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Trends Research Project Based Learning (PjBL) Model to Improve Problem Solving Skills in Students' Science Learning (2015-2024): A Systematic Review

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Abstract: Problem-solving ability is an important ability for students to have in science learning. With the ability to solve problems, students' critical, logical, and creative thinking skills can increase. Problem solving skills can be facilitated through learning with a project-based learning (PjBL) model. This research aims to identify and analyze research trends of PjBL model to improve problem solving skill in science learning. This research method is descriptive and analytical. The data used in this research was obtained from documents indexed by Google Scholar from 2015-2024 using Publish or Perish and Dimension.ai. Research procedures use PRISMA guidelines. The data identified and analyzed are the type of publication, publication source, and the title of research on PjBL model to improve problem solving skill in science learning that is widely cited. The data analysis method uses bibliometric analysis assisted by VOS viewer software. The results of the analysis show that research trend on PjBL model to improve problem solving skill in science learning indexed by Google Scholar from 2015 to 2024 has experienced a fluctuating increase. However, in 2024 there will be a decline in the research trend on it. There are many documents in the form of articles, proceedings, chapters, preprints and edited books that discuss research into the PjBL model to improve problem solving skill in science learning. Key words that are often used in research about it are STEM project, creative thinking skill, technology, critical thinking, discovery, etc.

Keywords: Problem solving; Project based learning; Review; Science learning

Introduction

Increasing the standards and quality of education is one of the strategies implemented by government as a response to the era globalization currently being faced (Zajda, 2020). Effort to improve educational standards aims to create human resources excellence that can be identified through mastery of 21st century skills by every individual (Van Laar et al., 2020). The level of Science and Innovation accomplished by a country may be a benchmark to see the degree of the nation's improvement and advance. Besides, in this time of globalization, the advance of a country is generally decided by quality human assets. One implies of making strides the quality of human assets is through instruction. Instruction will shape a person's identity and mental insights (Dewi Muliani & Citra Wibawa, 2019).

Effort to move forward instructive guidelines points to make human assets greatness that can be recognized through dominance of 21st century abilities by each person. Importance of 21st century abilities has

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made it a center major in current instructive inquire about Usually caused by the significance of 21st century abilities as planning of understudies in confronting different future challenges (Larson & Miller, 2011) and had a considerable affect on students' lives after them total their formal instruction (Kaufman, 2013). The execution 21st century abilities are considered to be a must in each handle learning (DiCerbo, 2014); (Griffin, 2017); (Lambert & Gong, 2010). 21st century education has focused on improving creative competence, critical thinking, problem solving, cooperation and communication (González-Pérez & Ramírez-Montoya, 2022). This will be a challenge for schools and teachers to find ways to ensure that 21st century competencies can be possessed by students (Azizah & Budijastuti, 2021).

The execution of comprehensive learning in Indonesia still has issues. This issue is demonstrated by the comes about of the 2018 Program for International Student Assessment (PISA) overview which appears that Indonesia is distant behind other nations, to be specific positioning 71st out of 79. Learning results are to a great extent decided by the quality of learning usage. The superior the exercises in learning, of course the learning results accomplished by understudies will be maximized. One of the variables causing the usage of learning to not be ideal is the utilize of learning models that are still less shifted (Songkram et al., 2023). (Susilawati et al., 2022), educator abilities are required in actualizing learning with different learning models that suit the characteristics of the learning fabric and the comes about to be accomplished.

In association with the request to make strides the quality of human assets, the quality of instruction has to be progressed in all subjects, including science subjects. Science is judicious and objective information around the universe and its substance. Science learning is learning that gives openings for children to think imaginatively. Science learning will be more important on the off chance that the learning prepare employments models of self-discovery (Dwi Apriliani et al., 2019; Chusni et al., 2020). Natural science is one of the sciences that studies natural phenomena. In science learning, students are not only equipped with mastery of a number of sciences, but are also given sufficient space to apply the knowledge they learn in everyday life (Astalini et al., 2022; Kurniawan et al., 2023; Nurlia, 2023). In every educational unit, the science learning process should be carried out interactively, inspiringly, fun, challenging, motivating students to actively participate, and providing sufficient space for creativity and independence according to the talents, interests, and physical and psychological development of students (Darmaji et al., 2021; Ayu Sri Wahyuni, 2022).

