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Improving Students' Science Process Skills Through Project Based Learning Models: A Systematic Review

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Abstract: Science process skills are very important for students to apply scientific methods and develop knowledge in order to gain new knowledge or enrich existing knowledge. Science process 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 science process 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 science process 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 science process 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 science process skill in science learning. Key words that are often used in research about it are local wisdom, inquiry model, PBL, scientific attitude, etc.

Keywords: Project based learning; Review; Science learning; Science process skill

Introduction

Learning in the current curriculum is learning that emphasizes the scientific process (Meltzer, 2002). It is expected that students will be able to improve scientific activities, scientific attitudes and also scientific process skills in the learning process. Scientific process skills are needed in scientific activities (Rahayu et al., 2021). In the 2013 curriculum and *merdeka* curriculum, learning takes place with four learning models, namely discovery learning, exploration, problem learning and project learning (Marmoah et al., 2022). The purpose of implementing this learning model is for students to learn independently so that the learning process is not centered on the teacher.

Preparing active learning is also a government strategy to face the era of globalization and respond to the demands of the 21st century (Peters-Burton & Stehle, 2019; Van Laar et al., 2020; Larson et al., 2011; González-Pérez & Ramírez-Montoya, 2022). This strategy is expected to produce individuals who are competent in technology and science so that they can advance the nation (Muliani et al., 2019; Mynbayeva et al., 2015). It is known that the demands of the 21st century are the main things that must be considered, especially in the field of education to face future challenges (Geisinger, 2016; Larson et al., 2011; Kaufman, 2013), so in other words the skills required in the 21st century must be mastered (Dicerbo, 2014; Fry et al., 2011; Griffin, 2017; Jang, 2016; Lambert et al., 2010; Sibille et al., 2010).

Quality education is inseparable from learning (Gómez & Suárez, 2020). The learning process aims to help students achieve optimal learning outcomes. The formation of students in a certain development is the

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main goal of the learning process (Putra, 2020). In teaching, active participation between teachers and students is very important to achieve the desired learning goals, as explained by Fa'idah et al. (2019). This participation has a major influence on achieving optimal learning outcomes. One of the subjects taught in schools is science. Science is one of the main learning contents in schools (Muhlisin et al., 2016). Science education is a series of learning activities carried out by educators together with students with the aim of improving students' thinking skills and building new knowledge as an effort to strengthen good mastery of science material. Science learning will be more important on the off chance that the learning prepare employments models/methods of self-discovery (Apriliani et al., 2019; Chusni et al., 2020).

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; Darmaji et al., 2021; Kurniawan & Astalini, 2019; 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 (Kurniawan et al, 2019; Maison et al., 2020; Nasution et al., 2023).

Teachers must have the ability to wholeheartedly guide, train and teach to achieve student success in clarifying educational goals (Fa'idah et al., 2019). Education is the responsibility of teachers to deliver teaching in a way that is easy for students to understand, because students have the right to receive information that is easy to understand and also suitable for learning. learning process (Lim et al., 2023), for example as a research activity (Century et al., 2020). With the support of this research activity, students can validate the theories obtained from the internet, books, teacher explanations, making them understand the concept and can also be trained to improve students' science process skills (Swart, 2014).

These scientific skills consist of core skills and integrative skills (Nasir et al., 2023). Basic skills consist of six aspects, namely observation, classification, prediction, measurement, investigation, and communication. Integrated skills include problem formulation, hypothesis, variable identification, research design, and research implementation (Duran & Dökme, 2016). During the teaching and learning process, skills in handling natural phenomena require a learning model that is suitable and appropriate for students (Yenti, 2021). Science skills are very important for students to apply scientific methods and develop knowledge in order to gain new knowledge or enrich existing knowledge (Safitri et al., 2022).

One of the efforts to improve students' science process abilities is by implementing active learning models in the classroom, for example PjBL (Suryaningsih & Nisa, 2021; Safaruddin et al., 2020; Lestari et al., 2018). PjBL is a model that regulates the learning process through project activities. A project is a complex task based on challenges in the form of questions or problems, which involves students in designing, solving problems, making decisions, and conducting research, giving students the opportunity to work for a predetermined length of time and produce a product or make a presentation (Nurfalah, 2019). The criteria for PjBL are that the project must be in accordance with the curriculum, focus on problems that invite students to connect with the main concept, involve students in conducting constructivist, realistic, and independent observations (Prihatiningtyas & Sholihah, 2020).

