figure 4. Top 10 Productive Countries in the Field of Problem-Solving Skills in Science Learning**

Figure 4 demonstrates that country-level analysis identified Indonesia as the nation with the highest publication contribution (33 documents). The United States stood in second place (11 documents), followed by Taiwan (7 documents), Chile, Malaysia, and Thailand (3 documents each), as well as China and Hong Kong (2 documents each). Cyprus and Ethiopia contributed 1 document each.

The high volume of documents from Indonesia in this dataset was likely influenced by the identical factors discussed regarding affiliation distribution, namely the dominance of Scopus-indexed proceedings and institutional publication mandates. The contributions from the United States and Taiwan reflect established research ecosystems concerning technology-based learning and problem-based learning. For instance, a study by [Liu et al., \(2021\)](#) from The University of Texas at Austin discovered that students’ science knowledge increased significantly after utilizing a PBL program by practicing problem-solving, collaboration, and self-directed learning skills. Overall, this disproportionate distribution underscores that global research collaboration on problem-solving skills within science learning requires further expansion.

**Top 10 Publication Sources**

The journals and proceedings that frequently published literature on problem-solving skills are presented in Table 2.

**Table 2. Journals/Proceedings with High Publication Volumes on Problem-Solving Skills in Science Learning**

Rank	Publication Source	Document Count
1	<i>Journal of Physics: Conference Series</i>	13
2	<i>AIP Conference Proceedings</i>	4
3	<i>International Journal of Information and Education Technology</i>	2
4	<i>International Journal of Instruction</i>	2

Rank	Publication Source	Document Count
5	<i>Journal of Turkish Science Education</i>	2
6	<i>Jurnal Pendidikan IPA Indonesia</i>	2
7	<i>Universal Journal of Educational Research</i>	2
8	<i>ASEE Annual Conference and Exposition Conference Proceedings</i>	1
9	<i>Asian Journal of University Education</i>	1
10	<i>Cell Biology Education</i>	1

Table 2 indicates that from the perspective of publication venues, the Journal of Physics: Conference Series constituted the most prolific source. Furthermore, ranks 2 and 8 were also published via conference proceedings, namely AIP Conference Proceedings and ASEE Annual Conference and Exposition Conference Proceedings. These findings reveal that two of the top three sources on the topic of problem-solving skills in science learning were disseminated through conference proceedings. The prevalence of the Journal of Physics: Conference Series indicates that problem-solving skills were heavily researched within physics instruction, as exemplified by [Taufiq et al., \(2021\)](#) regarding the “feasibility study of a solar system learning media based on merge cube augmented reality to embedding problem-solving skills.”

Conversely, the presence of the *International Journal of Instruction*, *Journal of Turkish Science Education*, and *Jurnal Pendidikan IPA Indonesia* underscores that the theme of problem-solving skills has also flourished in reputable science education journals. Diversifying publications toward indexed journals with stronger impact factors should be a focal point for the research community in this field moving forward.

### Top 10 Authors based On Total Citations and Document Counts

To identify influential authors in the field of problem-solving skills, a graphical representation mapping the top 10 authors based on their total citations and document relationships was generated, as shown in Figure 5.

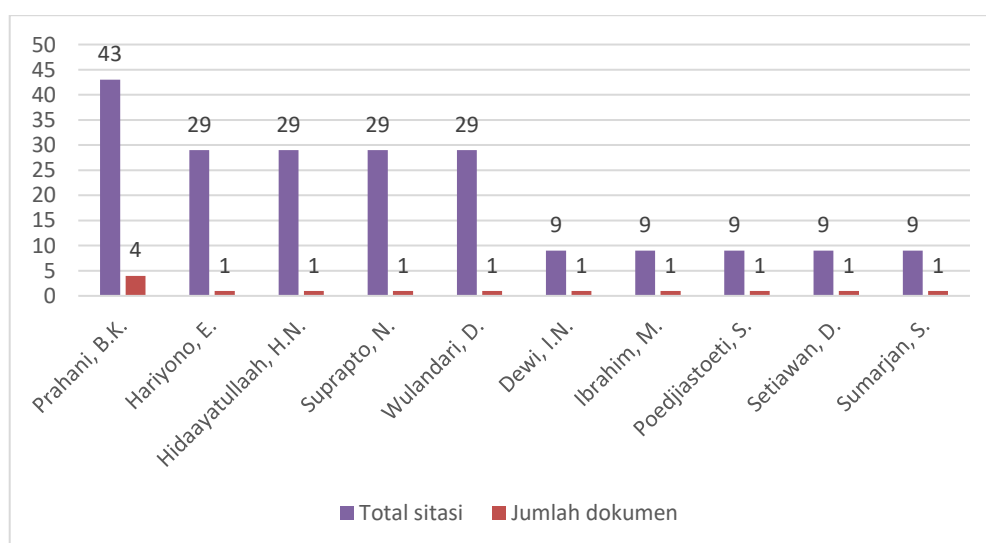


Figure 5. Top 10 Influential Authors Based on the Relationship Between Total Citations and Document Count

Note: Translation in Figure 5

■ Total Citations ■ Total Documents



The problem-solving skills keywords obtained in Figure 6 were classified into 7 primary thematic clusters. As anticipated, the most prominent terms across the network were “problem solving skills” and “science learning.”