This is because in science learning, students do not only memorize concepts and answer questions, but students are also expected to be able to understand, observe, analyze and solve problems that will later be useful in everyday life (Maison et al., 2020). Therefore, the success of science learning is related to students' problem-solving abilities (Misastri et al., 2023). Problem-solving ability is an important ability for students to have in science learning. With the ability to solve problems, students' critical, logical, and creative thinking skills can increase (Setiyowati et al., 2023). Students who have problem-solving skills can understand problems, plan strategies and implement plans to solve a problem (Mahrus et al., 2022); (Sinaga et al., 2023). To further develop students' problem-solving abilities, efforts can be made to create learning experiences that can provide students with the ability to adapt to be more dynamic in thinking critically during the learning process. This shows that problem-solving skills can build critical thinking skills in learning (Jama, 2023). One of the efforts to improve students' problem-solving abilities is by implementing active learning models in the classroom, for example PjBL (Awal et al., 2023). Therefore, this research wants to know the research trend of the project-based learning model to improve problem solving skills. It is hoped that this research can become a reference in developing further research related to problem solving in students' science learning.

Method

This research method is descriptive and analytical, which aims to understand and describe research trends in the project-based learning model to improve problem solving skills in science learning. The data used in this study was obtained from information sources indexed by Google Scholar using analytical tools such as Publish or Perish and Dimension.ai. To carry out a search on Google Scholar, keywords related to research trends on the project-based learning model to improve problem solving skills in science Learning.

In this research, an analysis was carried out on 1,000 documents that had been indexed by Google Scholar between 2015 and 2024. The Google Scholar database was chosen as a place to search for documents because Google Scholar applies consistent standards in selecting documents to be included in its index, and Google Scholar displays more documents than the top databases. Others, especially research in the field of education (Hallinger & Chatpinyakoop, 2019; Hallinger & Nguyen, 2020; Zawacki-Richter et al., 2019). To filter data that has been collected via Publish or Perish, researchers used the Preferred Reporting Items for

Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Result and Discussion

This research aims to describe research trends on project-based learning model to improve problem solving skills conducted from 2015 to 2024. Research documents on research trends project-based learning model to improve problem solving skills in science learning are taken from documents from 2015 to 2024. Figure 1 is presented below regarding research trends on the project-based learning model to improve problem solving skills in science learning.

Figure 1 shows that the trend in research on the project-based learning model to improve problem solving skills in science learning from 2015 to 2024 has increased. Where the research trend is with an increase in the number of publications every year, namely from 2015 to 2023. However, in 2024 the research trend on the project-based learning model to improve problem solving skills has decreased. The increasing trend in research on the project-based learning model to improve problem solving skills caused by 21st century education has focused on improving problem solving competence.

In 2015 there were 12 publications related to the problem-based learning model to improve critical thinking skills, then this will continue to increase to 564 publications in 2023. This increasing research trend provides a deeper understanding the problem which is low of problem-solving skills in science learning and ways to solve that problem. Research is able to improve problem solving skills through various methods, one of them is project-based learning model. Below are also table 1 presented research of project-based learning model to improve problem solving skills based on the type of publication.

