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A Systematic Literature Review: Development of Physics Learning Research with Project-Based Learning Model in Indonesia

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Abstract. Project based learning (PjBL) plays a crucial role in helping students develop 21st-century skills. This study aims to assess the development of PjBL implementation in physics education in Indonesia through a systematic literature review. By analyzing articles published between 2017 and 2023, this research employs identification, screening, and in-depth analysis techniques to evaluate the content. Inclusion and quality assessments of the articles are conducted meticulously to ensure accuracy and avoid bias. A total of 24 relevant articles were identified, with most studies being experimental and involving high school students with sample sizes ranging from 22 to 48 students. The most common research instrument was tests, focusing on fluid topics, and the frequently measured variable was students' creative thinking skills. PjBL is often integrated with the STEM approach. Recommendations from this review include the development of PjBL on a wider range of physics topics and more comprehensive measurement of students' skills. Teachers are also advised to manage time allocation effectively when implementing PjBL. The limitation of this study is its exclusive focus on PjBL in Indonesia. Further research is recommended to explore the application of PjBL in enhancing critical thinking, problem-solving, and student literacy in less commonly tested physics topics such as Newton's laws, temperature and heat, electromagnetism, light, and waves.
Keywords: Project based learning, systematic literature review, physics learning

Introduction

Education is a crucial component in the development of a nation. Through education, the intelligence level of the populace can increase, and the quality of human life can advance, becoming more prosperous and characterized by strong values. According to the provisions of Law Number 20 on the national education system of the republic of Indonesia, 2003, education refers to a deliberate and planned effort to create a dynamic learning environment and process. The focus is on enabling learners to develop their potential, including spiritual aspects, self-control, personality, intelligence, good morality, and skills beneficial to themselves as well as society, the nation, and the country. With a good education system, it is expected that a quality future generation of the nation will be

formed. Various innovations and reforms are continuously undertaken in the field of education to achieve this goal, one of which is by improving the learning process. The learning process plays a significant role in the field of education (Suindhia, 2023). Over the past few decades, Indonesia has been striving to implement various methods in the process of physics learning.

Physics is a branch of natural science that studies natural phenomena, from the atomic scale to the universe, using an objective and quantitative scientific approach (Kemdikbudristekdikti, 2022). Nearly every human activity is related to physics (Thohir & Yanti, 2018). Fundamentally, physics evolves along with the advancement of science and technology. The process of learning physics supports students' curiosity through direct experience in scientific activities. This includes the collection of facts, formation of concepts, principles, theories, and scientific methodologies (Fatonah & Wicaksana, 2023).

Education should be designed to prepare students to face various challenges in the future. Therefore, the education system and learning methods must be continually adjusted and improved to align with the times. This also applies to physics learning in schools. Physics learning plays a crucial role in equipping students with relevant 21st century skills (Jayadi et al., 2020). The teaching methods for physics in the classroom need to be designed in such a way as to stimulate the development of various 21st century skills in students, such as critical thinking, creativity, innovation, as well as the ability to collaborate and communicate (Khoiri et al., 2023). To achieve these goals, the physics learning process needs to be modified by giving students more freedom to actively choose and explore various learning resources. This approach is expected to make learning more enjoyable and effective, as well as enhance students' overall learning outcomes.

Project based learning (PjBL) is a model that has been adopted in many developed countries, including the United States. This model offers a more innovative learning approach by emphasizing contextual learning through complex activities. In PjBL, students are given the freedom to plan their own learning activities, collaborate on projects, and develop products that are then presented to others (Mahendra, 2017). Based on its fundamental concepts, the PjBL model is highly recommended as one of the teaching models for physics subjects.

Furthermore, PjBL is a student-centered model that emphasizes specific learning, active engagement, and achieving goals through social interaction and knowledge sharing. PjBL is characterized by six main features: formulating essential questions, focusing on learning objectives, active participation, collaboration, technology use, and creating tangible artifacts. This model goes beyond mere memorization; it encourages students to think analytically and critically while solving problems through projects. According to Muis & Dewi (2021), PjBL allows students to acquire important knowledge and skills through inquiry-based investigations driven by relevant questions, and it develops higher-order thinking skills such as analysis and synthesis. This approach creates a more enjoyable and effective learning experience, reflecting real-world situations.

