

Literature Study: The Influence Of The Project Based Learning Model On Science Process Skills And Students' Creative Thinking Skills On Fluid Materials

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Abstract— This study aims to analyze the influence of the project-based learning (PjBL) model on science process skills and students' creative thinking abilities in fluid materials through a literature study approach and bibliometric analysis. Data were collected using the Publish or Perish application with the keywords "project based learning", "science process skills", "creative thinking skills", and "fluids". The search results produced a number of articles which were then screened based on relevance and eligibility criteria. The inclusion criteria consisted of: (1) articles published in peer-reviewed journals, (2) studies focusing on the implementation of the PjBL model in science or physics learning, (3) research discussing science process skills and/or creative thinking skills, and (4) publications available in the last ten years and written in English. Based on these criteria, 20 main articles were selected for further analysis. Bibliometric analysis was conducted using the VOSviewer application to map research trends, relationships between topics, and the development of publications related to PjBL in physics learning. The results show that the PjBL model is consistently reported to improve students' science process skills and creative thinking skills, particularly in fluid materials. This model encourages active student engagement through project activities, contextual problem-solving, and collaboration, thereby positively influencing conceptual understanding and the development of 21st-century skills. The novelty of this study lies in the integration of a systematic literature review with bibliometric analysis to comprehensively map the research landscape of PjBL related to science process skills and creative thinking in fluid learning. This approach not only synthesizes empirical findings but also identifies research trends and thematic relationships, providing a clearer direction for future studies in physics education.

Keywords— Project Based Learning, Science Process Skills, Creative Thinking Skills, Fluids.

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1. Introduction

In the 21st century, human life has undergone various changes, including in the field of education. Education is defined as a process of interaction between teachers and learners aimed at achieving certain learning objectives and improving the quality of human life both individually and collectively [1]. In the context of 21st century learning, education is expected to equip students with various competencies that enable them to adapt to rapid developments in science, technology, and global challenges [2]. Therefore, 21st century education emphasizes not only the mastery of knowledge but also the development of essential skills such as critical thinking, creativity, communication, and collaboration [3].

Science learning, particularly physics, plays an important role in supporting the development of these competencies. Physics is a branch of natural science that studies the interaction between matter and energy to explain natural phenomena occurring in everyday life [4]. In essence, science consists of three main aspects: scientific processes, scientific products, and scientific attitudes

[5]. These aspects emphasize that science learning should not only focus on conceptual understanding but also involve students in scientific investigations and problem-solving activities.

In physics learning, students are required to understand interconnected concepts and apply them through scientific inquiry. Therefore, the development of science process skills and creative thinking skills becomes essential. Science process skills refer to the ability to conduct scientific investigations such as observing, formulating hypotheses, experimenting, analyzing data, and drawing conclusions [6]. Meanwhile, creative thinking skills enable students to generate new ideas, explore alternative solutions, and develop innovative approaches in solving problems [7]. These skills are important for supporting meaningful learning and fostering students' ability to address complex real-world problems.

However, the implementation of physics learning in Indonesia still tends to be teacher-centered, where teachers act as the main source of knowledge while students become passive recipients of information [8]. Such conditions often lead students to memorize concepts without fully understanding the underlying scientific processes and limit their opportunities to develop creative thinking skills. As a result, students are less trained to explore ideas independently and to solve problems creatively in physics learning contexts.

Student involvement in the learning process is essential so that they can connect theoretical concepts with real-life applications. One of the physics topics that requires active student engagement is fluids. This topic involves not only conceptual understanding but also observational, experimental, and analytical activities. Practical activities provide students with direct experiences that support the development of science process skills and deeper conceptual understanding [9]. Therefore, a learning model that actively involves students and facilitates the development of these skills is required.

One of the learning models that can support this goal is Project-Based Learning (PjBL). PjBL is an innovative student-centered learning model that emphasizes project-based activities to solve real-world problems [10]. Through PjBL, students are encouraged to identify problems, design project solutions, collaborate in groups, and evaluate the outcomes of their work. This learning model also promotes critical and creative thinking, as well as collaborative learning experiences [11]. By engaging in project activities, students can apply physics concepts, including fluid concepts, in meaningful and contextual ways.