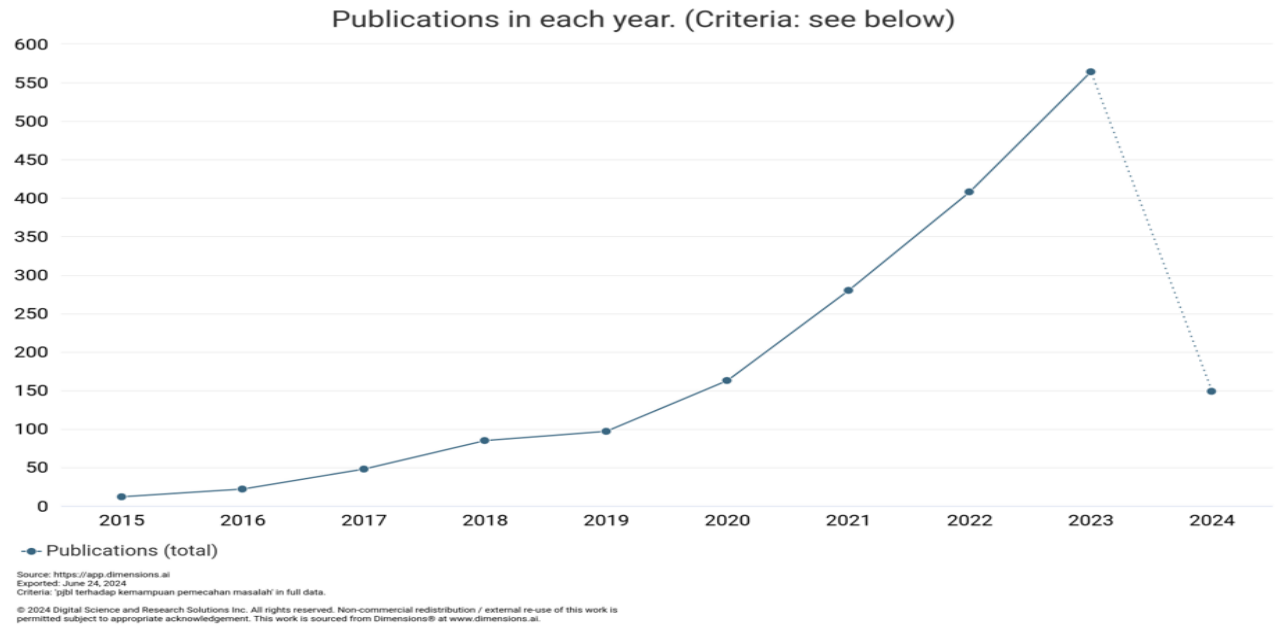

Figure 1. Research trends in project-based learning model to problem solving skills

Table 1. Trends in Project Based Learning Model to Improve Problem Solving Skills Research Based on Publication Types

Publication Type	Publications
Article	1,767
Edited Book	39
Proceeding	15
Chapter	11
Preprint	3

Based on Table 1, it is known that research project-based learning model to improve problem solving skills in science learning from 2015 to 2024 contained in 5 types of publications. In the form of articles there were 1,767 documents, chapters as many as 11 documents, proceedings as many as 15 documents, edited books as many as 39 documents, and preprints as many as 3 documents. Research trends project-based learning model to improve problem solving skills in science learning in article form is the type of publication that contains the most research compared to other types of publications. Meanwhile, the type of publication contains the least amount of research results project-based learning model to improve problem solving skills in science learning is a preprint. Research conducted by (2019) states that an article is a complete factual essay of

a certain length created for publication in online or print media (via newspapers, magazines or bulletins) and aims to convey ideas and facts that can convince and educate. These articles are usually published in scientific journals both in print and online (Suseno & Fauziah, 2020; Bahtiar et al., 2023).

Below are also table 2 presented top ten (10) sources title trends in research on project-based learning model to improve problem solving skills in science learning which are often cited by other researchers related to this matter.

Table 2 shows that the most widely published source of research trends on the project-based learning model to improve problem solving skills in science learning is the Jurnal Penelitian Pendidikan IPA, namely 49 publications with 97 citations and an average citation of 1.98. Jurnal Penelitian Pendidikan IPA contains scientific articles form of research results that include science, technology, and teaching in the field of science. The first edition was published in 2015. All edition in this journal is open access, i.e., the articles published in them are immediately and permanently free to read, download, copy & distribute. Below are also table 3 presented top ten (10) article title trends in research on project-based learning model to improve problem solving skills in science learning which are often cited by other researchers related to this matter.

Table 2. Top 10 Sources Title Trend of Project Based Learning Model to Improve Problem Solving Skills In Science Learning Research in 2015-2024

Name	Publications	Citations	Citations Mean
Jurnal Penelitian Pendidikan IPA	49	97	1.98
Jurnal Basicedu	44	341	7.75
Advances in Social Science, Education and Humanities Research	42	24	0.57
Edukatif Jurnal Ilmu Pendidikan	36	243	6.75
AKSIOMA Jurnal Program Studi Pendidikan Matematika	35	65	1.86
Jurnal Cendekia Jurnal Pendidikan Matematika	22	50	2.27
Journal of Physics Conference Series	21	185	8.81
Jurnal Ilmiah Profesi Pendidikan	20	15	0.75
Social Humanities and Educational Studies (SHEs) Conference Series	20	3	0.15
Jurnal Obsesi Jurnal Pendidikan Anak Usia Dini	18	29	1.61