The implementation of PjBL in Indonesia has been developing for a long time. However, in the process of learning physics in schools, teacher center method such as lectures and question-and-answer sessions still dominate, resulting in a teacher-centered approach. This approach often proves less effective in creating meaningful learning experiences, thereby preventing students' motivation and achievement in physics from reaching optimal levels. Teacher-centered learning approaches often cause students to

become passive, as they receive more knowledge rather than actively engaging in the learning process. This can reduce students' interest and motivation to deeply understand physics concepts. Additionally, this method is less effective in developing critical and creative thinking skills, which are crucial for solving complex physics problems. Similar findings are supported by a survey conducted by (Walidain et al., 2023) at Junior High School Plus Aisyah Samawa, where the majority of teachers not optimal knowledge in integrating project-based learning model into their curriculum.

Previous research conducted by (Yanti & Novaliyosi, 2023) highlighted the contribution of PjBL in developing skills at every level of education. Their analysis focused on the impact of PjBL in enhancing both technical skills (hard skills) and non-technical skills (soft skills) in mathematics education at the elementary school, junior high school, and senior high school and vocational school levels. These findings demonstrate that PjBL has a positive impact across various educational levels. Purwanti et al. (2022) onducted an analysis of 20 articles published over the past decade. Their focus was on Project-Based Learning as a model to train students' creative thinking abilities. They used qualitative analysis methods based on the Miles and Huberman model, which includes data reduction, data display, and conclusion drawing. The analysis results are presented in tabular form for ease of understanding. Additionally, there is another study that also analyzes PjBL articles with a different focus, namely based on specific issues in Islamic Education subjects conducted by Masruri & Misbah (2023). These findings highlight the importance of PjBL in the context of religious education, showing that this model can be applied across various subjects.

However, despite the research on PjBL conducted in various contexts, there has not yet been a comprehensive study analyzing the application of PjBL in physics learning in Indonesia. Existing analyses have not covered important aspects such as the type of research, research subjects, instruments used, physics topics taught, variables measured, learning models applied, development efforts, results obtained, and recommendations proposed by the studies. This comprehensive analysis is crucial to understand the extent to which PjBL can improve the quality of physics learning in Indonesia and provide guidance for future educational research and practice.

Studying PjBL is important as it provides insights to teachers that PjBL has the potential to positively impact the educational process, particularly in student development. Additionally, this research offers guidance for teachers on how to implement PjBL effectively. The positive effects of PjBL implementation have been experienced by students (Yanti & Novaliyosi, 2023). According to Oktadifani et al. (2017), Wahyudi (2021), Novianto et al. (2018), Sinurat & Muhammad (2022) dan Rezeki et al. (2023), PjBL has the potential to enhance student learning outcomes, develop science process skills, and foster creativity, as well as improve 21st century skills such as critical, creative thinking, and collaborative skills. This research not only confirms these findings but also highlights a distinctive feature of PjBL that may not have been extensively studied, namely the final products that demonstrate students' levels of creativity. In this context, PjBL is not merely a teaching method but also generates outputs that reflect the creative application of acquired knowledge. These findings provide additional insights into how the final products of PjBL contribute to the development of students' creative skills and offer practical guidance for teachers in effectively implementing PjBL. Therefore, research on the PjBL model is crucial in the context of education in Indonesia, especially in physics education.

This study aims to provide an overview of the development of research on the PjBL model in physics learning in Indonesia. This study presents significant information regarding the characteristics of research commonly conducted in the context of using the PjBL model in physics learning in Indonesia. The components analyzed include the type of research, research subjects, instruments used, physics content studied, variables measured, learning media used, research findings, and recommendations for further research. This data is valuable for guiding the direction of future research, developing more effective approaches, and formulating better educational policies related to the types of research needed in the future and areas that require special attention.

Methods

This research is a systematic literature review using content analysis as the data analysis method. This method was chosen because it can interpret complex data sets by breaking them down into simpler data, allowing the analysis to be summarized coherently (Lune & Berg, 2017). The stages of research with this method consist of three stages of article analysis: identification, screening or filtering of articles, and analysis of articles (Heo et al., 2022; Lee et al., 2022; Marín-Marín et al., 2021). These stages are illustrated in Figure 1.

