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# Bibliometric Analysis of Research Trends in Problem Based Learning (PBL) on Critical Thinking Skills in Science Education for the Period 2015–2025

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**Abstract**

This study aims to analyze trends in research on the Problem-Based Learning (PBL) model on students' critical thinking skills in science education during the period 2015–2025 through a bibliometric-based systematic review approach. Data were obtained from Google Scholar using the Publish or Perish application and visualized with VOS viewer and analyzed through Dimensions.ai. A total of 1,000 indexed documents were analyzed based on publication year, publication type, target journal, number of citations, and keyword mapping. The results showed that publications related to PBL and critical thinking skills had increased significantly since 2023. Scientific articles dominated the types of publications (80.08%), followed by proceedings and book chapters. Bibliometric visualization showed four main clusters related to the development of learning tools, PBL implementation, learning strategies, and classroom action research. These findings indicate that PBL is increasingly recognized as an effective learning model in developing the critical thinking skills of 21st-century students.



## INTRODUCTION

The era of the Fourth Industrial Revolution is marked by rapid developments in digital technology, requiring mastery of 21st-century skills [1], [2]. These skills include critical thinking, creativity, collaboration, communication, connectivity, and culture (6C) [3]–[6]. Critical thinking refers to the process of analyzing, questioning, and filtering information [7], [8]. Creativity refers to the ability to utilize knowledge and/or talent to create something new. Collaboration refers to the ability to work together with different personalities, knowledge, and talents to produce innovation. Communication refers to the ability to express ideas and information clearly. Connectivity refers to an individual's ability to always be connected to their world. Culture refers to the ability to relate to the surrounding environment and the values and beliefs around them [9]–[11].

An important competency that students must possess is critical thinking, commonly referred to as high order thinking skills (HOTS) [12]–[14]. Higher-order thinking skills consist of logical thinking, critical thinking, and reasoning skills, which are basic skills in everyday life [15]–[18]. Critical thinking is a rational and reflective thought process, carried out continuously to evaluate and improve one's thinking, and to assist in making decisions or determining what to believe or do [19], [20]. Critical thinking skills are essential for students to master in today's world [21], [22]. According to Ennis

(2011), critical thinking indicators include several aspects, namely providing simple explanations or basic clarifications, determining the basis for decision making or basic decisions, drawing conclusions or inferences, providing further explanations, reasoning, and integration [23]–[25].

There are six basic elements of critical thinking, abbreviated as FRISCO, namely F (Focus), to make a decision about what is believed, one must be able to clarify specific questions or issues. R (Reason), knowing the reasons that support or contradict the situation and relevant facts. I (Inference), making reasonable conclusions or presenting them. S (Situation), understanding the situation and always keeping the situation in mind when thinking. C (Clarify), explaining the meaning or terms used. O (Overview), taking a step back and thoroughly examining the decision made [8], [26], [27].

Natural Sciences (IPA) is a subject that contributes greatly to training these skills because it is closely related to scientific concepts and the application of scientific methods [2], [8], [28]. One effort to improve students' critical thinking skills is to implement active learning models in the classroom that are student-centered, for example, by using the Problem-Based Learning (PBL) model [4], [29]–[31]. Given the importance of PBL in improving critical thinking skills, a comprehensive study of research trends over a specific period of time is needed. Therefore, this study aims to analyze research trends on PBL models and their impact on students' critical thinking skills in science education during the period 2015–2025 through a systematic review approach based on bibliometric analysis.

## METHOD

This study uses a bibliometric analysis approach with a quantitative descriptive method to examine research trends on Problem Based Learning (PBL) on students' critical thinking skills in science learning during the period 2015–2025. Bibliometric analysis was chosen because this study focuses on mapping the development of publications, the number of citations, document types, and the relationship between keywords in scientific literature, rather than on an in-depth synthesis of article content as in a PRISMA based systematic review.

The research data was obtained from the Google Scholar database using the Publish or Perish application with the keywords: "Problem Based Learning" and "critical thinking" and "science learning". The publication year range was limited from 2015 to 2025 to see the trend development over the last decade. The search results yielded 1,000 indexed documents, which were then analyzed based on publication metadata, including the number of publications per year, the number of citations, the type of publication (articles, proceedings, and chapters), and the target journal for publication.