Table 3 shows that research on the project-based learning model to improve problem solving skills in science learning that is widely cited by other researchers is about "The Influence of Project-Based STEM (PjbL-STEM) Applications on the Development of 21st Century Skills" which is 27.67 (Herlita et al., 2023). Then the research entitled "The Effect of STEM-PjBL and Discovery Learning on Improving Students' Problem-Solving Skills of Impulse and Momentum Topic" was cited 26.75 times (Purwaningsih et al., 2020). Research by (Hebebcï & Usta, 2022) entitled "The Effects of Integrated STEM Education Practices on Problem Solving Skills, Scientific Creativity, and Critical Thinking Dispositions" is also widely cited by other researchers, namely 21.50 per year. (Kartini et al., 2021) in their research entitled "Promoting Student's Problem-Solving Skills through STEM Project-Based Learning in Earth Layer and Disasters Topic" was cited 10.33 per year.

This research data is comparable to data on the increasing trend of research on the project-based learning model to improve problem solving skills in science learning from 2015 to 2024. This means that in that year, research related to it was continuously cited by other researchers. In the articles researched and written by these researchers, there are many terms related to project-based learning model to improve problem solving skills in science learning. Below are presented ten (10) popular keywords related to project-based learning model to improve problem solving skills in science learning.

Table 3. Top 10 Citations on Trend of Project Based Learning Model to Improve Problem Solvinf Skills in Science Learning Research in 2015-2024

Cites/year	Year	Author	Title
27.67	2021	M Baran, M Baran, F Karakoyun, A Maskan	The Influence of Project-Based STEM (PjbL-STEM) Applications on the Development of 21st Century Skills
26.75	2020	E. Purwaningsih, S. P. Sari, A. M. Sari, A. Suryadi	The Effect of STEM-PjBL and Discovery Learning on Improving Students' Problem-Solving Skills of Impulse and Momentum Topic
21.50	2022	M T Hebebci, E Usta	The Effects of Integrated STEM Education Practices on Problem Solving Skills, Scientific Creativity, and Critical Thinking Dispositions

Cites/year	Year	Author	Title
10.33	2021	Kartini, Firdha Sarah; Widodo, Ari; Winarno, Nanang; Astuti, Lia	Promoting Student's Problem-Solving Skills through STEM Project-Based Learning in Earth Layer and Disasters Topic
8.00	2022	Kiong et al	Inventive Problem-Solving in Project-Based Learning on Design and Technology: A Needs Analysis for Module Development
3.00	2023	S Ilma, A Adhani, N T Sarira	Hybrid project-based learning for problem-solving skils and student creativity in plant anatomy and physiology courses
2.50	2020	N Harefa, L S L Purba	Problem solving skills improvement and the impact on students' learning outcomes: learning based e-project
2.00	2024	A Roosyanti, D Y Suryarini	Science problem solving in elementary schools through the application of project-based learning
1.00	2023	K Kurniahtunnisa, E C Wowor	Development of STEM - Project Based Learning Devices to Train 4C Skills of Students
0.67	2021	Parno, S Zulaikah, F U N Rosyidah1and M Ali	Faraday flashlight project-based STEM to enhance problem-solving skill of students

Table 4 shows that the keywords that often appear related to research on the the project-based learning model to improve problem solving skills in science learning are STEM project, 12 times with a level of 2.52. PJBL models are often combined with STEM to improve a variety of 21st century skills, including problem solving skills (Kurniahtunnisa & Wowor, 2023). Table 4 also shows that creative thinking skill is also a keyword that appears frequently in research trends on the project-based learning model to improve problem solving skills in science learning, namely 9 times with a relevance of 2.14. There are many articles of the PjBL model to problem solving and creative thinking (Ilma et al., 2023).

Table 4. Keywords on Trend Project Based Learning Model to Improve Problem Solving Skills In Science Learning Research in 2015-2024

Terms	Occurrences	Relevance
STEM project	12	2.52
Creative thinking skill	9	2.14
Technology	24	2.10
Critical thinking	16	1.28
Discovery	9	1.18
Local wisdom	9	1.12
Physics	21	0.95
Motivation	24	0.89
Inquiry	20	0.66
PBL	39	0.60

Below is the visualization is accomplished by generating a landscape map, which offers a visual representation of subjects related to scientific studies. The outcomes of bibliometric mapping for the co-word network in articles related to the topic project-based learning model to improve problem solving skills in science learning are illustrated in Figure 2.

