Trends in Problem-Based Learning (PBL) Models to Improve Science Process Skills in Students' Science Learning (2015-2024): A Systematic Review

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Abstract: Intelligence ecological must owned by each humans to be able to interact with Good together nature, science process skills can improved through various method. PBL is one of the learning models based on problems that have been tested as one of the to increase science process skills through settlement problem. Research This is analysis literature data about study science process skills. The data used in study This obtained from Google Scholar indexed documents from 2020-2024 using Publish or Perish and Dimension.ai. Procedure study use PRISMA guidelines. Data identified and analyzed is type publications, sources publication, and title study about the PBL model for increase science process skills in lots of science learning quoted. The data analysis method uses analysis assisted bibliometrics with device VOS viewer software. Research results Analysis show that trend PBL model research for increase science process skills in Google Scholar indexed science learning from 2020 to 2024 experienced fluctuating increase. However, in 2024 it will happen decline trend study about it. There are many document in form articles, proceedings, chapters, preprints, and edited books that discuss study about the PBL model for increase science process skill.

Keywords: Problem based learning; Science process skills; Technology

Introduction

Learning model based on problems (Problem Based Learning, PBL) have appear as one of the approach innovative in education, in particular in science teaching. PBL emphasizes involvement active student in solve complex and relevant problems, which are encouraging they for apply knowledge and skills that have been studied. Approach This No only help student understand science concepts, but also develop essential science process skills, such as observation, analysis, and testing hypothesis.

In context science education, process skills are very important Because allow student for do investigation scientific in a way systematically. Through PBL, students trained for think critical, collaborative, and communicating findings they, who are competencies needed in the information age moment this. With face real problems, students can to hook learning with experience life every day, so that increase motivation and interest they towards science.

Problem-Based Learning (PBL) has emerged as a key educational strategy to enhance students' science process skills. This model emphasizes student-centered learning, where students engage in solving complex, real-world problems while applying their knowledge and critical thinking skills. As PBL encourages active participation, students not only understand scientific concepts more deeply but also develop essential skills such as observation, analysis, hypothesis testing, and communication. In particular, research has highlighted that PBL fosters the development of students' scientific inquiry skills, crucial for performing systematic investigations. Studies have shown that integrating technology into the PBL process, such as using digital simulations for experiments, helps to engage students in more collaborative and interactive learning environments (Savery, 2006). This active involvement in

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solving problems allows students to connect theoretical knowledge with real-world applications, thus enhancing their science process skills.

Moreover, PBL is effective in improving students' metacognitive skills, which play an important role in scientific inquiry. By engaging in reflective thinking during problem-solving tasks, students become more aware of their cognitive processes, which enables them to better identify their strengths and areas for improvement. According to Hmelo-Silver (2004), this reflective aspect of PBL helps students gain a deeper understanding of the subject matter while simultaneously fostering critical thinking. Additionally, PBL promotes teamwork, as students often work in groups to tackle problems. The collaborative nature of PBL not only improves communication skills but also encourages students to learn from one another, thus enhancing their problem-solving abilities. This integrated approach to learning is particularly useful in the context of science education, where students must be able to work together and apply a range of scientific techniques in a systematic way (Barrows, 2002).

The application of PBL in science classrooms has also been shown to increase student engagement and motivation. By presenting students with authentic, real-world problems, they are more likely to see the relevance of science to their daily lives, which can increase their interest and motivation to learn. This is particularly important in a time when scientific literacy is increasingly crucial for students' future careers. In a study by Johnson et al. (2000), it was found that PBL not only improves science process skills but also boosts student confidence in applying those skills to new situations. The opportunities provided by PBL for students to actively engage in their learning process and work collaboratively lead to improved scientific understanding and problem-solving capabilities. As a result, students are better equipped to face the challenges of the modern world, making PBL a highly effective method for fostering essential 21st-century skills (Prince, 2004).