Several previous studies have shown that the implementation of PjBL can improve science process skills and creative thinking abilities. Research indicates that PjBL contributes positively to students' scientific investigation abilities, creativity, and learning outcomes in physics education [12]. These findings indicate that PjBL has strong potential to support the development of competencies required in 21st century learning.

However, although many studies have examined the effectiveness of PjBL in science and physics learning, studies that comprehensively synthesize research findings and map research trends related to the influence of PjBL on science process skills and creative thinking skills, particularly in fluid learning materials, are still limited. Most previous studies focus on classroom experimental implementation without providing a broader overview of research developments and thematic relationships in this field. Therefore, a more comprehensive study is needed to analyze the development of research related to PjBL and its influence on science process skills and creative thinking skills in physics learning.

Based on this research gap, this study aims to analyze the influence of the Project-Based Learning (PjBL) model on students' science process skills and creative thinking abilities in fluid materials through a literature study approach combined with bibliometric analysis. This study also seeks to identify research trends, thematic relationships, and the development of publications related to the implementation of PjBL in physics learning.

2. Method

This study employed a literature study approach combined with bibliometric analysis to examine the influence of the Project-Based Learning (PjBL) model on students' science process skills and creative thinking skills in fluid learning materials. Data were collected using the Publish or Perish (PoP) application with the Google Scholar database. The search used the keywords "project based learning", "science process skill", "creative thinking skill", and "fluid". The search was limited to publications within the period of 2018–2025 to ensure the relevance of recent research developments.

The article selection process was conducted through several stages. In the identification stage, the initial search produced 50 articles related to the specified keywords. In the screening stage, duplicate records and articles that were not relevant to the research topic were removed based on title and abstract examination. In the eligibility stage, the remaining articles were further evaluated based on several inclusion criteria, including: (1) articles published in peer-reviewed journals, (2) studies discussing the implementation of Project-Based Learning in science or physics learning, (3) research addressing science process skills and/or creative thinking skills, and (4) full-text articles accessible for analysis. After this process, 20 main articles that met all criteria were selected as the final dataset for further analysis.

The selected articles were then exported in RIS format and analyzed using VOSviewer software. The bibliometric analysis aimed to visualize and map the relationships among keywords, identify thematic clusters, and examine publication trends related to the implementation of PjBL in physics learning. Through this analysis, the network of research topics and the level of connectivity among variables such as project-based learning, science process skills, creative thinking skills, and fluid learning could be identified.

In addition to bibliometric analysis, a content analysis was conducted on the selected articles to obtain a deeper understanding of the research findings. The content analysis was carried out through several steps. First, each article was carefully read to identify its main components, including research objectives, research design, sample characteristics, learning materials, and instruments

used to measure science process skills and creative thinking skills. Second, relevant information from each article was systematically coded and categorized based on these components. Third, the findings of each study were compared and synthesized to identify common patterns, similarities, and differences in the reported effects of PjBL on students' science process skills and creative thinking abilities. Finally, the results of the bibliometric analysis and the content analysis were integrated to produce a comprehensive synthesis of the effectiveness of the PjBL model in improving students' science process skills and creative thinking skills in fluid learning.

3. Result and Discussion

The articles studied in this study focus on the application of the project-based learning model (PjBL) to science process skills and students' creative thinking skills, especially in learning Physics on fluid materials. Based on the results of a literature review from 2018 to 2025 using the Publish or Perish application and bibliometric mapping with VOSviewer, 20 articles relevant to the topic were obtained. The search results data from Publish or Perish produce a list of articles that have the highest and most relevant number of citations, as shown in Table 1 as the basis of analysis in this literature study.