Therefore, this research wants to know the research trend of the project based learning model to improve science process skills. It is hoped that this research can become a reference in developing further research related to science process 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 science process 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 science process 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 et al., 2019, 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 science process

skills conducted from 2015 to 2024. Research documents on research trends project based learning model to improve science process 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 science process skills in science learning.

Figure 1 shows that the trend in research on the project based learning model to improve science process 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 science process skills has decreased. The increasing trend in research on the project based learning model to improve science process skills caused by 21st century education has focused on improving various kinds of competencies, one of which is science process skills.

In 2015 there were 7 publications related to the problem based learning model to improve science process skills, then this will continue to increase to 538 publications in 2023. This increasing research trend provides a deeper understanding the problem which is low of science process skills in science learning and ways to solve that problem. Research is able to improve science process 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 science process skills based on the type of publication.

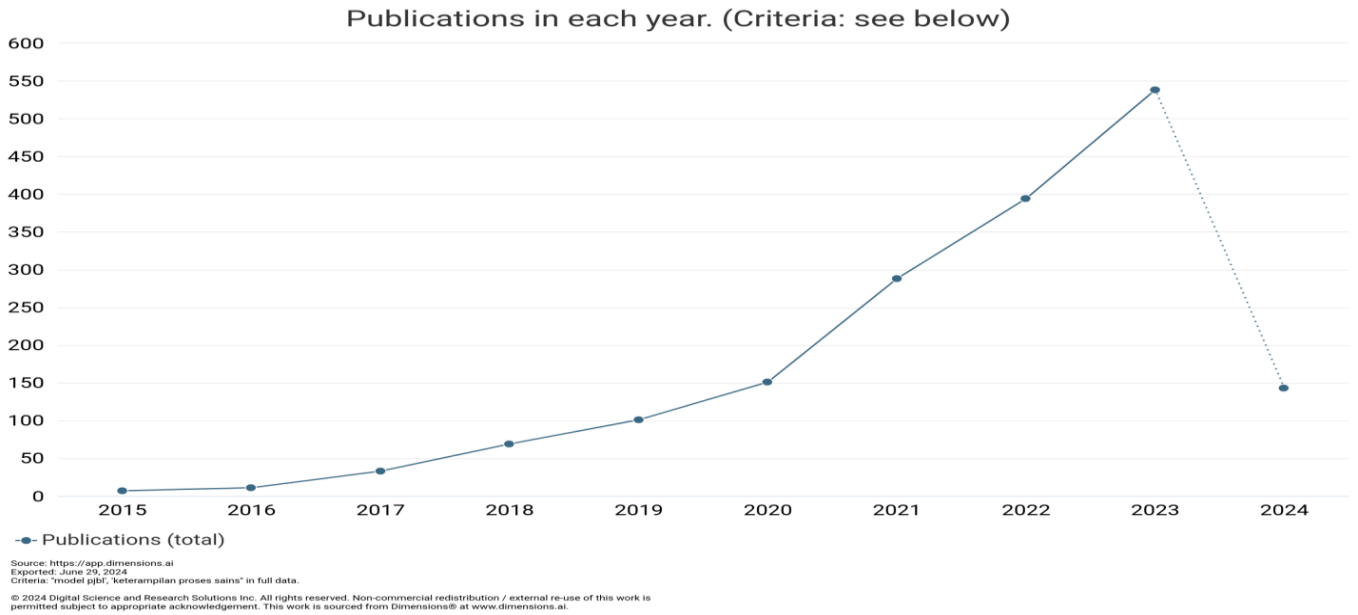

Figure 1. Research trends in improving science process skills through project based learning model

Table 1. Trends in Improving Science Process Skills through Project Based Learning Model Research Based on Publication Types

Publication Type	Publications
Article	1,639
Edited Book	55
Proceeding	35
Chapter	10
Preprint	2

Based on Table 1, it is known that research project based learning model to improve science process skills in science learning from 2015 to 2024 contained in 5 types of publications. In the form of articles there were 1,639 documents, chapters as many as 10 documents, proceedings as many as 35 documents, edited books as many as 55 documents, and preprints as many as 2 documents. Research trends project based learning model to improve science process 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 science process skills in science learning is a preprint. Research conducted by Oltarzhevskyi (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 et al., 2020).