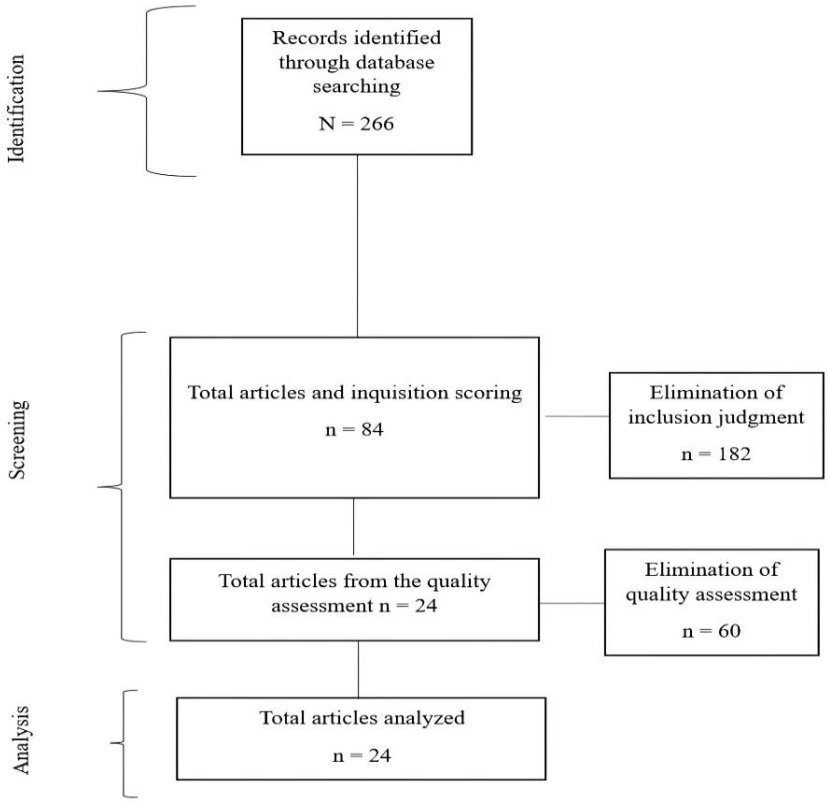

Figure 1. Research Stages Process

The identification stage in this research involves searching for literature in online databases such as google scholar with the help of publish or perish and garba rujukan digital tools. in searching for articles and journals, researchers used several keywords, including the Indonesian terms PjBL (physics learning with PjBL), (PjBL in physics learning), and (physics learning based on PjBL. The keywords used must be part of the article titles published between 2017 and 2023. This search resulted in 266 research articles, which were aggregated from various databases.

After the identification stage, the next step in this research process is screening. This stage is crucial because it employs inclusion criteria and quality assessments, which help ensure objectivity in filtering the articles. The inclusion criteria are based on the standards set by Zawacki-Richter et al. (2020), as outlined in Table 1. These criteria serve as a guideline to determine which studies are relevant and meet the necessary quality for inclusion in this research.

Table 1. List of inclusion and exclusion criteria guidelines in selecting relevant studies from online source

Inclusion	Exclusion
Articles related to PjBL in the context of physics topics in Indonesia	Articles outside the research topic
Articles published from 2017 to 2023	Publications before 2017
Full articles	Unfull articles

After the inclusion assessment, 84 articles were selected to proceed to the next stage, which is screening with quality assessment. The quality assessment of the articles is based on their quality index, where articles must be listed in both national and international indexes. Articles should be indexed in the science and technology index (SINTA) and garba rujukan digital (GARUDA). The SINTA accreditation standards were chosen because this research focuses on scientific articles that have been evaluated through national journal accreditation (ARJUNA). Meanwhile, articles listed in international indexes include publications from *the international journal of evaluation and research in education* (IJERE) and IOP. The analysis revealed that 24 articles met the established criteria. Specifically, there are two articles indexed as SINTA 1, six articles indexed as SINTA 2, two articles indexed as SINTA 3, five articles indexed as SINTA 4, three articles indexed as SINTA 5, five articles indexed in the GARUDA database, and one article published in IOP. In the bibliography that includes these articles, each article is marked with an asterisk (*) to indicate its quality and relevance in the context of this research.

The article analysis method adopted the content analysis concepts from three main sources: Barnard et al. (2022), (Marín-Marín et al., 2021), dan (Marín et al., 2018). This approach was then modified to suit the specific objectives of the research. The modifications were made through the synthesis and replication of the three methods. The elements examined include the year of publication, type of research, research subjects, instruments used, physics content reviewed, research variables analyzed, learning models

applied, development efforts in the research, research findings obtained, and recommendations proposed by the researchers in the scientific articles.