Figure 2 shows the results of bibliometric keyword mapping on research trends on the project-based learning model to improve problem solving skills in science learning. In Figure 2 there are 61 keyword items that are often used in research on the project-based learning model to improve problem solving skills in science learning from 2015 to 2024. Figure 2 also contains 6 clusters, where the first cluster is colored red and consists of 14 keyword items, namely creative thinking, critical thinking, stem project, physics, etc. The second cluster in green consists of 13 keyword items, namely discovery, effectiveness, science learning, etc. The third cluster in blue consists of 11 keyword items, namely ability, development, motivation, model, etc. The fourth yellow cluster consists of 10 keyword items, namely approach, case study, inquiry, teacher, etc. The fifth purple cluster consists of 8 keyword items, namely curriculum, mathematics, technology, etc. and the last cluster consists 6 items, namely analysis, integration, local wisdom, study and use.

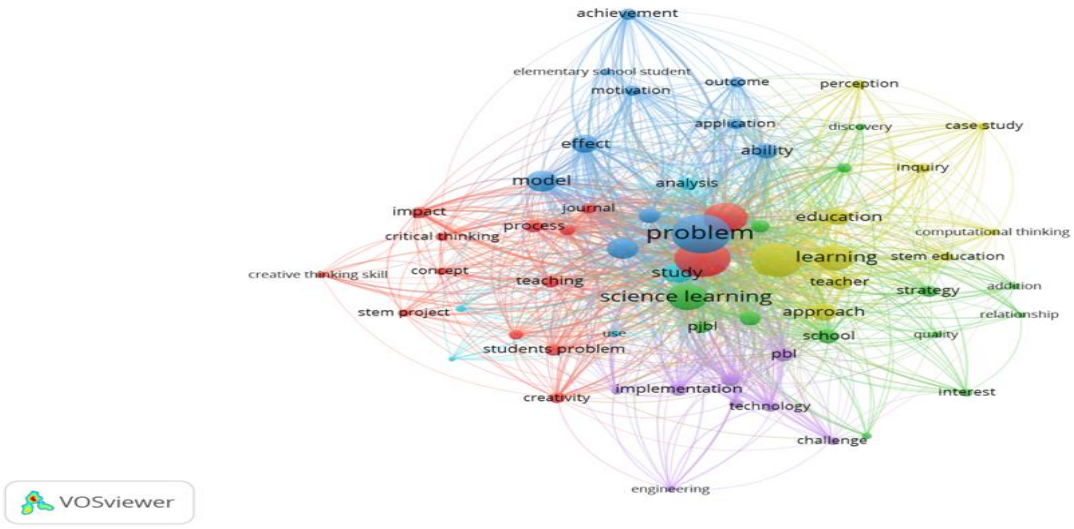

Figure 2. Network visualization on trend project-based learning model to improve problem solving skills in science learning research

Figure 2 also shows that network visualization shows the network between the terms being visualized. Keywords classified into six clusters are arranged in a color chart showing the divisions that are connected to each other. The results of this analysis can be used to determine keyword research trends in the last year. This analysis shows several keywords that are often used in research on the project-based learning model to improve problem solving in science learning. The more keywords that appear, the wider the visualization displayed. Below are also presented keywords regarding the project-based learning model to improve problem solving skills in science learning based on overlay visualization.

Figure 3 shows the trend of keywords related to research on project-based learning model to improve problem solving skills in science learning in Google Scholar indexed journals from 2015 to 2024. Trends in the themes of writing articles related to project-based learning model to improve problem solving skills in science learning from the oldest to the newest year are marked with purple, blue themes, turquoise, dark green, light green and yellow. In the picture below you can see that the creative thinking skill, case study, technology, etc. This shows that these keywords were widely used by researchers in 2020. In 2021, the keywords that frequently appeared were critical thinking, local wisdom, PjBL, computational thinking, STEM, etc.