Below are also table 2 presented top ten (10) sources title trends in research on project based learning model

to improve science process 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 science process skills in science learning is the Jurnal Penelitian Pendidikan IPA, namely 88 publications with 164 citations and an average citation of 1.86. 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 were published in 2015. All edition in this journal are 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 science process skills in science learning which are often cited by other researchers related to this matter.

Table 2. Top 10 Sources Title Trend of Improving Science Process Skills through Project Based Learning Model Research in 2015-2024

Name	Publications	Citations	Citations Mean
Jurnal Penelitian Pendidikan IPA	88	164	1.86
Advances in Social Science, Education and Humanities Research	62	57	0.92
Jurnal Basicedu	44	230	5.23
Journal of Physics Conference Series	25	167	6.68
Edukatif Jurnal Ilmu Pendidikan	23	50	2.17
Jurnal Pendidikan Sains Indonesia	22	160	7.27
Jurnal Ilmiah Profesi Pendidikan	20	12	0.60
Jurnal Ilmiah Pendidikan dan Pembelajaran	19	36	1.89
AKSIOMA Jurnal Program Studi Pendidikan Matematika	17	56	3.29
Berkala Ilmiah Pendidikan Biologi (BioEdu)	16	46	2.88

Table 3 shows that research on the project based learning model to improve science process skills in science learning that is widely cited by other researchers is about "The Effect of Project-Based Learning Assisted by Electronic Media on Learning Motivation and Science Process Skills" which is 35.50 (Safaruddin et al., 2020). Then the research entitled "Contribution of STEAM Project Based Learning in Measuring Students' Science Process Skills and Creative Thinking" was cited 28.00 times (Suryaningsih & Nisa, 2021). Research by Lestari et al. (2018) entitled "STEM-Based Project Based Learning Model to Increase Science Process and Creative Thinking Skills of 5th Grade" is also widely cited by other researchers, namely 21.50 per year. Parmiti et al. (2021) in their research entitled "The Effectiveness of Local Culture-Integrated Science Learning through Project-Based Assessment on Scientific Attitudes and Science Process Skills of Elementary School Students" was cited 14.00 per year.

This research data is comparable to data on the increasing trend of research on the project based learning model to improve science process 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/keywords related to project based learning model to improve science process skills in science learning. Below are presented ten (10) popular keywords related to project based learning model to improve science process skills in science learning.

Table 3. Top 10 Citations on Trend of Improving Science Process Skills through Project Based Learning Model Research in 2015-2024

Cites/year	Year	Author	Title
35.50	2020	S Safaruddin, N Ibrahim, J Juhaeni, H Harmilawati, L Qadrianti	The Effect of Project-Based Learning Assisted by Electronic Media on Learning Motivation and Science Process Skills
28.00	2021	S Suryaningsih, F A Nisa	Contribution of STEAM Project Based Learning in Measuring Students' Science Process Skills and Creative Thinking
21.50	2018	T P Lestari, S Sarwi, S Sumarti	STEM-Based Project Based Learning Model to Increase Science Process and Creative Thinking Skills of 5th Grade
14.00	2021	D. P. Parmiti, N. N. Rediani, I. G. W. S. Antara, M. G. Jayadiningrat	The Effectiveness of Local Culture-Integrated Science Learning through Project-Based Assessment on Scientific Attitudes and Science Process Skills of Elementary School Students
10.33	2018	D Hernawati, M Amin, M Irawati, S Indriwati, M Aziz	Integration of Project Activity to Enhance the Scientific Process Skill and Self-Efficacy in Zoology of Vertebrate Teaching and Learning