### **Cluster 1 (Red)**

The primary keywords represented in Cluster 1, marked in red, tended to focus on the application of computer programs in science learning to enhance participants' problem-solving skills. The emerging keywords included problem-based learning, science, computer program, computer-assisted instruction, computer simulation, and software design. Furthermore, the focus within this cluster also encompassed several factors influencing learners' problem-solving skills, such as gender and motivation. The presence of these keywords indicates that research within this cluster emphasized not only instructional model aspects but also technology integration and student characteristics.

Within this cluster, problem-based learning (PBL) appeared as the most widely implemented instructional model to enhance problem-solving skills (Panda *et al.*, 2025). Additionally, instructional modalities such as direct experimentation, technology integration, and collaborative learning were found capable of boosting learner engagement, problem-solving skills, and scientific knowledge retention (Barrientos, 2025).

Furthermore, this cluster illustrates the utilization of computers as media to elevate problem-solving skills, such as the use of educational multimedia videos, design integration, and computational thinking. This can be implemented across levels spanning from elementary schools to higher education (Bockholt *et al.*, 2003; Chusinkunawut *et al.*, 2021; Hunter *et al.*, 2023; Wibawa *et al.*, 2024).

From the standpoint of student characteristics, gender differences were also proven to influence problem-solving skills. Male students learning through a project-based learning (PjBL) model integrated with a productive failure (PF) instructional design tended to be more confident and critical in solving problems compared to female students. However, female students demonstrated better self-regulation (personal control) than male students (Song & Lung, 2017).

### **Cluster 2 (Green)**

Cluster 2, marked in green, was dominated by the term learning systems. The keywords in this cluster related to technological application and decision-making, such as decision making, remotely operated vehicles, robotics, sensory feedback, and engineering education. This reveals that problem-solving skills within science instruction have also evolved within the contexts of engineering, learning systems, and technology-driven activities.

Examples include learning that utilizes the EDP (Engineering, Design, and Processing) framework as well as underwater robotics projects, which can enhance learners' problem-solving skills (Fauziah *et al.*, 2024; Stolkin *et al.*, 2006). Accordingly, this cluster shows that the reinforcement of problem-solving skills is achieved not merely through conceptual learning, but also via design- and engineering-based learning experiences.

**Cluster 3 (Navy)**

Cluster 3, marked in navy, terms associated with educational supporting components appeared more frequently, such as teaching, curricula, school buildings, education, and learning activity. Moreover, the keyword game-based learning fell into this cluster, indicating that digital game-based learning can be implemented in science education to enhance problem-solving skills (Chu & Hung, 2015; Sánchez, Flores, & Sáenz, 2008; Sánchez & Flores, 2008; Spires & Lester, 2016). More specifically, the utilization of sandbox games (Ching, 2012), mobile games (Sánchez & Salinas, 2008), and virtual laboratories represented viable strategies to boost learners' problem-solving skills (Eliyawati *et al.* 2021). Additionally, integrating argumentation, dialogues, and historical archives/artworks into the science curriculum was proven to enhance critical thinking and problem-solving capacities (Muslim *et al.*, 2025; Wang *et al.*, 2019).

**Cluster 4 (Yellow)**

Cluster 4, distinguished by yellow, exhibited primary keywords including education computing, learning models, data analysis techniques, student response, and primary schools. This cluster indicates that problem-solving skills have also been heavily examined within the context of primary education, particularly through the integration of computing, instructional models, and self-regulation strategies.

In this framework, computational thinking is viewed as a cognitive method for resolving problems (Taufiq *et al.*, 2023). Furthermore, metacognitive and self-regulated learning strategies independently proved to exert a positive impact on problem-solving skills and self-efficacy among primary school students (Arianto & Hanif, 2024).