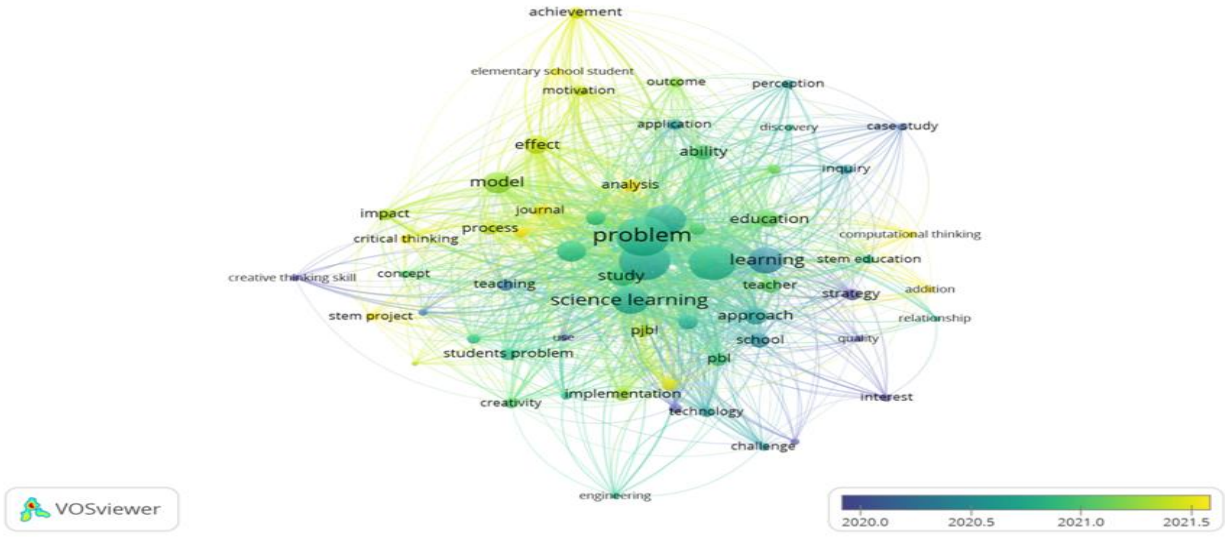

Figure 3. Overlay visualization on trend project-based learning model to improve problem solving skills in science learning research

Research on project-based learning model to improve problem solving in science learning is one area of research that has developed rapidly in recent years. The following also presents keywords for project-based learning model to improve problem solving in science learning research based on density visualization. Figure 4 shows density visualization. The density of research themes is shown in bright yellow. The brighter the colors of a theme, the more research is done. The fainter the color means the theme is rarely researched (Kaur et al., 2022; Liao et al., 2018). Faintly colored themes such as local wisdom, inquiry, case study, effectiveness are dimly colored keywords. This shows that these keywords can be used as a reference for further research. (2023) and (2023) stated that yellow indicates keywords that are currently and frequently used in research, like science learning, project, PBL, etc.