Cites/year	Year	Author	Title
3.33	2021	D J W Sejati, W Isnaeni, S Saptono	Analysis of High Level Thinking Skills, Character and Skills of Science Process of High School Students in Project Based Learning
3.00	2021	M Marjanah , E Pandia , N Nursamsu	Development of Practicum Instruction Module Based on Project Based Learning (PjBL) Integrated with Science Process Skills and Scientific Literacy
3.00	2017	C P Citradevi, A Widiyatmoko, M Khusniati	The Effectiveness Of Project Based Learning (Pjbl) Worksheet To Improve Science Process Skill For Seven Graders Of Junior High School In The Topic Of Environmental Pollution
1.00	2023	F Wulandari, P P Sari	The effect of project-based learning integrated STEM toward science process skill of elementary school student
1.00	2020	Nuraini, W Muliawan	Development of Science Learning with Project Based Learning on Science Process Skill : A Needs Analysis Study

Table 4. Keywords on Trend Improving Science Process Skills through PjBL MODEL RESEARCH in 2015-2024

Terms	Occurrences	Relevance
Local wisdom	10	2.55
Inquiry model	11	2.34
PBL	14	2.27
Scientific attitude	12	2.21
Meta analysis	10	1.88
Scientific literacy	10	1.76
E module	25	1.75
STEM	9	1.45
Technology	13	1.38
Assessment	15	1.09

Table 4 shows that the keywords that often appear related to research on the the project based learning model to improve science process skills in science learning are local wisdom, 120 times with a level of 2.55. PJBL models are often combined with local wisdom or local culture to improve a variety of 21st century skills, including science process skills (Parmiti et al., 2021). Table 4 also shows that STEM is also one of the keyword that appears frequently in research trends on the project based learning model to improve science process skills in science learning, namely 9 times with a relevance of 1.45. There are many articles of the PjBL integrated with STEM (Suryaningsih & Nisa, 2021; Lestari et al., 2018; Wulandari & Sari, 2023).

Below are 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 science process skills in science learning are illustrated in Figure 2.

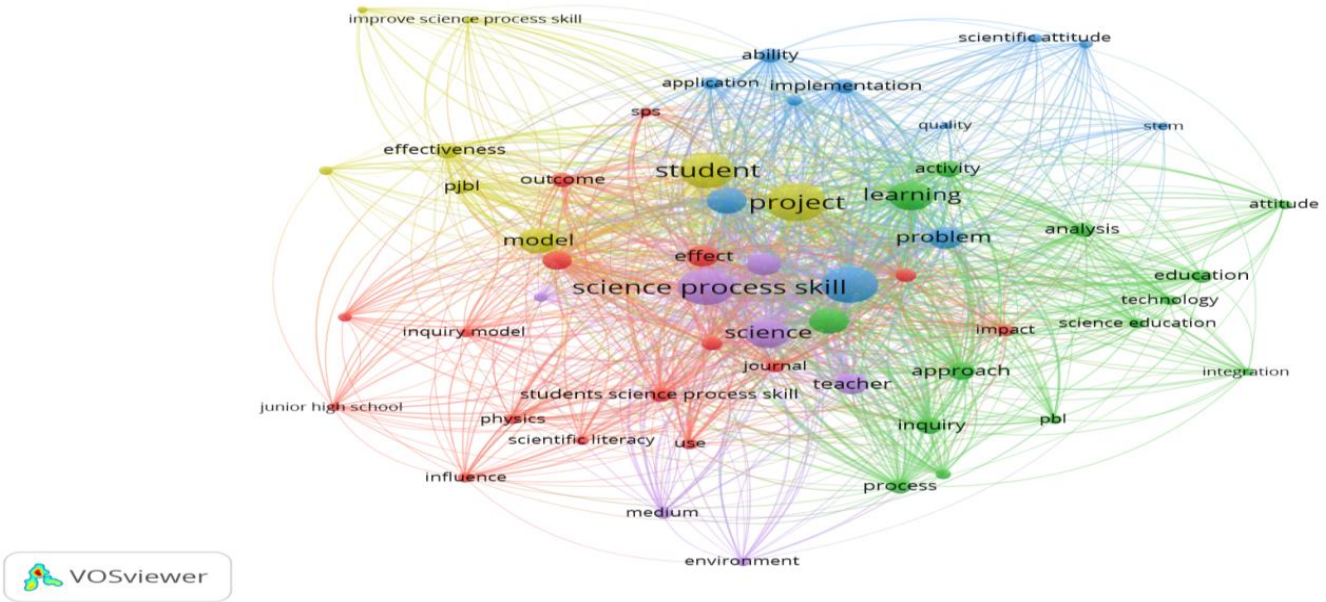

Figure 2. Network visualization on trend improving science process skills through project based learning model research

