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Research Trends of Problem Based Learning (PBL) Models to Improve Students' Critical Thinking Skills and Learning Outcomes (2016-2025): A Systematic Review

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Abstract: This study examines the trend of the Problem Based Learning (PBL) model in improving critical thinking skills and student learning outcomes during the period 2016-2025. The PBL model is a learning model that involves students to solve a problem through the stages of the scientific method so that students can learn knowledge related to the problem and at the same time have the skills to solve problems. In learning, critical thinking is a high-level thinking skill that plays an important role in solving problems. Critical thinking is the ability to develop and explain arguments from data that is arranged into a complex decision or idea. Critical thinking is able to analyze data or information in a systematic way based on logic in investigating data or facts. This study aims to identify and analyze the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes. This research method is descriptive and analytical. The data used in this study were obtained from documents indexed by Google Scholar from 2016-2025 using publish or perish and dimension.ai. The data identified and analyzed were the types of publications, publication sources, and research titles on the PBL model to improve critical thinking skills and student learning outcomes that were widely cited. The data analysis method used bibliometric analysis assisted by VOS viewer software. The results of the study showed an increase in the number of publications from 2016 to 2020, with the peak of publications occurring in 2020 and a decline in 2021 to 2022. And there was an increase again in 2023 to 2024. In 2025 there was still a decline because the title was still rarely used. However, there are fluctuations that indicate challenges in this study. In addition, there are many types of publications in the form of article chapters, proceedings, edited books and monographs. However, the most common type of publication is articles, indicating a strong contribution from research in this field.

Keywords: Critical thinking; Learning outcomes; PBL model

Introduction

Education is needed as a means of self-development, because education is one of the foundations that determines the resilience and progress of a nation. The educational pathways that exist in Indonesia are currently available through formal, informal and non-formal education pathways. Schools as formal educational institutions require a good and optimal learning process. As stated in Law of the Republic of Indonesia No. 20 of 2003 Chapter 1 Article 1 concerning the National Education System, it explains that "education is a conscious and planned effort to create a learning atmosphere and learning process so that students can actively develop their potential to have spiritual religious strength, self-control, noble values

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and skills needed for control, personality, intelligence, morality, self, society, nation and state (Arifudin, 2020).

The 21st century is a century where science is increasingly developing, this century is also often referred to as the century of a knowledge-based economy (Muliyadi et al., 2023; Susilawati et al., 2022). The world of education in the era of globalization is facing increasingly complex and rapid world developments, therefore it is necessary to develop 21st century skills. In developing 21st century learning, teachers are starting a new step by changing learning patterns that are teacher-centered to student-centered (Doyan et al., 2020; Hayati et al., 2023; Susilawati et al., 2021).

Natural Sciences (known with IPA) is a discipline that aims to find curiosity and a positive attitude towards science, technology and society, develop process skills to understand the environment, solve problems and make decisions. Learning uses the application of the Problem Based Learning (PBL) model to improve students' critical thinking in Biodiversity material because this material is very close to students' daily lives (Amaludin, 2023).

The current state of science and technology is characterized by rapid development. This means that the education system must adapt to provide opportunities and services that will help students with the support of educational professionals to support the improvement of their abilities and quality (Larisang, 2024).

The learning process is important in the world of education because through learning humans can add and update knowledge that is useful for their future. We all know that science is developing from time to time, so the learning process will also develop. In addition, the learning process can reflect the quality of education. Learning objectives will also achieve maximum results if the learning process runs effectively. Effective learning is able to actively involve all students. Learning activities are carried out based on a plan that has been prepared in advance by the teacher. In this plan, the teacher determines all learning needs including objectives, learning approaches, and learning methods (Mayasari et al., 2021).