Table 1. Literature Analysis Results of the Articles with the Highest Citations

No	Article Title	Author	Journal Title	Year	Number of Quotes
1	The Contribution of STEAM Project Based Learning in Measuring Students' Science Process and Creative Thinking Skills	Suryaningsih, S., & Nisa, F. A.	Indonesian Journal of Education	2021	151
2	The Effect Of The Pjb-HOTS Learning Model On Cognitive Learning, Analytical Thinking Skills, Creative Thinking Skills, and Metacognitive Skills Of Biology Education Students	Liline, S., Tomhisa, A., Rumahlatu, D., & Sangur, K.	Journal of Turkish Science Education	2024	38
3	Development of STEM-Based Physics Teaching Materials Integrated 21st Century Skills (4C) and Characters	Waluyo, R., & Wahyuni, S.	Scientific Journal of Mathematics and Natural Sciences Education	2021	24
4	Project-Based Learning on Science Process Skills and Learning Outcomes in High School Physics: A Quasi-Experimental Study on the Topic of Fluids	Sutaryani, L. G., Pujani, N. M., & Tika, I. N.	Journal of Education Research and Evaluation	2024	9
...
30	The Effectiveness of Using Project-Based Learning Static Fluid Modules in Improving Student SEPs Skills	Chasani, A., Azizahwati, A., & Yennita, Y.	Journal of Research in Science Education	2024	0

Based on Table 1, the article by Suryaningsih and Nisa (2021) has the highest number of citations, reaching 151 citations. This study integrates the STEAM approach within the Project-Based Learning model to measure students' science process skills and creative thinking abilities. Using an experimental design, the study shows that project-based activities integrated with interdisciplinary approaches can effectively foster both investigative skills and creative idea generation. The findings indicate that combining project-based inquiry with creativity-oriented learning tasks allows students to construct knowledge through experimentation and innovation [13].

Another influential study was conducted by Liline et al. (2024), which has received 38 citations. This research implemented a PjBL model oriented toward Higher Order Thinking Skills (HOTS) and examined its influence on cognitive learning outcomes, analytical thinking, creative thinking, and metacognitive skills among biology education students. Although conducted in a biology learning context, the findings demonstrate that the characteristics of PjBL are interdisciplinary and effective in promoting higher-order thinking abilities across subject areas. Compared with studies conducted in physics contexts, this research highlights the cognitive and metacognitive dimensions of learning supported by project-based activities [14].

Waluyo and Wahyuni (2021), with 24 citations, contributed through the development of STEM-based physics teaching materials integrated with 21st-century skills (4C). Using a research and development design, the study demonstrated that integrating PjBL into STEM-based instructional materials can support the simultaneous development of science process skills and creative thinking skills. The findings emphasize that PjBL can function not only as a learning model but also as a framework for designing learning resources that facilitate inquiry-based and collaborative learning experiences [15].

Similarly, Sutaryani et al. (2024), with nine citations, examined the implementation of PjBL in high school physics learning using a quasi-experimental design. The study found that PjBL significantly improved students' science process skills and learning outcomes. Through project-based experimental activities, students were actively involved in observing physical phenomena, formulating research questions, collecting experimental data, and analyzing the results of their investigations. The study specifically focused on static fluid topics, such as pressure and buoyancy, which are well suited for project-based experiments due to their observable and measurable characteristics [16].

In contrast, the study conducted by Chasani et al. (2024), although it has not yet received citations, still provides an important contribution to the literature because it introduces a project-based module for static fluid learning. This research focuses on developing learning modules designed using the PjBL framework to improve students' Science and Engineering Practices (SEPs). Despite its recent publication, the study highlights emerging research trends related to the integration of project-based modules in physics education [17].

Overall, the synthesis of these studies shows variations in research design, including experimental, quasi-experimental, and research-and-development approaches. Experimental and quasi-experimental studies mainly evaluate the effectiveness of PjBL in improving students' science process skills and creative thinking abilities, while development studies emphasize the design of instructional materials that support inquiry and project-based investigation. Despite these methodological differences, the studies consistently report positive impacts of PjBL on students' engagement and higher-order thinking skills.

The bibliometric analysis conducted using VOSviewer further strengthens these findings. The co-occurrence map of keywords presented in Figure 1 shows that the keyword "project" forms the largest and most central node, indicating that project-based activities are the main focus of the studies analyzed. The keywords "PjBL," "creative thinking skill," "science process skill," and "student" appear closely connected, suggesting that research on PjBL is strongly associated with the development of students' higher-order thinking abilities.