Several instructional models applied to enhance problem-solving skills included: 1) The PO2E2W (Prediction, Observation, Explanation, Elaboration, Write, and Evaluation) learning model in science instruction, which proved effective in enhancing the problem-solving skills of primary school students (Pratiwi *et al.*, 2019); 2) Learning with the LI-PRO-GP e-module (Project-based Scientific Literacy within the School Literacy Movement integrated with Character Education Reinforcement) (Pantiwati *et al.*, 2025); 3) The OrDeP2E (Problem Orientation, Problem Definition, Hypothesis Submission, Hypothesis Testing, and Evaluation) learning model, which also proved effective for training the science problem-solving skills of elementary school learners (Mashluhah *et al.*, 2019); (4) The Discovery Learning Modification Model (Chusni *et al.*, 2020); (5) Project-based learning featuring a Productive Failure instructional design (Song & Lung, 2018). Broadly, this cluster underscores the importance of developing innovative instructional models at the primary education level to anchor problem-solving capabilities from an early stage.

**Cluster 5 (Purple)**

Cluster 5, marked in purple, the primary keywords that emerged were students, junior high schools, physics, and inquiry learning. Within this cluster, inquiry learning surfaced due to its close affinity with physics instruction. Physics instruction rooted in ethnoscience and the integration of the engineering design process can cultivate scientific literacy and student problem-solving skills (Hidayatullaah *et al.* 2021; Syukri *et al.* 2018).

Several studies indicated that inquiry learning models and STEM (Science, Technology, Engineering, and Mathematics) activities can enhance the problem-solving skills of junior high school students (Chaithong *et al.*, 2021; Mouromadhoni *et al.*, 2019; Sholikhah *et al.*, 2020). Furthermore, the incorporation of ethnopedagogi (culture-based instruction) can engage students in cultural exploration while simultaneously developing problem-solving skills (Rahmawati *et al.*, 2020). Hence, this cluster demonstrates that contextual, culture-laden, and inquiry-based science instruction possesses great potential for nurturing problem-solving skills.