Problem Based Learning (PBL) learning model is a student-centered learning model by confronting students with various problems faced in real life and students try to solve these problems. In this model, the lesson focuses on a problem that must be solved by students, so that students have the responsibility to analyze and solve the problem with their own abilities, while the role of the educator is only as a facilitator and provides guidance to students (Januarti et al., 2024; Meilasari et al., 2020).

The PBL model is effective in stimulating active student involvement and forming high-level thinking skills, especially critical thinking. PBL also encourages students to build their own knowledge through information searches and reflections on the results of group discussions. In the context of science learning, this model has been shown to improve conceptual understanding while building student awareness of relevant issues in everyday life (Hayati et al., 2023).

The Problem Based Learning (PBL) learning model can teach students to collaborate with others in solving problems. In learning using the problem-based learning model, the learning process is carried out by presenting problems in the surrounding environment related to the learning material (Hartiyaningsih et al., 2024).

According to Afkari et al. (2021), Problem Based Learning (PBL) encourages students to construct their own knowledge through real problems that require problem solving). The learning process that applies the Problem Based Learning (PBL) model will confront students with real problems that are close to daily activities. Through real experiences, students' critical thinking skills will improve. Learning that applies the Problem Based Learning (PBL) model can improve critical thinking skills and cognitive learning outcomes of students (Mardiah et al., 2025).

Critical thinking skills help a teacher prepare students to be able to live in their time (Wahyudi et al., 2021). Critical thinking is a high-level thinking skill that has the potential to increase students' critical analytical power. Therefore, developing students' critical thinking skills in learning is an effort to improve student learning outcomes. Critical thinking skills are a potential that everyone has, can be measured, trained, and developed. The best effort to develop critical thinking skills that can be done is by linking learning materials to students' real experiences in their daily environment (Haris et al., 2024; Kartini et al., 2019).

One of the high-level thinking skills is critical thinking skills. Critical thinking skills are an important aspect and a skill that students must have to face challenges in the 21st century so that students do not just believe in the facts around them without proving and trying to prove that the information is truly valid and accountable (Hartini, 2020). In addition, critical thinking skills according to Agnafia (2019) are the ability to think reflectively and strengthen arguments with credible reasons. Critical thinking skills are the ability to analyze, evaluate, and synthesize logically and rationally a problem.

Critical thinking is an active, coordinated, complex process, namely reading and writing, speaking and listening activities that involve the process of thinking by actively gathering information to produce reasonable decisions (Wati et al., 2020). Efforts to form optimal

critical thinking skills in students require interactive classes, students are seen as thinkers, not as those being taught, and teachers act as mediators, facilitators, and motivators who help students learn, not teach. Critical thinking skills encourage students to be active, develop trust and take action (Qomariyah, 2019). Critical thinking skills are the ability to process and evaluate information objectively, and reach appropriate and effective decisions (Doyan et al., 2022). Critical thinking is a process that is clear and has a directed process that can be used as a problem-solving activity, analyzing assumptions, in decision making, and can also be used as scientific research (Istiqomah et al., 2021).

Critical thinking is a reflective thinking ability that focuses on decision-making patterns about what to believe, what to do and what to be responsible for. Critical thinking skills are essential because someone who thinks critically will be able to think logically, answer problems well and be able to make rational decisions about what to do or what to believe. Critical thinking is a high-level thinking skill that has the potential to increase students' critical analytical power (Ennis, 2018).

The problem of learning outcomes is also an equally important problem (Telaumbanua, 2022). Learning outcomes are changes that occur in the individual who is learning, both changes in knowledge and behavior, which are shown through test scores (Rosarina et al., 2016). Learning outcomes according to Bloom include mastery of concepts, ideas, factual knowledge and relating to intellectual skills. The Affective Domain relates to attitudes and values, feelings and emotions, character, personal philosophy, self-concept, acceptance or rejection of something and mental health that is inherent and shapes a person's personality. Reflections of affective learning outcomes in students will be seen in various forms of behavior such as their attention to lessons, discipline, motivation to learn, respect for teachers and classmates, learning habits and social relationships. The Psychomotor Domain relates to learning outcomes expressed in the form of skills in completing manual tasks and physical movements or the ability to do something. Learning outcomes in this domain also include social aspects such as communication skills and the ability to operate certain tools (Jufri, 2017).