Results and Discussion

The application of the PjBL model in physics learning in Indonesia is still rare. This is due to the challenges faced by teachers in implementing project-based learning. Although some research on physics learning using the PjBL model has been conducted, its implementation remains limited. Various aspects related to the PjBL model in physics learning have been examined and explained in these studies. It is hoped that the findings from this research can serve as a guide for teachers in adopting the PjBL model in physics learning, so that this approach can be more widely implemented across schools in Indonesia.

Based on the review conducted, PjBL is a learning approach that focuses on using projects or practical activities as the primary means for teaching and evaluating students. Fathurrohman (2016) explains that through PjBL, students are encouraged to actively engage in projects designed to help them develop various competencies. This model aims not only to enhance students' theoretical understanding but also to enrich their practical skills and attitudes towards learning. In the context of PjBL, these projects serve as a bridge to achieve comprehensive educational goals, encompassing cognitive, affective, and psychomotor aspects. Thus, students not only gain knowledge but also develop relevant practical skills and cultivate positive attitudes towards the learning process.

According to research conducted by Oktadifani et al. (2017) teachers implement or integrate PjBL during the learning process with structured and detailed steps. First, the teacher begins the learning process with a central question that becomes the main focus of the project to be undertaken by the students. This question is designed to spark students' interest and motivation in the learning process. Next, the teacher assists students in designing a project plan. In this step, students are guided to determine the project's objectives, the steps to be taken, and the resources needed to complete the project. After designing the project plan, the teacher helps students create a project schedule. With a structured schedule, students can manage their time effectively to complete the project according to the established targets. Subsequently, the teacher monitors the progress of the project being worked on by the students. In this step, the teacher provides guidance, feedback, and support to help students overcome any obstacles that may arise during the learning process. Once the project is completed, the teacher assesses the final outcome of the project. The assessment covers both the substance of the project and the learning process experienced by the students. Finally, the teacher and students jointly evaluate the entire learning experience gained from the project.

The integration of project-based learning approaches has proven effective in teaching physics concepts, as demonstrated by Kristanti et al. (2017). In their study, the teacher provided the necessary tools and materials, while each student group was given the freedom to design their own projects and the steps to be taken. By applying the PjBL model, students are actively engaged in projects that challenge them to find solutions to the problems they encounter. This process not only enhances students' problem-solving skills but also stimulates their critical and creative thinking. Additionally, by focusing on

projects relevant to advancements in technology and science, students can develop innovative ideas that meet the demands of the times. The PjBL model also helps students gain a deeper understanding of the subject matter, as they must apply the knowledge they have acquired in practical contexts. Thus, students' abilities in creativity and innovation are further honed, preparing them to face real-world challenges

This study conducts a content analysis to evaluate scientific articles that apply PjBL in physics learning, specifically in Indonesia. Basic information from the analyzed articles is presented comprehensively in Table 2.

Table 2. Basic information of the article

Data	Result
Year of publication	2017-2023
Number of articles analysed	24
Overall Citation	49.94
Average citations per-article	19
H-Index	28.5
Author-per-article	2.86

Table 2 presents general information about the articles analyzed overall. The majority of articles using the PjBL model in physics learning are authored by groups of authors, with the number of authors ranging from 3 to 6. These articles also have a relatively high citation rate, with an average of 49.94 citations per year and 19 citations per article. Among all the articles analyzed, five articles have the highest number of citations, detailed further in Table 3.

Table 3. List of Highest Cited Articles

No.	Year of Publication	Article Title	Author Name	Number of Citations
1	2017	The effect of PjBL with virtual media assistance on student's creativity in physics	Gunawan, et al. (SINTA 1)	198
2	2017	PjBL model for physics learning in high school	Oktadivani, et al. (SINTA 5)	186
3	2018	Development of a PjBL module on static fluid materials to increase learning creativity of students in class x SMA/MA	Novianto, et al (SINTA 4)	90
4	2023	Systematic literature review: PjBL learning model on skills developed at the education unit level	Yanti & Novaliyosi (SINTA 4)	28
5	2019	Effect of PjBL model on creative thinking skills in applied physics learning	Umamah et al, (SINTA 2)	27

Table 3 contains data on the articles with the highest number of citations. One of the top-ranked articles is authored by Gunawan in 2017, with a total of 198 citations. This article, through their experimental research, discusses the effects of using PjBL with virtual assistant media support on enhancing students' creativity in physics learning (Gunawan et al., 2017). The research on PjBL within the context of physics material has shown significant impact, as evidenced by a relatively high number of citations recorded by Kristanti et al. (2017). Their article outlines the positive effects of implementing the PjBL model on improving students' learning achievements and creativity. Such findings indicate that both articles have become important references in the scientific literature related to the development of project-based models in physics education.