Study show that PBL can in a way significant increase science process skills and outcomes Study students. This model give student chance For play a role active in the process of learning, developing creativity, as well as increase ability think critical and analytical. This article aiming for explore How the application of the PBL model can increase students' science process skills and their impact to mastery science material.

Method

Research methods this nature descriptive analytical, which aims for analyze trend study science process skills. The data used in study This obtained from source information indexed by Google Scholar then filter the data that has been collected through Publish or Perish, researchers using Preferred Reporting Items for Guidelines Review Systematic Reviews and Meta-Analysis (PRISMA).

Result and Discussion

Results Study This aiming for describe trend learning model research problem based learning for increase science process skills carried out in 2020 to with 2024. Document study about trend learning model research in amount publication every the year increased , namely from 2020 there were 563 publications. 2021 there were 862. Next in 2022 the number is 1,043 and in 2023 it will reach number highest a total of 1,235 publications. But in 2024 the trend study about the problem solving learning model for increase science process skills experience decline to number 750.
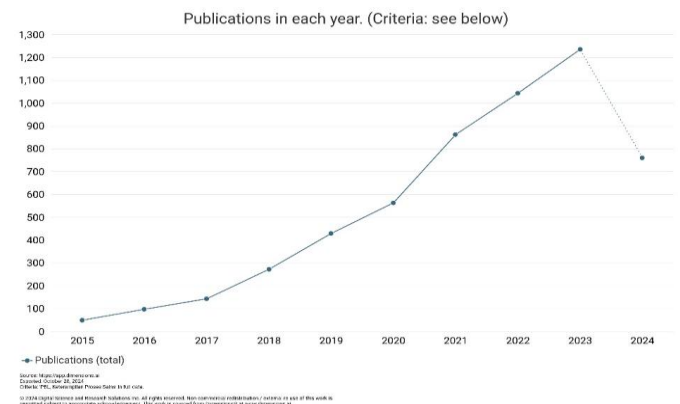

Figure 1. Shows that trend PBL research for increase science process skills from year to year

Table 1. Shows Trend Type Publication of Problem Solving Learning Models in Increase Science Process Skills

Publication Type	Publication
Article	5.325
Addition Book	80
Chapter	17
Monograph	3
Proceeding	84

Based on table 1 shows that trend study about How PBL is influential in increase participants' science process skills educate shows data in 5 types frequent publications used by researchers for publish results his research. The amount publication on type publication article reach the number 5,325 then this type of edited book contains 80 articles. There are 17 chapters, then the monograph is also there at number 3. Last is in the proceeding section showing at 84 publications.

This matter show that article is type place many publications used by researchers. This is because of

articles, especially those published online, can accessible to the public wide without limitation geographical. This is make it easier distribution information and knowledge to readers around the world.

Table 2. Shows Trend Place Publication Problem Based Learning Research for Increase Skills Participant Educate

Name	Publication	Citation	Citation means
Journal Science Education Research	456	1,235	2.71
Journal Basicedu	340	2,044	6.01
Educative Journal Educational Science	238	670	2.82
Advances in Social Science, Education and Hu	221	289	1.31
Journal of Physics Conference Series	181	913	5.04
Journal Scholar Journal of Mathematics Education	162	609	3.76
AKSIOMA Journal of Education Study Program M	142	344	2.42
Journal Incandescent Science	132	500	3.79
Journal Scientific Education Profession	123	451	3.67
Journal of Educational Theory Research and Development	120	413	3.44

Second table this shows five names journal the top most publish about PBL for increase science process skills. Journal This among them journal Science Education research totaling 197 publications, Journal Basicedu as many as 157, Educational Journal Educational Sciences 95 publications, Advances in Social Science, Education and Hu 88 publications, and Journal Scientific Education Profession as many as 67 publications.

Publication in journals scientific own Lots benefit for researchers. Publication good journal can increase reputation researcher so that Can become support career. During his devotion Then researcher Lots publish article so researcher the considered as expert in his field. This is Can proven with how much many people access article. Based on the data above place publication the most journals is science education journal. Journal This is journal syntax 1 that can it is said as very good journal. Journal This describe visibility a more articles tall compared to sinta below. Advantages This can spread use article with extensive network and increase citation in the article.