Learning outcomes reflect the extent to which learning objectives have been achieved, both in mastering concepts, developing positive attitudes towards lessons, and skills relevant to the material being taught. Furthermore, learning outcomes are also closely related to the learning methods and models used in the classroom. Interactive learning models, such as Problem Based Learning (PBL), have been shown to improve student learning outcomes because they actively involve them in the process of critical thinking and problem solving (Noviati, 2022).

In the context of 21st century education, learning outcomes also include students' abilities in critical thinking, communication, collaboration, and innovation. Therefore, teachers are required to not only deliver subject matter, but also create a learning environment that supports the development of these skills. Evaluation of learning outcomes must cover the three domains of cognitive, affective, and psychomotor in order to provide a comprehensive picture of student achievement (Rediasih et al., 2019).

There are two sources of factors that influence learning outcomes, namely internal factors and external factors, internal factors include physiological factors, psychological factors including basic intelligence, motivation, interest, attitude, talent, self-confidence and fatigue factors. While for external factors, namely the way parents educate, relationships between family members, home atmosphere, family economic conditions, parental understanding, cultural background, school factors namely teaching methods, curriculum, teacher-student relationships, student-student relationships, school discipline, learning tools, school hours, student standards, building conditions, learning methods, homework and community factors namely student activities in society, mass media, friends, forms of community life (Parwati et al., 2018).

Method

This research method is descriptive and analytical, which aims to understand and explain research trends on the Problem Based Learning (PBL) Model to improve critical thinking skills and student learning outcomes. Researchers collected data from the Dimension database for the past 10 years, namely from 2016 to 2025, related to the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes. The software used to analyze and visualize is the Vosviewer application. Searches on Google Scholar were carried out by entering keywords relevant to research trends on the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes. In this study, an analysis was carried out on 1,000 documents indexed in Google Scholar during the period 2016 to 2025 downloaded through the Publish or Perish (PoP) application, which facilitates the extraction of metadata such as title, abstract, author name, and number of citations. To ensure the relevance and accuracy of citation data, researchers also use Dimensions.ai as a supporting database.

To ensure the data selection process is carried out accurately and reliably, this study follows the PRISMA

(Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The steps applied include the process of identification, screening, eligibility assessment, and selection of appropriate documents. Duplicate or irrelevant articles were removed based on an initial review of the title and abstract, followed by a complete examination of the contents of articles that passed the initial stage.

Documents that successfully passed the final selection stage were analyzed descriptively to determine the main themes that were often discussed, the dominant focus of development in the application of the Problem Based Learning (PBL) model, the development of publications from year to year, and aspects of research that were still rarely explored. This analysis provides a complete picture of how the application of the PBL model can improve critical thinking skills and student learning outcomes in the context of modern science learning.

Result and Discussion

This study aims to describe research trends on the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes. Documents relevant to this research trend were taken from the period 2016 to 2025. The following is Figure 1 which describes research trends on the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes.