Next, the data obtained was exported in RIS format and visualized using VOS viewer software to produce bibliometric maps in the form of network visualization, overlay visualization, and density visualization. These visualizations aim to identify research topic clusters, interrelationships between keywords, and developments in research focus over time. Additional analysis of the target publication journals and citation metrics was conducted using the Dimensions.ai platform to strengthen data interpretation. The 2025 data was recorded as partial data because the data collection was carried out while the publication year was still ongoing.

## RESULT AND DISCUSSION

This study aims to describe research trends on the Problem Based Learning (PBL) model to improve critical thinking skills. Research documents on research trends on the Problem Based Learning (PBL) model to improve critical thinking skills were taken from documents from 2015 to 2024.

Figure 1 shows that the research trend on the Problem-Based Learning (PBL) model on critical thinking skills shows a significant development from year to year. In 2015 to 2016, the number of publications was still very low, even almost non-existent. The trend began to show an increase in 2017 and 2018, although it was still stagnant at a low number, namely around 6 publications. A more noticeable increase occurred starting in 2019, with the number of publications reaching 17 and remaining stable until 2020. The year 2021 saw another increase to 23 publications, although there was a slight decline in 2022 to 18 publications. However, a big jump occurred in 2023 with the number

of publications skyrocketing to 66. This positive trend continued in 2024 with the highest number of publications during the observation period, namely 88 publications.

Interestingly, data from 2025 shows a sharp decline to only 6 publications, which is most likely due to the fact that the data collected is still provisional or incomplete as the year is still ongoing. Overall, this graph shows that researchers' interest in PBL models for improving critical thinking skills has increased in recent years, especially since 2023. This surge may be influenced by a growing awareness of the importance of learning that emphasizes problem solving and critical thinking at various levels of education.

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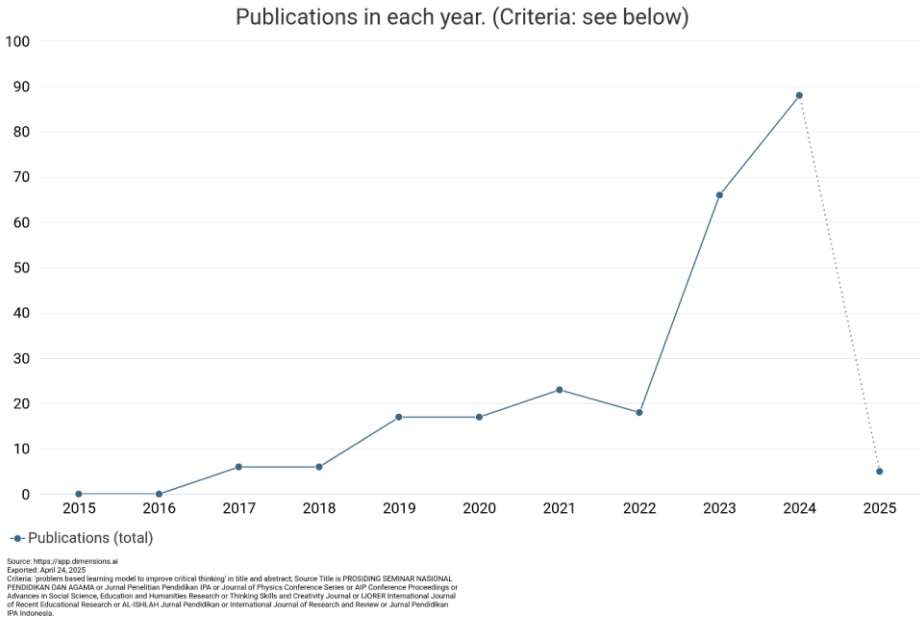


Figure 1. Research Trends on Problem Based Learning (PBL) Models and Critical Thinking Skills

Figure 2 shows that research trends related to the Problem-Based Learning (PBL) model on critical thinking skills are dominated by publications in the form of scientific articles. Articles account for 80.08% of all publications, indicating that articles are the primary medium for disseminating research results in this field. Meanwhile, publications in the form of proceedings ranked second with a percentage of 15.85%, indicating that quite a lot of research results were presented at seminars or scientific conferences before being published further. As for publications in the form of chapters, they only contributed 4.07%, which shows that the presentation of research results in books is still relatively small compared to articles and proceedings.