Table 3. Shows Trend Name Researcher with Topic Problem Based Learning for Increase Science Process Skills

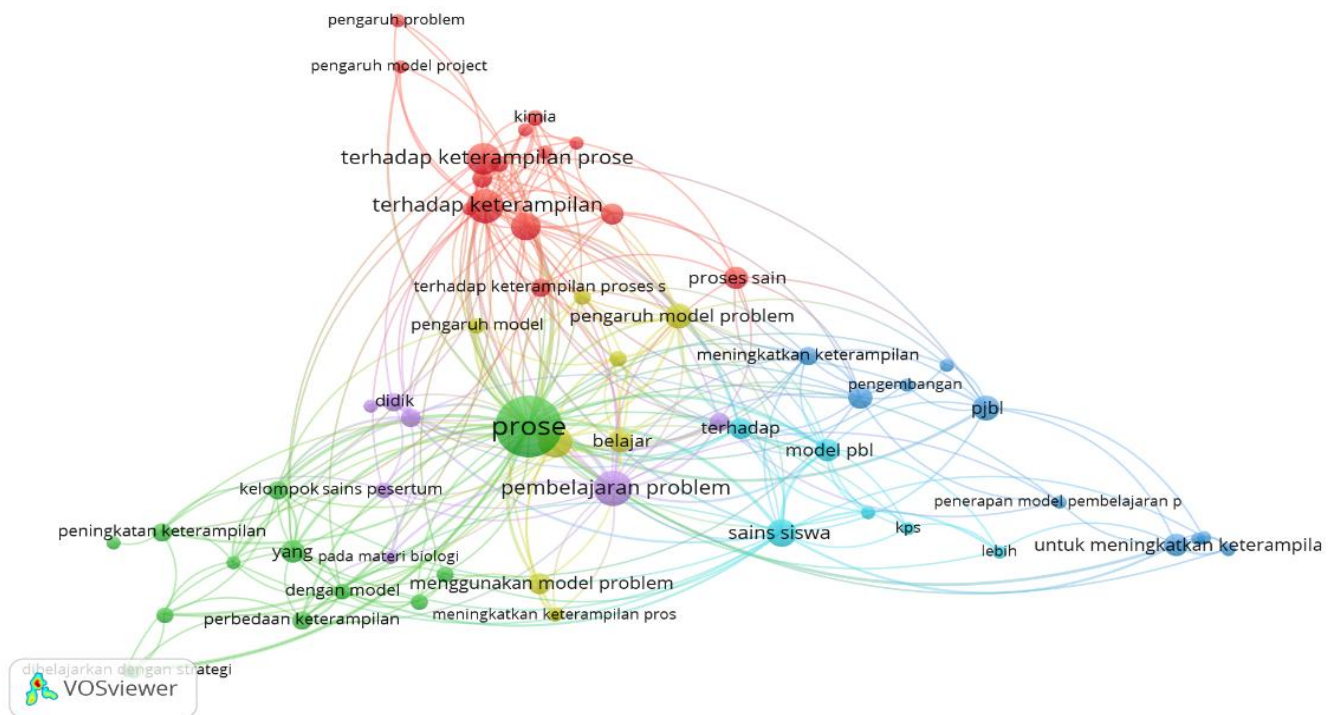| Cite/year	Year	Author	title
8	2020	Habibi, M. R.	Increase Science Process Skills in Theme 5 Lessons Through the Problem Based Learning Model for Students Grade IV of SDN 1 Sembalun North Lombok Roof
2	2023	Khotimah, K., & Supratiyoko, K.	Upgrade science process skills with the Problem Solving learning model
23	2021	Nuraini, E Waluyo	Development design integrated project based learning instructional model science process skills for increase scientific literacy
25	2024	Sandy, U. P., Kartini, K., & Ningrum, V.S.	The Influence of the Problem Based Learning Model on Science Process Skills for Grade V Students on Human Movement Organs
	2023	Silaban, Hebron Pardede , Asnita The Market	Implementation Learning Based on Problems to increase yield Study Cognitive and Science Process Skills of Junior High School Students
10	2022	Tiyasrini	Implementation of Learning Models Based on Problem Based Learning (PBL) Problems in Improving Social Studies Learning Outcomes on Economic Activities in ASEAN Countries for Students Class VI of Dawuhansengon II Elementary School in 2020
3	2022	Mosque Qurrotu Aini	Difference Students' Science Literacy in the Implementation of Problem Based Learning and Project Based Learning Models
6	2023	Muh. Rafi'y, Ferry Irawan The Dharma Gyta Sari Harahap	Development of Interactive Teaching Materials Based on Problem Based Learning for Increase Ability Student Science Literacy
17	2020	Arman, Muhsinah Annisa, Kartini	Development Devices Learning Science Characterful Based on the Integration of Problem Based Learning Models and Science Process Skills
3	2022	Evy Aldiyah	Improvement Student Process Skills Class VII State Junior High School 202 Jakarta Through Implementation of Problem Based Learning with Experimental Method on Heat Material

