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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. 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 (González-Pérez & Ramírez-Montoya, 2022; Laar et al., 2020; Larson & Miller, 2011; Peters-burton & Stehle, 2019). This strategy is expected to produce individuals who are competent in
technology and science so that they can advance the
(Muliani & Wibawa, 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;
Kaufman, 2013). So, in other words the skills required in
the 21st century must be mastered (DiCerbo, 2014; Fry &
Seely, 2011; Griffin, 2017; Jang, 2016; Lambert & Gong,
2010; Sibille et al., 2010).
Quality education is inseparable from learning. The
learning process aims to help students achieve optimal
learning outcomes. The formation of students in a
certain development is the main goal of the learning
process. 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. 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
of self-discovery (Chusni et al., 2020; Dwi Apriliani et al.,
2019).
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; Darmaji et al., 2021;
Kurniawan et al., 2019; Nursya, 2023; 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., 2023; Maison et al.,
2020). Teachers must have the ability to wholeheartedly
guide, train and teach to achieve student success in
clarifying educational goals. 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, for example as a research activity. 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.
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. During
the teaching and learning process, skills in handling
natural phenomena require a learning model that is
suitable and appropriate for students (Yenti et al., 2022).
Science skills are very important for students to apply
scientific methods and develop knowledge in order to
gain new knowledge or enrich existing knowledge. One
of the efforts to improve students’ science process
abilities is by implementing active learning models in
the classroom, for example PjBL (Heriansyah, 2020).
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. 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 & 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 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.

<table>
<thead>
<tr>
<th>Publication Type</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Article</td>
<td>1,639</td>
</tr>
<tr>
<td>Edited Book</td>
<td>55</td>
</tr>
<tr>
<td>Proceeding</td>
<td>35</td>
</tr>
<tr>
<td>Chapter</td>
<td>10</td>
</tr>
<tr>
<td>Preprint</td>
<td>2</td>
</tr>
</tbody>
</table>

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 & Fauziah, 2020).

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 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 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 Project Based Learning Model to Improve Science Process Skills in Science Learning Research in 2015-2024**

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

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

<table>
<thead>
<tr>
<th>Cites/year</th>
<th>Year</th>
<th>Author</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.50</td>
<td>2020</td>
<td>S Safaruddin, N Ibr ahim, J Juhaeni, H Harmilawati, L Qadrianti</td>
<td>The Effect of Project-Based Learning Assisted by Electronic Media on Learning Motivation and Science Process Skills</td>
</tr>
<tr>
<td>28.00</td>
<td>2021</td>
<td>S Suryaningsih, F A Nisa</td>
<td>Contribution of STEAM Project Based Learning in Measuring Students' Science Process Skills and Creative Thinking</td>
</tr>
<tr>
<td>21.50</td>
<td>2018</td>
<td>T P Lestari, S Sarwi, S Sumarti</td>
<td>STEM-Based Project Based Learning Model to Increase Science Process and Creative Thinking Skills of 5th Grade Students</td>
</tr>
<tr>
<td>14.00</td>
<td>2021</td>
<td>D. P. Parmiti, N. N. Rediani, I. G. W. S. Antara, M. G. Jayadiningrat</td>
<td>The Effectiveness of Local Culture-Integrated Science Learning through Project-Based Assessment on Scientific Attitudes and Science Process Skills of Elementary School Students</td>
</tr>
<tr>
<td>10.33</td>
<td>2018</td>
<td>D Hernawati, M Amin, M Irawati, S Indriwati, M Aziz</td>
<td>Integration of Project Activity to Enhance the Scientific Process Skill and Self-Efficacy in Zoology of Vertebrate Teaching and Learning</td>
</tr>
<tr>
<td>3.33</td>
<td>2021</td>
<td>D J W Sejati, W Isnaeni, S Suryaningsih, F A Nisa</td>
<td>Analysis of High Levels Thinking Skills, Character and Skills of Science Process of High School Students in Project Based Learning</td>
</tr>
<tr>
<td>3.00</td>
<td>2021</td>
<td>M Marjanah, E Pandia, N Nursamsu</td>
<td>Development of Practicum Instruction Module Based on Project Based Learning (PjBL) Integrated with Science Process Skills and Scientific Literacy</td>
</tr>
<tr>
<td>3.00</td>
<td>2017</td>
<td>C P Citradevi, A Widiyatmoko, M Khusniati</td>
<td>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</td>
</tr>
<tr>
<td>1.00</td>
<td>2023</td>
<td>F Wulandari, P P Sari</td>
<td>The effect of project-based learning integrated STEM toward science process skill of elementary school student</td>
</tr>
<tr>
<td>1.00</td>
<td>2020</td>
<td>Nuraini, W Muliawan</td>
<td>Development of Science Learning with Project Based Learning on Science Process Skill: A Needs Analysis Study</td>
</tr>
</tbody>
</table>

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 (Rizki et al., 2022). Research by Pramesi et al. (2022) 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 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 are local wisdom, 120 times with a level of 2.55.

Table 4 shows that the keywords that often appear related to research on the Project Based Learning model to improve science process skills in science learning are local wisdom, 120 times with a level of 2.55.

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

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. Bahtiar et al. (2023) and Doyan et al. (2023) stated that yellow indicates keywords that are currently and frequently used in research, like science education, effectiveness, PjBL, scientific literacy, etc.

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 (Siahaan et al., 2017). 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 (Jian et al., 2023; Markula & Aksela, 2022; Meng et al., 2023). 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 (Nuraini et al., 2023).

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

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

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References


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