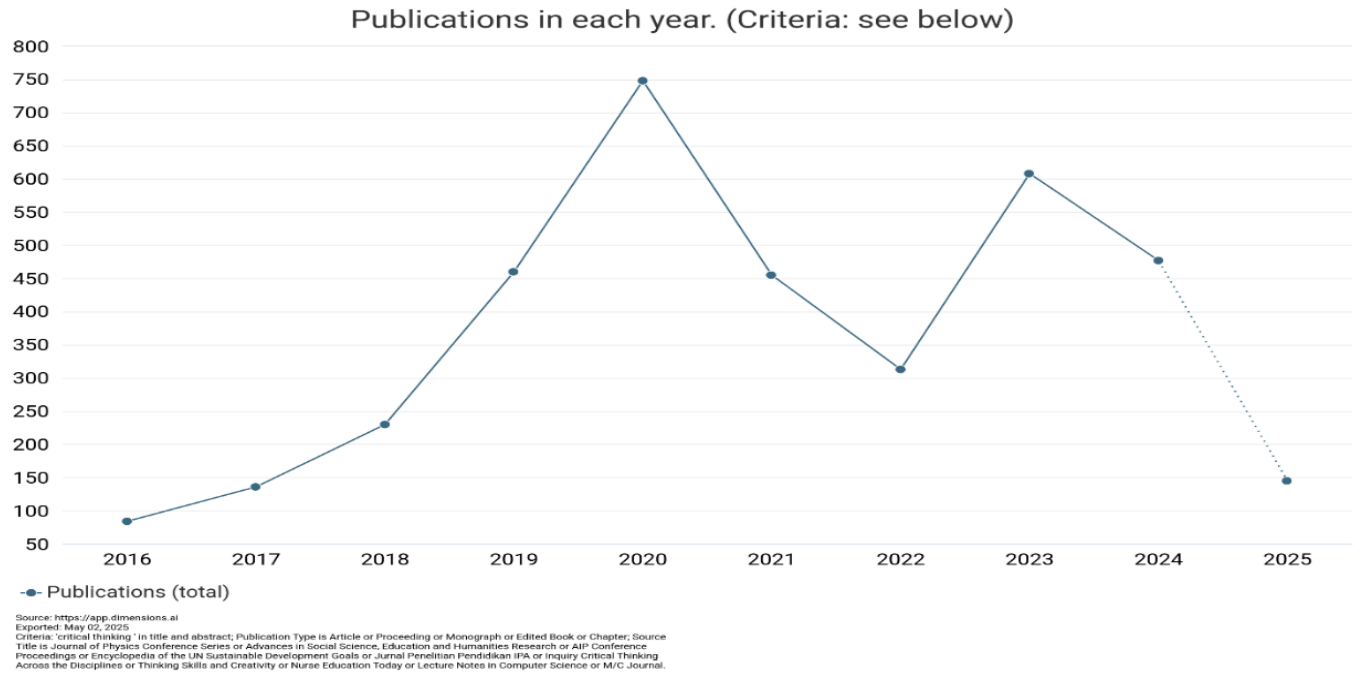

Figure 1. Trends study in model based learning *problem based learning* (PBL) for improving critical thinking skills and student learning outcomes

Figure 1 based on the graph trend publication that the model Problem Based Learning to improve critical thinking skills and student learning outcomes have increased and decreased. Where is the research trend? with improvement amount publication from year 2016 to 2025. However on year 2019 And 2022 trend study Model Problem Based Learning (PBL) to improve critical thinking skills and student learning outcomes experienced an increase and decrease. Critical thinking skills and student learning outcomes increased from the previous year and trend study return increase on year 2023. The increasing trend of research on Problem Based Learning models to improve critical thinking skills are caused by century education 21 which focus on improvement critical thinking skills and student learning outcomes.

In 2016, the number of publications was relatively low, at around 100 publications. This number gradually increased in the following years, reaching around 250 publications in 2018 and skyrocketing in 2020 with a peak of around 750 publications. This sharp increase was most likely due to the increasing interest in innovation in learning, especially during the COVID-19 pandemic, when approaches such as Problem Based Learning (PBL) became increasingly relevant. However, after 2020, the number of publications dropped significantly to around 500 in 2021, and continued to decline until reaching its next lowest point of around 350 publications in 2022. However, this trend increased again in 2023 with around

600 publications, before declining again in 2024. The data for 2025 is shown as a dotted line, indicating that the data for this year is incomplete or still in the process of being collected. The value also looks much lower, around 150 publications, so it cannot be used as a final reference.