Figure 2. Visualization network trend problem based learning research for increase science process skills

Figure 2 above show that visualization network show network between term or keywords that currently visualized. Keywords contained is a classified keyword to in three twelve division arranged in chart colors indicating interconnected divisions connected. The image above is a keyword yes often used in study about learning models problem based learning for increase science process skills during a number of year final.
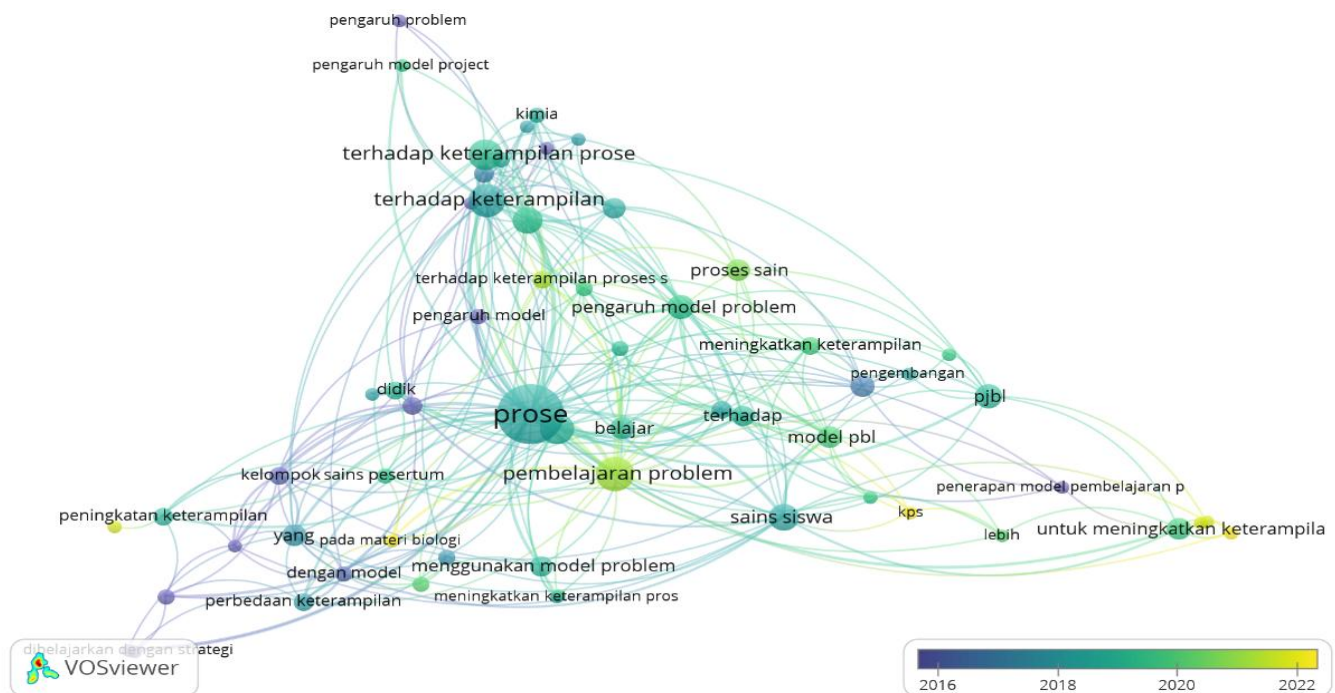