The distribution of articles by publication year is presented below. The distribution chart shows the number of articles published from 2017 to 2023.

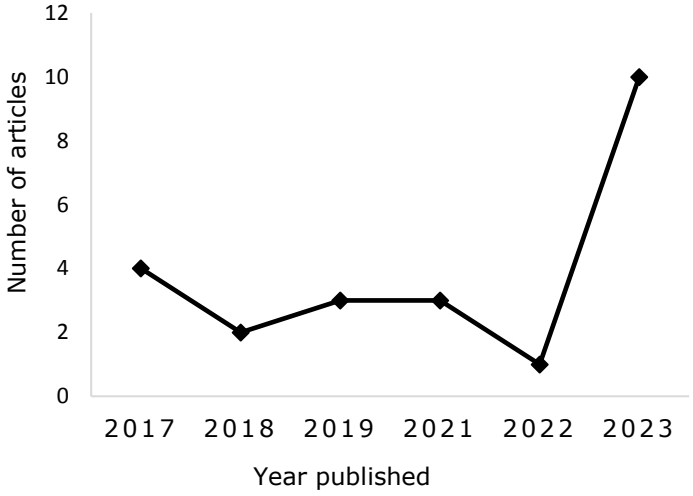

Figure 2. Article Distribution 2017-2023

Figure 2 illustrates the distribution of articles, showing the number of articles published from 2017 to 2023. The graph depicts fluctuations in the number of articles published each year regarding the project-based learning model. It shows a significant increase from 2022 to 2023, with the number of articles rising from 1 in 2022 to 10 in 2023. This indicates a strong upward trend in recent years concerning research on the PjBL model. Despite a decrease in the number of articles in 2018 and 2022, this is likely due to the limited number of articles analyzed in those years. If more articles were analyzed, the recorded number might be higher, reflecting a more consistent increase year by year in research on the PjBL model in Indonesia's physics education.

The analysis of the types of research used in the articles examined is presented in Figure 3:

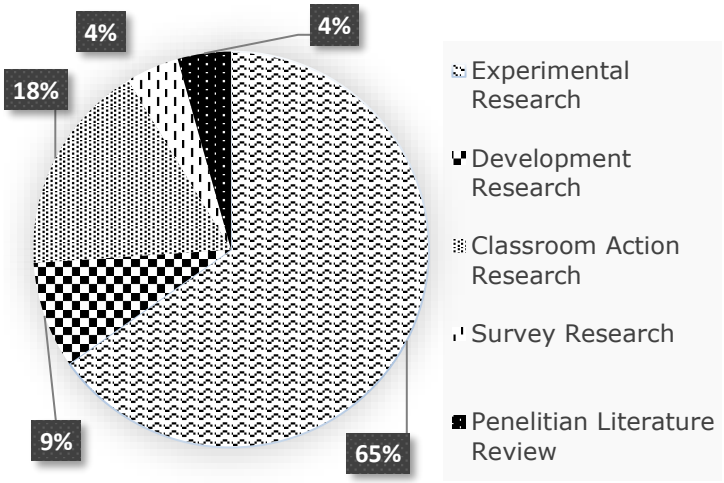

Figure 3. Analysis of research types in articles

Based on Figure 3, the prevalence of experimental research methods in educational studies, particularly in testing project-based learning models, is presented. Experimental research is the most frequently used method, with 15 articles documenting its application. This indicates a significant interest among researchers in testing the effectiveness of various teaching models. Support from the literature, as expressed by Sugiyono (2022), reinforces the view that experimental research has advantages in flexibility and wide coverage of research variables. However, it is important to note that such research is often limited to specific topics, which may restrict the generalizability of its findings. Quasi-experimental research is also commonly used, especially in educational contexts. Sumarni et al. (2020) emphasize that this method offers benefits as it does not require completely random sampling, which is often difficult to achieve in real educational settings. This makes quasi-experimental research a more practical and still valid alternative for evaluating the effectiveness of teaching models.