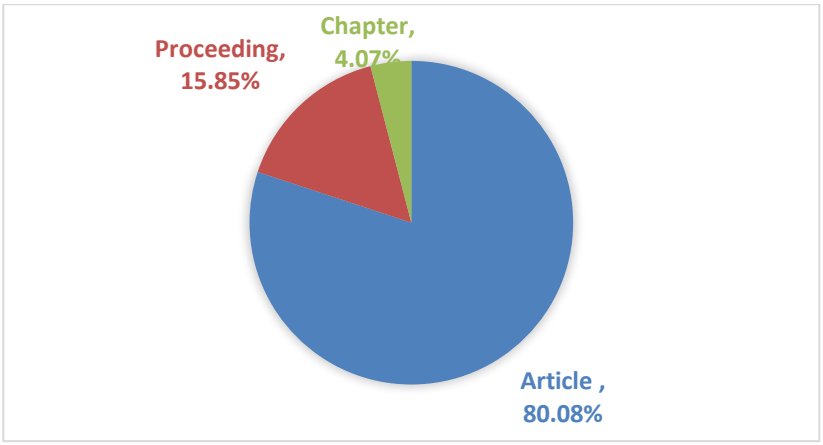


Figure 2. Research Trends on Problem-Based Learning (PBL) Models on Critical Thinking Skills Based on Publication Type

Table 1. 10 Target Journals for Publication on Research Trends in Problem-Based Learning (PBL) Models and Their Impact on Critical Thinking Skills

| Name | Publication | Citations | Citations Mean |
|---|---|---|---|
| Prosiding Seminar Nasional Pendidikan dan Agama | 63 | 4 | 0.06 |
| Jurnal Penelitian Pendidikan IPA | 50 | 181 | 3.62 |
| Journal of Physics Conference Series | 48 | 347 | 7.23 |
| AIP Conference Proceedings | 28 | 32 | 1.14 |
| Advances in Social Science, Education and Humanities Research | 21 | 57 | 2.71 |
| Thinking Skills and Creativity Journal | 10 | 9 | 0.90 |
| IJORER International Journal of Recent Educational Research | 10 | 51 | 5.10 |
| Al-Ishlah Jurnal Pendidikan | 9 | 10 | 1.11 |
| International Journal of Research and Review | 9 | 6 | 0.67 |
| Jurnal Pendidikan IPA Indonesia | 7 | 227 | 32.43 |

Based on Table 1, data taken from Dimensions.ai, journals targeting publications on trends in Problem Based Learning (PBL) on critical thinking skills, there are ten journals that are publication targets. The Proceedings of the National Seminar on Education and Religion are suitable for initial publication, even though they have fewer citations. The Journal of Science Education Research and the Indonesian Journal of Science Education are highly relevant for publications linking PBL to science, with a high number of citations, especially the Indonesian Journal of Science Education, which has the highest average number of citations. The Journal of Physics Conference Series and AIP Conference Proceedings are international proceedings options, especially if the research is related to science or engineering education. Advances in Social Science, Education and Humanities Research offers a platform for PBL studies in general and social education. Thinking Skills and Creativity Journal is ideal because it focuses directly on the development of critical thinking and creativity. In addition, IJORER and Al-Ishlah: Jurnal Pendidikan offer space for innovative research in the field of education, while the International Journal of Research and Review can be used for general publications with developing citation visibility.

Table 2. Top 10 Citations on Research Trends in Problem-Based Learning (PBL) Models on Critical Thinking Skills (2015-2025)

| Cite/year | Year | Author | Title |
|---|---|---|---|
| 81.00 | 2019 | Eka Yulianti, Indra Gunawan | Model Pembelajaran *Problem Based Learning* (PBL): Efeknya Terhadap Pemahaman Konsep dan Berpikir Kritis |
| 56.88 | 2017 | Arief Juang Nugraha, Hardi Suyitno, Endang Susilaningsih | Analisis Kemampuan Berpikir Kritis Ditinjau dari Keterampilan Proses Sains dan Motivasi Belajar melalui Model PBL |
| 55.00 | 2019 | Enok Noni Masrinah, Ipin Aripin, Aden Arif Gaffar | *Problem Based Learning* (PBL) Untuk Meningkatkan Keterampilan Berpikir Kritis |
| 49.75 | 2021 | Iga Mas Darwati, I Made Purana | *Problem Based Learning* (PBL): Suatu Model Pembelajaran Untuk Mengembangkan Cara Berpikir Kritis Peserta Didik |
| 41.60 | 2020 | Selvi Meilasari, Damris M, Upik Yelianti | Kajian Model Pembelajaran Problem Based Learning (PBL) dalam Pembelajaran di Sekolah |
| 36.44 | 2016 | Galuh Rahayuni | Hubungan Keterampilan Berpikir Kritis dan Literasi Sains pada Pembelajaran IPA Terpadu dengan Model PBM Dan STM |