Figure 3. Overlay visualization on the trend problem based learning research for increase science process skills

Figure 3 next show Keyword Trends related research on problem solving learning models for increase the relevance of the scientific process in journals indexed by Google Scholar from 2015 to with year connected. Analysis results this can used for knowing 2024. Theme trends writing article related to problem

based learning model trends keyword research in a few years last. Analysis shows some frequently used keywords used in learning model research problems for increasing science process skills in science learning. The more many keywords appear, the more wide visualization is shown. Below this also presents keywords regarding learning models based on project for increasing science process skills in science-based learning overlay visualization.

Learning models For increase science process skills in science learning from year the oldest until latest marked with theme color purple, blue, turquoise, green old, green young and yellow. In the image below this seen that skills think creative, study cases, technology, etc. This show that keyword the Lots used by researchers in 2020. In some year final this, the keywords that are often appear is process skills, effectiveness PBL,science students , problem learning, etc.
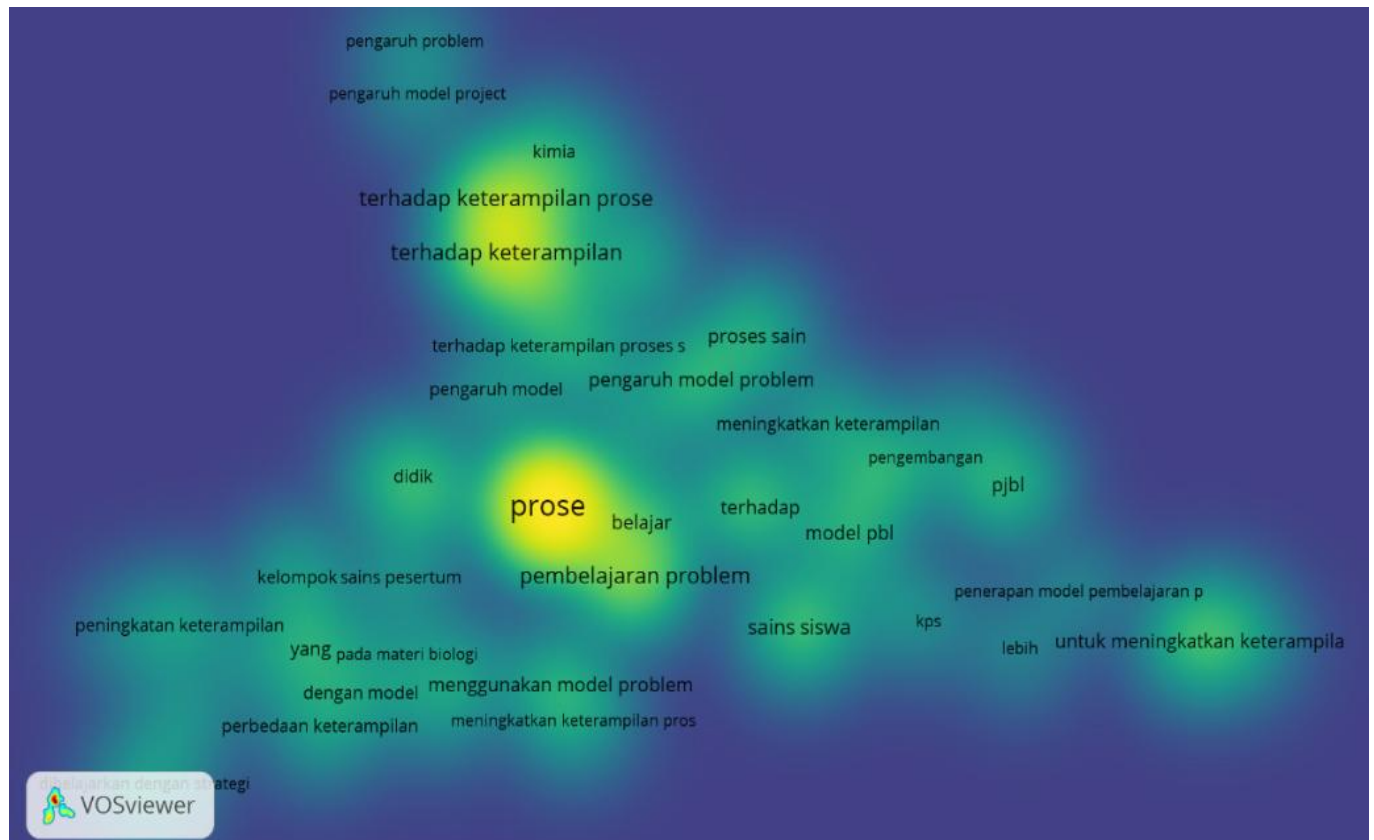