Overall, this graph shows fluctuations in the number of relevant studies, with a significant peak in 2020 and an upward and downward trend thereafter. This reflects the dynamics of academic attention and interest in the researched topic, and is likely influenced by external factors such as the pandemic or changes in education policy. In addition, this study also presents a model study Problem Based Learning to improve critical thinking skills and student learning outcomes according to the publication categories that can be seen in Table 1.

Table 1. Data on Research Trends Based on the Problem Based Learning Model to Improve Critical Thinking Skills and Student Learning Outcomes Based on Publication Type

Publication Type	Number of Publications
Article	82,151
Chapter	18,068
Proceeding	5,167
Monograph	3,063
Edited Book	1,842

The table above presents data on research trends based on the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes based on the type of publication. From the table, it can be seen that the type of publication that contains the most research results based on the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes is articles, with a total of 82,151 publications. Furthermore, Chapters recorded 18,068 publications, indicating contributions from scientific conferences. Furthermore, Proceedings had 5,167 publications, while Monographs had 3,063 publications. And finally, Edited Books had the lowest number of publications, namely 1,842. These data illustrate the distribution of significant publication types in research on the Problem Based Learning (PBL) Model to develop critical thinking skills and student learning outcomes.

Next, the researcher presents ten (10) source titles that are trending in research on the Problem Based Learning (PBL) model which aims to improve critical thinking skills and student learning outcomes, and are often referred to by other researchers related to this topic, which can be seen in Table 2.

Table 2. Trends in 10 Journal Source Titles of Problem Based Learning (PBL) Model to Improve Critical Thinking Skills and Student Learning Outcomes (2016-2025)

Journal Name	Publication	Quote	Average Quote
Journal of Science Education Research	115	327	2.84
Scholarly Journal Journal of Mathematics Education	54	276	5.11
Basicedu Journal	51	456	8.94
Journal of Advances in Social Science, Education and Humanities Research	50	64	1.28
Educational Journal of Educational Sciences	47	162	3.45
Kalam Cendekia Scientific Journal of Education	44	22	0.50
Scientific Journal of Education Profession	36	50	1.39
AKSIOMA Journal of Mathematics Education Study Program	35	56	1.60
Scientific Periodical Journal of Biology Education (BioEdu)	32	124	3.88
Journal on Education	29	29	1.00

Table 2 shows the number of publications from each journal and the number of citations that vary reflect the level of recognition and relevance of each source title among researchers, where journals with higher citations indicate significant contributions to the field. It can be seen that the source that most publishes research trends on Problem Based Learning (PBL) Models to improve critical thinking skills and student learning outcomes is the Science Education Research Journal, which has 115 publications with 327 citations and an average citation of 2.84 citations per article. The Science Education Research Journal publishes scientific articles that cover research results in the fields of science, technology, and science teaching including the learning model, namely Problem Based Learning (PBL) on critical thinking and student learning outcomes. In addition, the Cendekia Journal: Mathematics Education Journal has made a significant contribution to the academic field, as seen from the number of its publications reaching 54 articles. From these publications, this journal has been cited 276 times, with an average citation per article of 8.94. This figure shows that each article published by this journal is quite often used as a reference by other researchers.

On the other hand, the Scientific Periodical Journal of Biology Education (BioEdu) and the Journal on Education do have fewer publications, namely 32 and 29

articles respectively. However, even though the number of citations is 124 citations for BioEdu and 29 citations for the Journal on Education, these two journals still show a strong influence, because the average citations per article are 3.88 and 1.00 respectively. This average indicates that although the articles are not as many as other journals, the content is still relevant and often referred to by researchers, which shows a positive impact on the development of science, especially in academic circles.

Overall, information from various sources shows that research on the application of the Problem Based Learning (PBL) model as an effort to improve critical thinking skills and student learning outcomes has received quite extensive attention among academics. Studies on this topic are not only published in journals that specifically focus on the field of science education, but also appear in educational technology journals and even in interdisciplinary publications.