| Cite/year | Year | Author | Title |
|---|---|---|---|
| 35.60 | 2020 | Resti Fitria Ariani | Pengaruh Model Pembelajaran *Problem Based Learning* Terhadap Kemampuan Berpikir Kritis Siswa SD Pada Muatan IPA |
| 35.20 | 2020 | Putu Sintya Devi, Gede Wira Bayu | Berpikir Kritis dan Hasil Belajar IPA Melalui Pembelajaran *Problem Based Learning* Berbantuan Media Visual |
| 34.71 | 2018 | Sry Astuti, Muhammad Danial, Muhammad Anwar | Pengembangan LKPD Berbasis PBL (*Problem Based Learning*) Untuk Meningkatkan Keterampilan Berpikir Kritis Peserta Didik Pada Materi Kesetimbangan Kimia |
| 33.63 | 2017 | Ahmad Farisi, Abdul Hamid, Melvina | Pengaruh Model Pembelajaran *Problem Based Learning* Terhadap Kemampuan Berpikir Kritis dalam Meningkatkan Hasil Belajar Siswa Pada Konsep Suhu dan Kalor |

Table 2 was obtained through the Publish or Perish application. The research trend on the Problem-Based Learning (PBL) model on critical thinking skills shows a significant increase in the period from 2015 to 2025. There are ten top citations that describe the important contributions of various researchers in the development and application of PBL to improve students' critical thinking skills. The highest citation count was obtained from an article written by Eka Yulianti and Indra Gunawan (2019) with a score of 81 citations per year, which discussed the effects of PBL on conceptual understanding and critical thinking. In addition, an article by Nugraha et al., (2017) and Masrinah et al., (2017) also shows the significant influence of PBL in improving critical thinking skills through science process skills and learning motivation. Other studies, such as those conducted by Darwati & Purana (2021), and Meilasari et al., (2020), further strengthens the evidence that PBL can effectively develop students' critical thinking skills. Several studies also link PBL with other learning approaches such as visual media and the development of PBL based teaching tools, as well as its relevance to specific topics such as temperature and heat [36]–[40]. Overall, this data reflects that the PBL model remains a relevant and highly sought-after approach for improving critical thinking skills across various levels and contexts of learning.

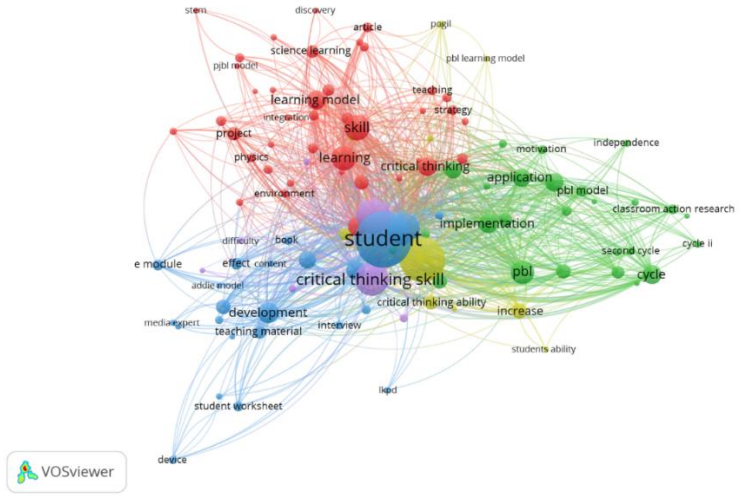


Figure 3. Network Visualization of the Problem Based Learning (PBL) Model Trend on Critical Thinking Skills

Figure 3 shows the mapping of relationships between keywords in a literature review discussing the Problem-Based Learning (PBL) model and critical thinking skills. This visualization was analyzed using VOS viewer software, which produced four main clusters, marked with different

colors based on the relationships between concepts. The first cluster (blue) consists of keywords such as student, critical thinking skill, development, teaching material, e-module, and student worksheet. This cluster represents a focus on the development of learning tools as an effort to improve students' critical thinking skills, including through the development of ADDIE-based teaching materials and interactive learning media. The second cluster (red) contains keywords such as learning model, skill, learning, science learning, project, and integration. This cluster reflects a project-based learning approach and science learning integration oriented towards strengthening students' critical thinking skills through the application of innovative learning models.