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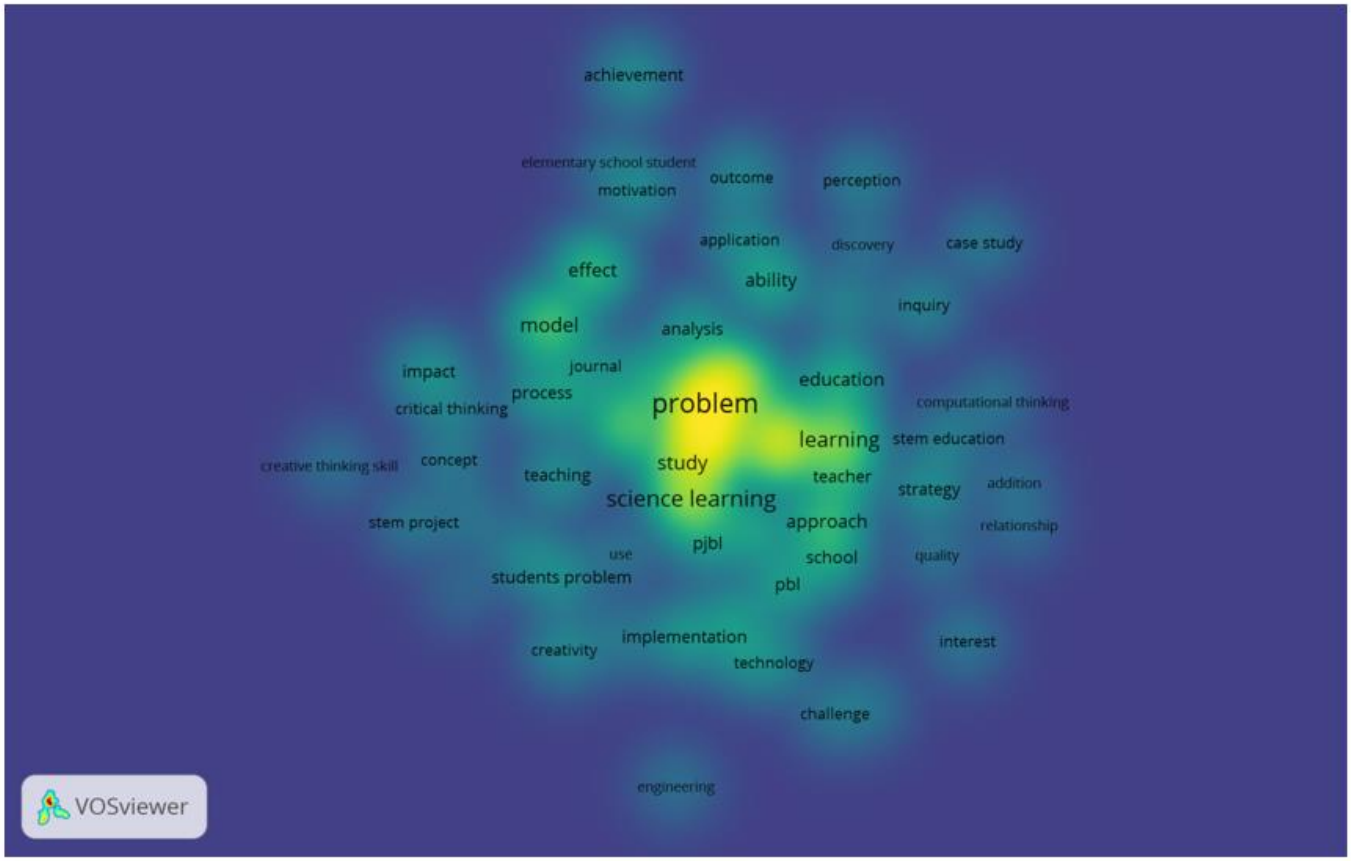

Figure 4. Density visualization on trend project-based learning model to improve problem solving skills in science learning research

Overall, research on problem-based learning model to improve critical thinking skills project-based learning model to improve problem solving in science learning is important because it makes significant contributions to the 21st century education and PjBL model is a learning model that is able to facilitate problem solving skills (Apriadi et al., 2020; Roemintoyo & Budiarto, 2023; Stehle & Peters-Burton, 2019). Students must have problem solving skills, so that students are able to process information to solve problems both in learning and in real life. The research trend in project-based learning model to improve problem solving in science learning is expected to continue to develop in the next few years (Markula & Aksela, 2022; Darling-Hammond et al., 2020; Parker et al., 2022; Zhang et al., 2024). This can be done by developing new combination of PjBL model with technology or other things like STEM to facilitate students' problem-solving skills, especially in science subjects.

Conclusion

Research on trends in the project-based learning model to improve problem solving in science learning has urgency high because of its potential to provide various benefits to 21st century education. The research trend on the project-based learning model to improve problem solving in science learning indexed by Google Scholar from 2015 to 2024 has experienced a fluctuating increase. However, in 2024 there will be a decline in the research trend on the project-based learning model to

improve problem solving in science learning. There are many documents in the form of articles, proceedings, chapters, preprints and edited books that discuss research into the project-based learning model to improve problem solving in science learning. Key words that are often used in research about it are STEM project, creative thinking skill, technology, critical thinking, discovery, etc.

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Conceptualization; A. D.; methodology.; A. H.; validation; formal analysis; M. Q.; investigation.; A. D.; resources; A. H.; data curation: M. Q.; writing—original draft preparation. A. D.; writing—review and editing: A. H.; visualization: M. Q. All authors have read and agreed to the published version of the manuscript.

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