This shows that the PBL approach is considered relevant and important by researchers from various scientific backgrounds. In other words, interest in this topic continues to increase, along with the awareness of the importance of learning strategies that can encourage students to think critically while improving their learning outcomes.

Next, the image shows the results of data analysis from VOSviewer on journals connected to Google Scholar. This analysis looks at the relationship between topics discussed in various scientific studies. Figure 2 shows the results of the relationship between words from articles discussing the Problem-Based Learning (PBL) model to improve critical thinking skills and student learning outcomes.

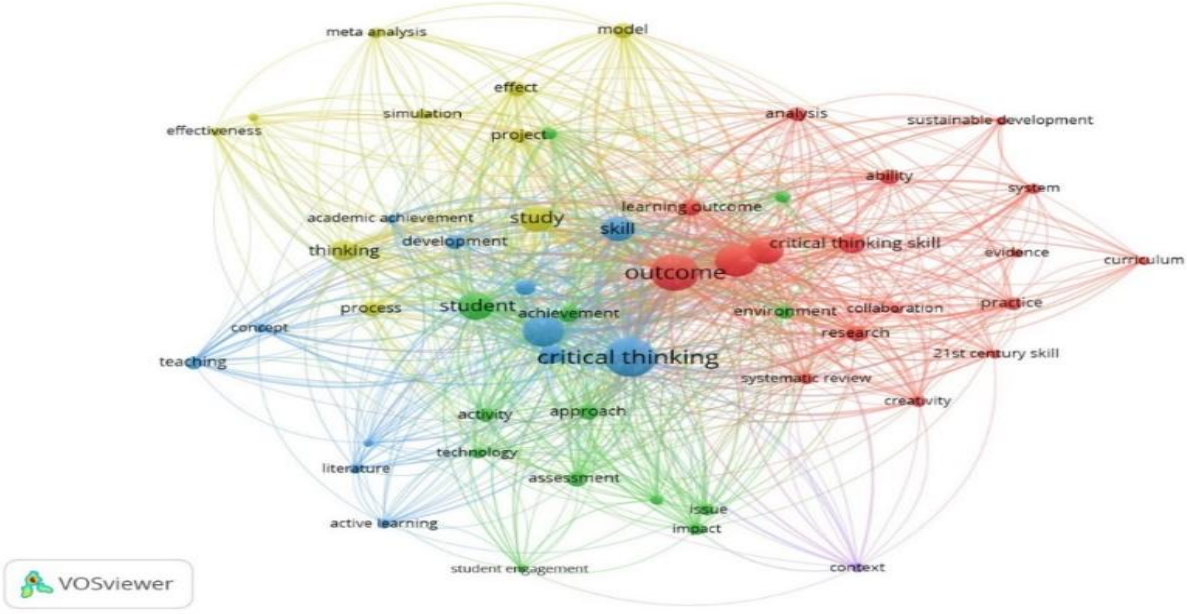

Figure 2. Visualization of the problem based learning (PBL) model network to improve students' critical thinking skills and learning outcomes (2016-2025)

Figure 2 shows the results of mapping word relationships on research trends related to the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes. Figure 2 contains 42 keyword items that are often used in research on the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes from 2016 to 2025. In addition, Figure 2 also contains 5 clusters, where the first cluster in blue is the center of the network consisting of 8 items with the main keywords, namely critical thinking, skill, active learning, literature, teaching, concept, development and achievement. The second cluster in red consists of 15 items that include keywords, namely critical thinking skills, outcomes, learning outcomes, analysis, systematic review, system, ability, curriculum, practice, evidence, 21st century skill, creativity, research, collaboration, and sustainable development.