Meanwhile, the third cluster (green) includes keywords such as PBL, PBL model, implementation, application, cycle, and classroom action research. This cluster highlights the direct application of the PBL model in learning and systematic efforts to improve critical thinking skills through classroom action research using a cyclical approach. The fourth cluster (yellow) contains keywords such as teaching, strategy, students' ability, increase, and PBL learning model. This cluster emphasizes the importance of appropriate teaching strategies to improve students' abilities, especially with the PBL approach that requires active involvement and higher-order thinking skills. Overall, this visualization illustrates that students' critical thinking skills are closely correlated with the development of learning tools, the application of the PBL model, and innovative and integrated teaching strategies. The relationship between clusters shows a strong connection between these components in forming a learning ecosystem that supports the comprehensive improvement of critical thinking skills.

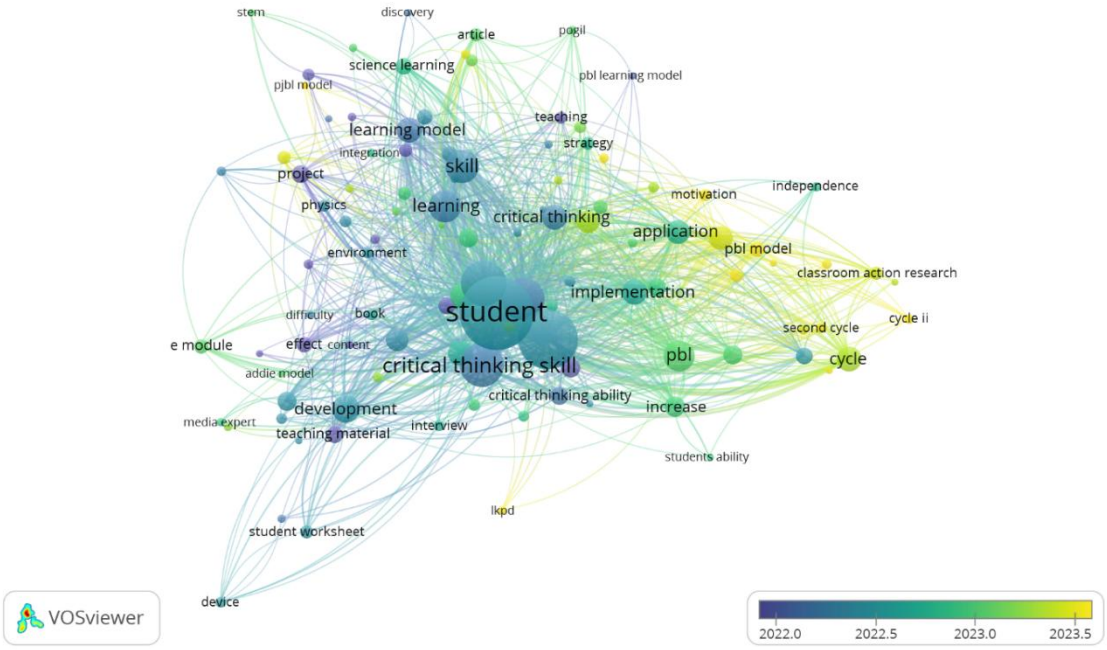


Figure 4. Visualization Overlay on the Trend of Problem-Based Learning (PBL) Models on Critical Thinking Skills

Figure 4 The visual overlay generated using VOS viewer illustrates the trend in research related to the Problem-Based Learning (PBL) model on students' critical thinking skills from 2022 to 2023. This visualization presents the distribution of keywords based on their average time of appearance, indicated by color gradation. Purple-blue indicates keywords that frequently appeared in 2022 publications, such as student worksheet, teaching material, development, learning model, science learning, physics, and Addie model. These keywords show that initially, the focus of research was more on developing teaching tools and science-based learning models to support problem-based learning. Furthermore, from mid-2022 to early 2023 (marked with a bluish green color), keywords such as critical thinking skill, implementation, learning, project, teaching strategy, and critical thinking ability appeared. This change indicates a shift in the focus of research towards the implementation of

PBL in the context of improving students' critical thinking skills. From 2023 to mid-2023 (marked in light green to bright yellow), research trends show an increase in attention to keywords such as PBL, PBL model, application, increase, motivation, classroom action research, cycle, and independence. This indicates that current research is beginning to explore the effectiveness of applying the PBL model in improving critical thinking skills through practical approaches such as classroom action research (CAR), with implementation in several learning cycles. Thus, this visualization provides an overview of the evolution of research focus from the development of teaching tools to the stage of implementation and evaluation of the impact of the PBL model on students' critical thinking skills in a more systematic and structured manner.