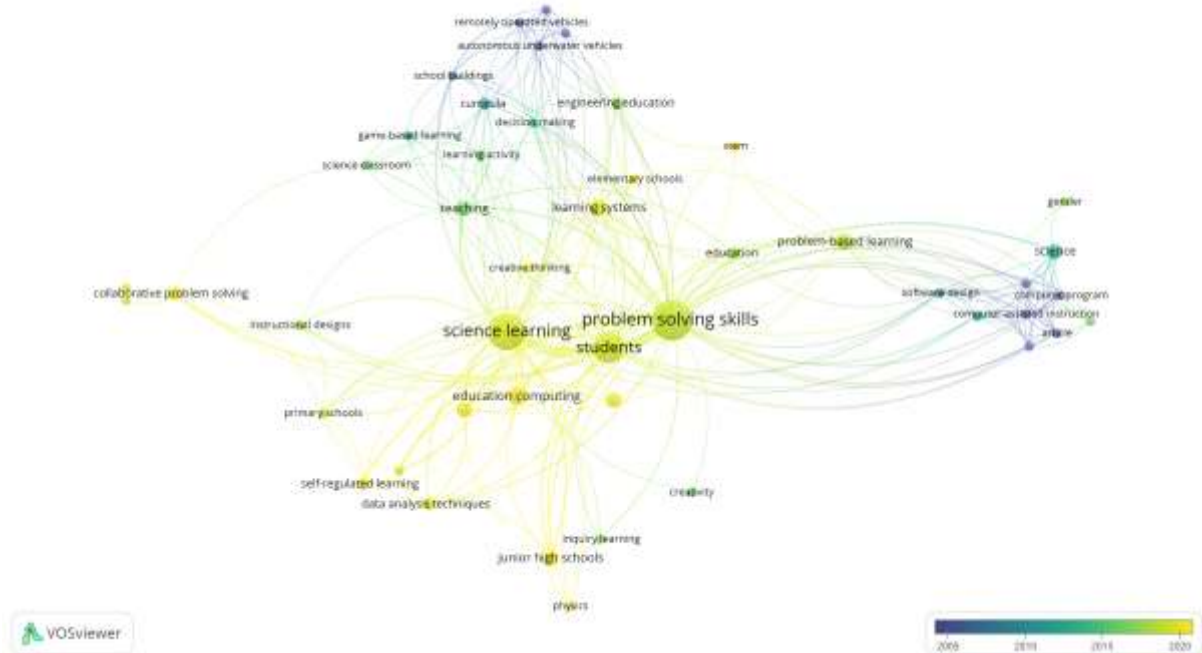
#### **Cluster 6 (Light Blue)**

Cluster 6, marked in light blue, contained primary keywords such as problem-solving skills, science learning, augmented reality, and creativity. This cluster represents the integration of problem-solving skills within science learning through the utilization of technology and other supporting competencies. The robust connection between science learning and problem-solving skills reinforces that science learning serves as a primary domain for developing problem-solving capabilities, particularly when supported by creativity (Chajjalearn *et al.*, 2023; Sumarni *et al.*, 2025) and tech-driven interventions such as Augmented Reality Limited Inquiry Laboratories (Ismail *et al.*, 2025). Beyond students, assessing the problem-solving capabilities of prospective teachers is also deemed vital in science instruction (Winarto *et al.*, 2022). In fact, integrated science learning was reported to enhance the problem-solving and communication skills of pre-service teachers (Winarto *et al.*, 2025). Consequently, this cluster exhibits an expansion of research focus from students to prospective educators, while affirming the critical role of technology and creativity in science education.

#### **Cluster 7 (Orange)**

Finally, Cluster 7 was characterized by orange, with primary keywords consisting of collaborative problem solving, instructional design, group science learning, and self-confidence. This cluster indicates that collaborative problem solving is becoming an increasingly vital research direction, emphasizing group work and student self-confidence. This focus demonstrates that problem-solving skills are no longer viewed strictly as an individual trait, but rather as a socio-cognitive capability that develops through peer interaction.

The CPS (Collaborative Problem Solving) model and the GSL (Group Science Learning) model were effective in enhancing collaborative problem-solving skills and self-confidence (Alfin *et al.*, 2019; Chen *et al.*, 2024; Fuad *et al.*, 2019). Overall, this cluster establishes that collaborative instructional designs play an instrumental role in reinforcing problem-solving skills within the context of science learning. An overlay visualization using VOSviewer regarding the topic of problem-solving skills in science learning is displayed in Figure 7.



**Figure 7. Overlay Visualization of Problem-Solving Skills in Science Learning Based on Co-occurrence Analysis**

Figure 7 reveals that in the past five years, research on problem-solving skills in science learning was heavily linked with education computing, augmented reality, STEM, collaborative problem solving, self-regulated learning, and creative thinking, which can serve as benchmarks for other researchers in future investigations on this topic.

Keywords such as computer program, computer-assisted instruction, and software design tended to represent earlier developmental themes, whereas keywords like problem solving skills, science learning, students, problem-based learning, self-regulated learning, and education computing emerged as relatively newer and strengthening themes.

These findings indicate that research on problem-solving skills in science instruction has shifted from focusing on technological support toward student-centered pedagogical designs, self-regulation, and collaboration. Collectively, this overlay map confirms that problem-solving skills have become a core competency in modern science education, continuously evolving toward technology integration, active pedagogy, and STEM.

### Conclusion

A bibliometric analysis of 65 Scopus documents (2002–2026) indicates that publications regarding problem-solving skills in science learning have tended to increase, particularly since 2018, reaching a peak in 2025 with 10 documents. Universitas Negeri Surabaya represented the most productive affiliation, and Indonesia constituted the nation with the highest publication contribution. The Journal of Physics: Conference Series emerged as the most prolific publication venue. At the author level, Prahani, B.K. was the most productive and highly cited author. Keyword analysis revealed seven primary clusters, focusing heavily on problem solving skills, science learning, students, education computing, learning systems, and problem-

based learning. These findings confirm that research on problem-solving skills in science instruction is expanding toward innovative instruction, technology integration, and the reinforcement of 21st-century skills. Future research is recommended to target topics trending within the last five years, such as education computing, augmented reality, STEM, collaborative problem solving, self-regulated learning, and creative thinking.

Theoretically, this study contributes to mapping the knowledge structure of the problem-solving skills domain in science education, identifying heavily researched and emerging themes, and highlighting research gaps to be filled, particularly regarding cross-country research collaboration and diversification into higher-reputation journals. Practically, these findings provide guidance for researchers in determining subsequent research topics, for educators in understanding thoroughly investigated approaches to enhance problem-solving skills in science learning, and for curriculum developers in identifying relevant competency trends.

This study has several limitations, including: (1) it solely utilized a single database (Scopus), thereby excluding publications indexed in Web of Science, ERIC, or Google Scholar; (2) the relatively small number of documents (65 documents) restricts the generalizability of the findings; (3) the dominance of proceedings within the dataset potentially affects the representation of research quality ; and (4) this analysis did not evaluate the methodological quality of individual articles.

Based on these findings and limitations, future research is advised to: (1) expand the database coverage by combining Scopus, Web of Science, and ERIC; (2) merge bibliometric analysis with systematic reviews to obtain a deeper qualitative analysis ; and (3) develop bibliometric studies focusing on trending sub-themes, such as augmented reality, collaborative problem solving, and self-regulated learning within the context of science learning.

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