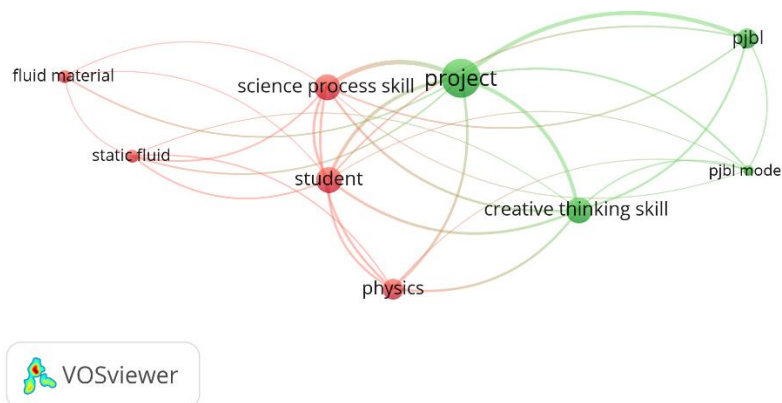


Fig. 1. Keyword relationship map vosviewer analysis results

In addition, several keywords related to physics learning and fluid materials, such as "physics," "static fluid," and "fluid materials," form a cluster that is directly connected to the PjBL cluster. This indicates that fluid materials are frequently used as a context for implementing PjBL because they provide opportunities for contextual and experimental learning activities. In many studies, static fluid concepts such as pressure, Pascal's law, and buoyancy are commonly used in project-based experiments, as these topics allow students to conduct simple investigations and laboratory-based projects. In contrast, dynamic fluid concepts such as fluid flow, continuity equations, and Bernoulli's principle are less frequently explored in PjBL research, even though these concepts also provide potential contexts for project-based investigations involving real-life phenomena such as water flow systems and aerodynamic applications.

The color distribution on the bibliometric map also illustrates the development of publications between 2018 and 2025, indicating that research on PjBL, science process skills, and creative thinking skills continues to grow. The strong connections among keywords reflect a consistent research trend emphasizing the development of Higher Order Thinking Skills (HOTS) through student-centered learning approaches.

From a theoretical perspective, these findings support constructivist learning theory, which emphasizes that knowledge is actively constructed through experience and interaction. PjBL facilitates this process by encouraging students to explore problems, design solutions, and develop knowledge through collaborative inquiry. From a pedagogical perspective, the results highlight the importance of integrating project-based activities into physics learning to promote active student participation, experimentation, and creative problem-solving.

However, the literature analysis also reveals an important research gap. Many previous studies examine science process skills and creative thinking skills separately. Research that integrates both variables simultaneously within a single PjBL learning design, particularly in the context of dynamic fluid materials, remains relatively limited. Therefore, further research is needed to explore how PjBL can be designed to simultaneously develop multiple higher-order thinking skills across different physics topics.

Overall, the results of the literature review and bibliometric analysis confirm that Project-Based Learning is an effective instructional strategy for developing students' higher-order thinking skills. By involving students in investigative projects, collaborative learning, and contextual problem-solving activities, PjBL enables students to connect physics concepts with real-world phenomena, making learning more meaningful and relevant.

4. Conclusion

Based on the results of the literature review and bibliometric analysis of twenty selected articles, it can be concluded that the Project-Based Learning (PjBL) model plays an important role in improving students' science process skills and creative thinking skills in physics learning, particularly on fluid materials. The characteristics of PjBL that emphasize project activities, investigation, and collaboration encourage students to actively construct knowledge and develop higher-order thinking skills relevant to 21st-century learning.

Bibliometric mapping using VOSviewer also shows a strong relationship between the keywords project, PjBL, science process skill, and creative thinking skill, indicating that PjBL is widely used as an approach to support the development of students' higher-level thinking abilities.

However, this study is limited to articles obtained from the Google Scholar database and a relatively small number of selected publications. Therefore, future research is recommended to include broader databases and to further examine the integration of science process skills and creative thinking skills in PjBL across various physics topics, including dynamic fluid materials.

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