Figure 2 shows the results of bibliometric keyword mapping on research trends on the project based learning model to improve science process skills in science learning. In Figure 2 there are 56 keyword items that are often used in research on the project based learning model to improve science process skills in science learning from 2015 to 2024. Figure 2 also contains 5 clusters, where the first cluster is colored red and

consists of 16 keyword items, namely e module, physics, meta analysis, scientific literacy, etc. The second cluster in green consists of 14 keyword items, namely inquiry, PBL, technology, science education, etc. The third cluster in blue consists of 11 keyword items, namely ability, assessment, local wisdom, STEM, etc. The fourth yellow cluster consists of 8 keyword items, namely effectiveness, project, student, etc. The fifth purple cluster consists of 7 keyword items, namely development, teacher, environment, etc.

Figure 2 above also shows that network visualization shows the network between the terms being visualized. Keywords classified into five clusters are arranged in a color chart showing the divisions/clusters 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 science process 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 science process 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 science process 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 science process 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 assessment, implementation, application, etc. This shows that these keywords were widely used by researchers in 2020. In 2021, the keywords that frequently appeared were STEM, improving science process skill, effectiveness, technology, etc. While in 2022, there were keywords like scientific attitude, PjBL, meta analysis, inquiry model, scientific literacy, etc that frequently appeared.

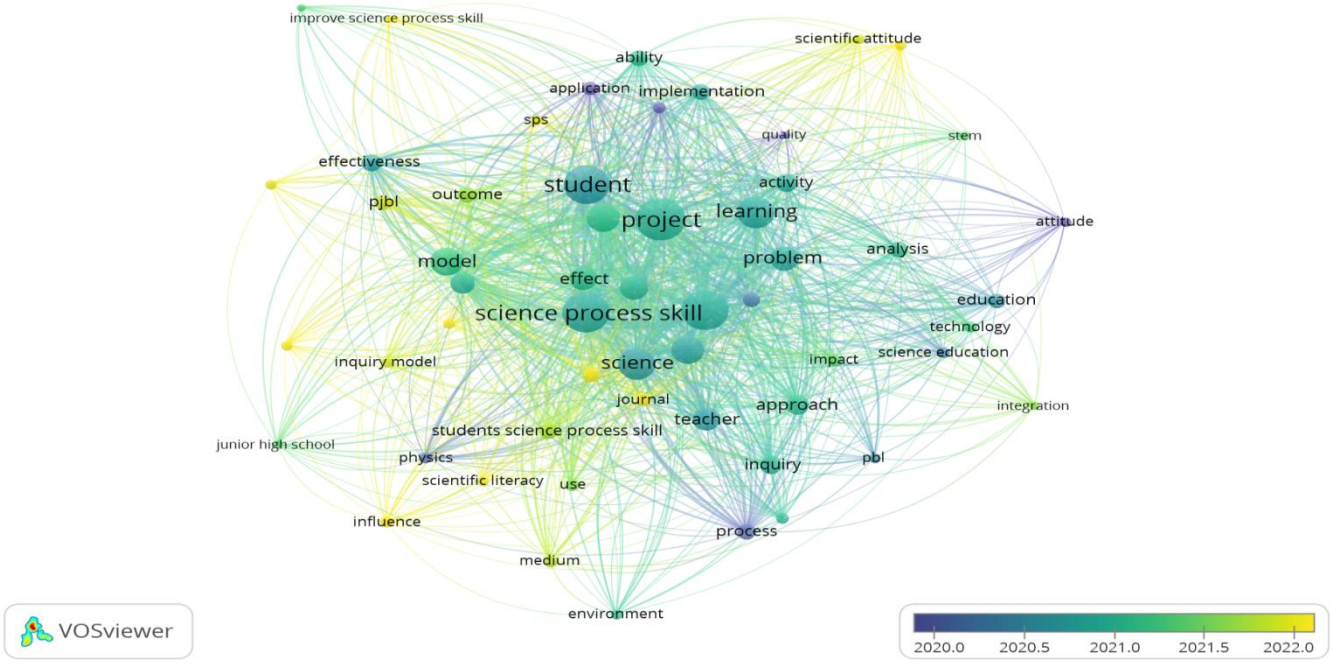

Figure 3. Overlay visualization on trend improving science process skills through project based learning model research

Research on project based learning model to improve science process 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 science process 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 e-module, elementary school, inquiry model are dimly colored keywords. This shows that these keywords can be used as a reference for further research. Doyan et al. (2023) and Bahtiar et al. (2023) stated that yellow indicates keywords that are currently and frequently used in research, like science education, effectiveness, PjBL, scientific literacy, etc.