Figure 4. Visualization density trend problem based learning research for increase science process skills

Following this, the study presents keywords for a learning model project designed to increase the breakdown of problems in science learning, with a focus on visualization density. Figure 4 displays the visualization density of the themes, with brighter yellow colors indicating more research in a given area. The brighter the color, the more studies have been conducted in that specific area. Conversely, the dimmer the color, the less explored the topic is. This representation highlights key themes in Problem-Based Learning (PBL) research. Themes that are brighter, such as science process skills, learning effectiveness, and problem-based learning, show areas with more frequent studies. On the other hand, the dimmed themes, like certain scientific process skills or new research in PBL methods, indicate areas with limited exploration and research. These dimmed themes suggest that there is room for further

study and development in these areas (Suryani, 2020; Susanto & Darmawan, 2018).

Research on learning models based on problems, particularly those designed to improve science process skills in students, shows that less frequently studied areas (highlighted by dimmer colors) should be prioritized in future research. Studies by Kaur et al. (2022) confirm that the themes with dimmed color in visualization represent research topics that are seldom studied. Moreover, keywords that are somewhat vague, such as science processes, science process skills, and learning effectiveness, remain less explored despite their potential to further advance education research. These vague themes indicate opportunities for expanding the effectiveness of the science process learning models, which should be further explored to enhance the quality and impact of science education (Rahmawati, 2022; Wijnen & Lamberts, 2018).

Conclusion

Based on the analysis of research trends on the problem-based learning (PBL) model for enhancing science process skills from 2020 to 2024, it can be concluded that the number of publications increased annually, reaching its peak in 2023 before declining in 2024. Scientific articles were the most dominant type of publication, primarily due to their ease of dissemination online. Jurnal Penelitian Pendidikan IPA, Jurnal Basicedu, and Edukatif Jurnal Ilmu Pendidikan were the main sources of PBL-related research publications, highlighting the crucial role of these journals in increasing research visibility and academic reputation. Several researchers, such as Muhamad Ridwan Habibi, Khotimah, and Supratiyoko, made significant contributions to PBL studies, particularly in enhancing students' science process skills. Network visualizations indicate that keywords such as science process skills, PBL effectiveness, and problem-solving learning have become more prominent in recent research, reflecting a shift in focus. Thus, PBL continues to evolve as an effective approach for improving science process skills, with great potential for further research in the future.

Conflicts of Interest

All authors declare that they have no conflict of interest.

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