The third cluster is green, consisting of 9 items with keywords, namely student engagement, issue impact, assessment, technology, activity, approach, student, achievement, and environment. The fourth cluster is yellow, consisting of 9 items with the keywords model, meta analysis, effect, project, simulation, effectiveness, study, thinking, and process. The fifth cluster is purple, consisting of 1 item with the keyword context. Below is also presented Figure 3 with keywords regarding the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes based on overlay visualization.

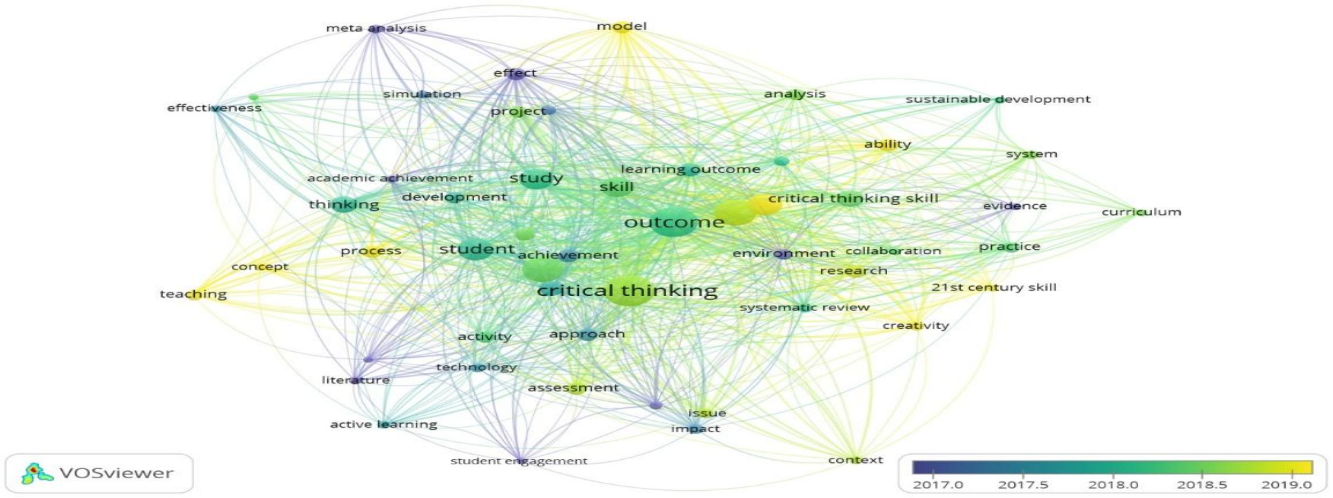

Figure 3. Visualization of the problem based learning (PBL) model overlay to improve critical thinking skills and student learning outcomes

Figure 3 this visualization shows the development of keywords related to research on the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes indexed by Google Scholar from 2016 to 2025. The trend of research on the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes with a blue color gradation is a topic that has been discussed for a long time, while yellow is a topic that is newer. The larger the size of the circle (node), the more frequently the topic appears in research. It can be seen in Figure 3 that the keywords student engagement, literature, metaanalysis, effect, environment, and evidence were found in 2017. While in 2019 the keywords that often appeared were critical thinking skills, 21 st century skills, teaching, concept, process, model, research, ability and creativity. Research on the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes has become one of the fastest growing research fields in recent years. Furthermore, the keywords of the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes based on density visualization in Figure 4 are also presented.