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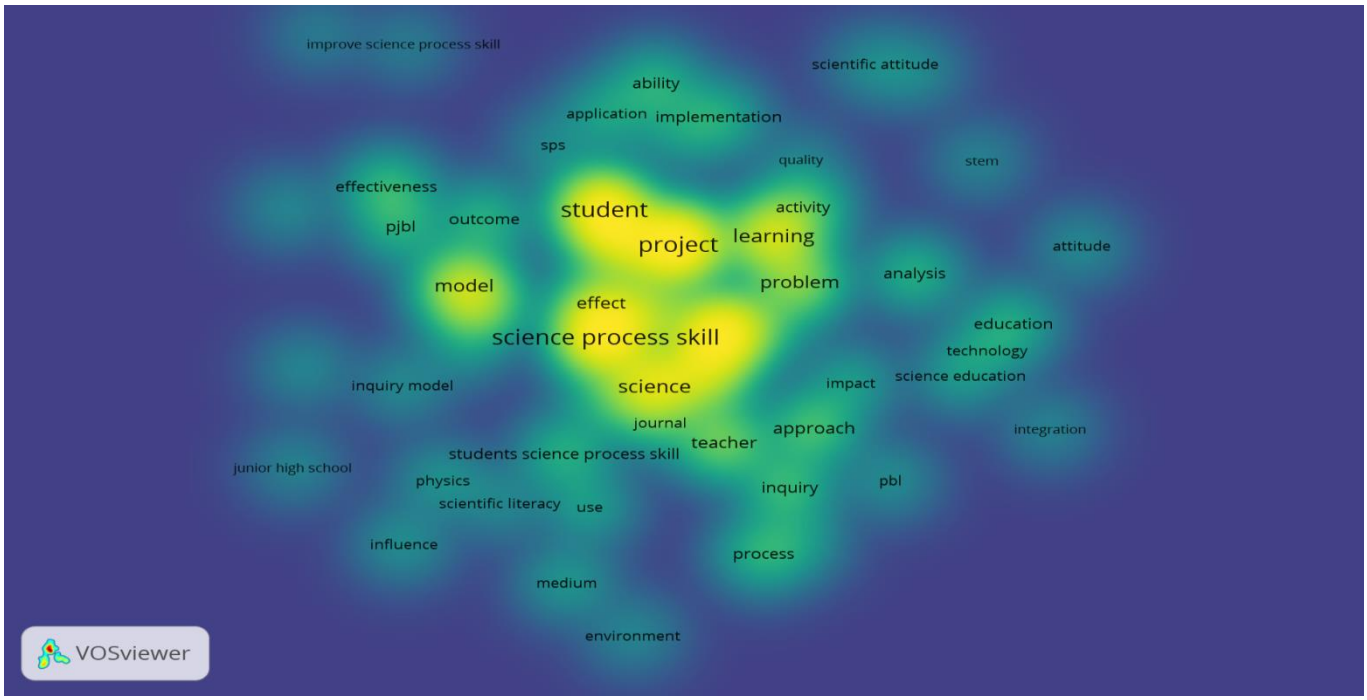

Figure 4. Density visualization on trend improving science process skills through project based learning model research

Overall, research on project based learning model to improve science process 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 science process skills. Students must have science process 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 science process in science learning is expected to continue to develop in the next few years. This can be done by developing new combination of PjBL model with technology or other things like STEM or local wisdom to facilitate students' science process skills, especially in science subjects.

Conclusion

Research on trends in the project based learning model to improve science process 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 science process 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 science process 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 science process in science learning. Key words that are often used in research about it are local wisdom, inquiry model, PBL, scientific attitude, etc.

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