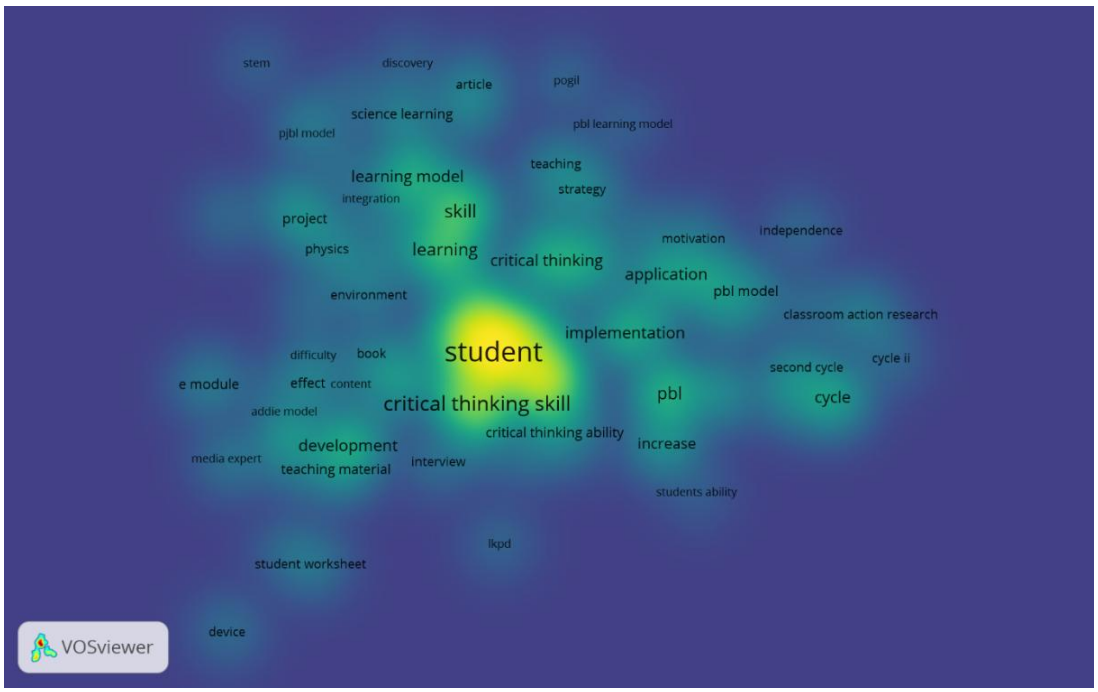


Figure 5. Density Visualization of the Trend of Problem-Based Learning (PBL) Models on Critical Thinking Skills

Figure 5 Density Visualization using VOS viewer shows that the topic "student" is the center of attention in research related to the Problem Based Learning (PBL) model and critical thinking skills. Terms such as critical thinking skill, learning, skill, and learning model appear with high intensity, indicating a strong relationship between PBL and the development of students' critical thinking skills. In addition, keywords such as implementation, application, and strategy indicate a research focus on the practical application of PBL in the classroom. The presence of terms such as teaching material, student worksheet, and media expert indicates that the development of learning tools is an integral part of the application of this model. This visualization also shows the relationship between PBL and classroom action research and cycle, indicating a sustainable approach through classroom action research. Overall, PBL has proven to be a dominant learning model in supporting the improvement of students' critical thinking skills in various educational contexts.

## CONCLUSION

Based on the results of bibliometric analysis of publications from 2015 to 2025, it can be concluded that research on the Problem-Based Learning (PBL) model and its effect on students' critical thinking skills shows a significant upward trend, especially since 2023. Scientific articles are the dominant form of publication, and science education journals are the main medium for disseminating research results. Bibliometric mapping shows that PBL research focuses not only on improving critical thinking skills, but also on developing learning tools, implementation strategies, and classroom action research. Thus, PBL can be declared a relevant and effective learning model in supporting the

development of critical thinking skills in 21st-century students. Further research is recommended to examine the effectiveness of PBL implementation longitudinally and integrate it with technology-based learning approaches and local wisdom.

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