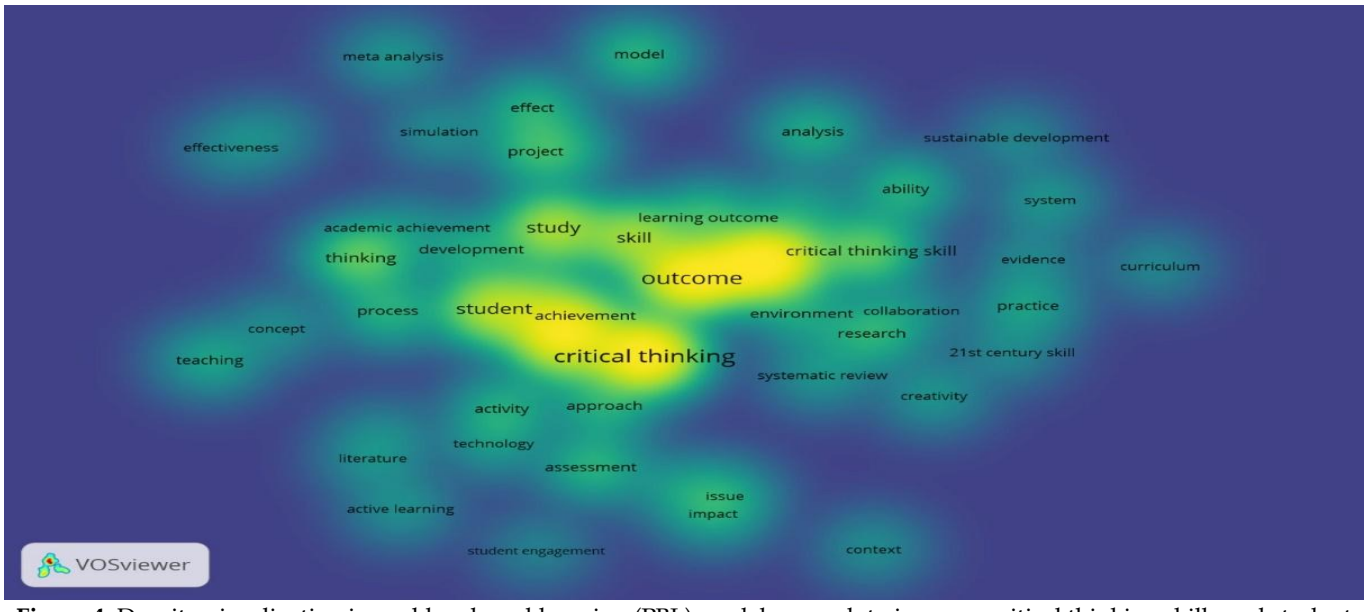

Figure 4. Density visualization in problem based learning (PBL) model research to improve critical thinking skills and student learning outcomes

Figure 4 shows the density visualization. Density visualization shows that the brighter the color of a research topic, the more people are doing research on that topic. In the density visualization, brightly colored

topics, namely critical thinking, students, skills, achievement, outcomes and learning outcomes indicate that these topics are the center of attention and are often discussed in research. However, the dimmer the color means that the topic is rarely researched. Topics that are dimmer in color such as Context, impact, student engagement, System, curriculum, sustainable development, Model, simulation, and effect indicate that the topic can be used as a reference for further research.

Overall, research on the Problem Based Learning (PBL) model that aims to improve critical thinking skills and student learning outcomes has become one of the fields that has experienced significant development in recent years. This increase is due to the shift in the focus of global education that emphasizes the development of 21st century skills, such as critical thinking skills, collaboration, communication, and creativity. The PBL model is considered relevant because it can link learning to real problems, encourage collaboration, exploration, and reflection, all of which contribute to improving critical thinking skills and learning outcomes.

Conclusion

Based on the analysis of research trends on the Problem Based Learning (PBL) model to improve critical thinking skills and student learning outcomes, it can be concluded that the Problem Based Learning (PBL) model has proven effective in creating an interactive and collaborative learning environment. Research shows that the application of the Problem Based Learning (PBL) model not only improves critical thinking skills, but also has a positive effect on students' academic outcomes. With a focus on real problems and active student involvement in the learning process, PBL is a relevant method to face the challenges of education in the modern era. Therefore, further development in the implementation of PBL in various educational contexts is highly recommended to maximize student potential. Data shows an increase in the number of publications from 2016 to 2025, with the peak of publications occurring in 2025.

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