The distribution of research subjects used in the articles studied is presented in Figure 4.

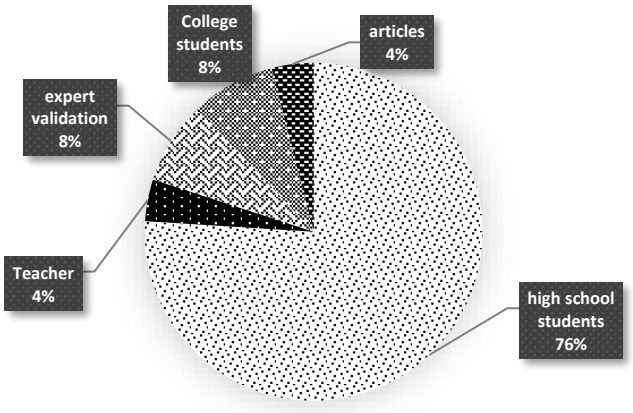

Figure 4. Analysis of the distribution of Research Subjects on articles

The analysis reveals that the majority of research on the PjBL model in physics learning in Indonesia focuses on students as the primary subjects of the study. There are 21 articles utilizing students from various educational levels, ranging from high school to university students. High school students dominate as research subjects, with 76% of the total articles analyzed. This research includes grades X through XII, highlighting researchers' attention to the dynamics of learning at the secondary level, which is considered crucial in students' academic development. In addition to high school students, 8% of the research subjects consist of university students and expert validators. PjBL at the university level is recommended for deepening the understanding of fundamental physics concepts, as explained by Zakirman (2023). The variation in the number of research samples depends on the study design, with small-scale studies using between 5 to 22 samples in a class, while large-scale studies involve between 48 to 75 samples, divided between experimental and control classes. An article using a survey method also involved 5 physics teachers as research subjects. Some articles do not specify research subjects as they are literature review studies, focusing on the examination and analysis of existing literature without involving new subjects.

The data collection instruments used in the article under study can be seen in the Figure 5.

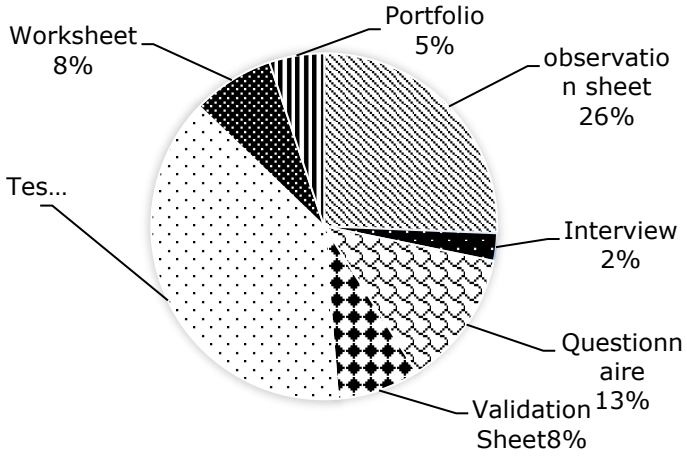

Figure 5. Analysis of Research Instruments from Articles

Figure 5 provides a detailed overview of the test instruments used in the research studies. Out of the 23 articles analyzed, 38% of the instruments used are from these sources, with the most common formats being multiple-choice and essay questions. Interestingly, there is a noticeable trend towards the use of essay instruments. This can be attributed to the prevalence of studies adopting the PjBL model. Researchers tend to use more than one type of data collection instrument to enhance the quality of their research. This approach is deemed appropriate as it not only increases the utility of the research findings but also demonstrates the researchers' attention to the validity and reliability of the instruments by utilizing various data collection techniques, as noted by Ormanci (2020). By considering the variety of instruments and data collection techniques, these studies contribute more robustly to the understanding of their respective fields. The use of diverse instruments not only enriches the obtained data but also ensures that the research results are more robust and reliable. This is crucial in the academic context, where the validity and reliability of research findings are key aspects in achieving meaningful and applicable results. The following is an overview of the distribution of physics material in the articles studied.

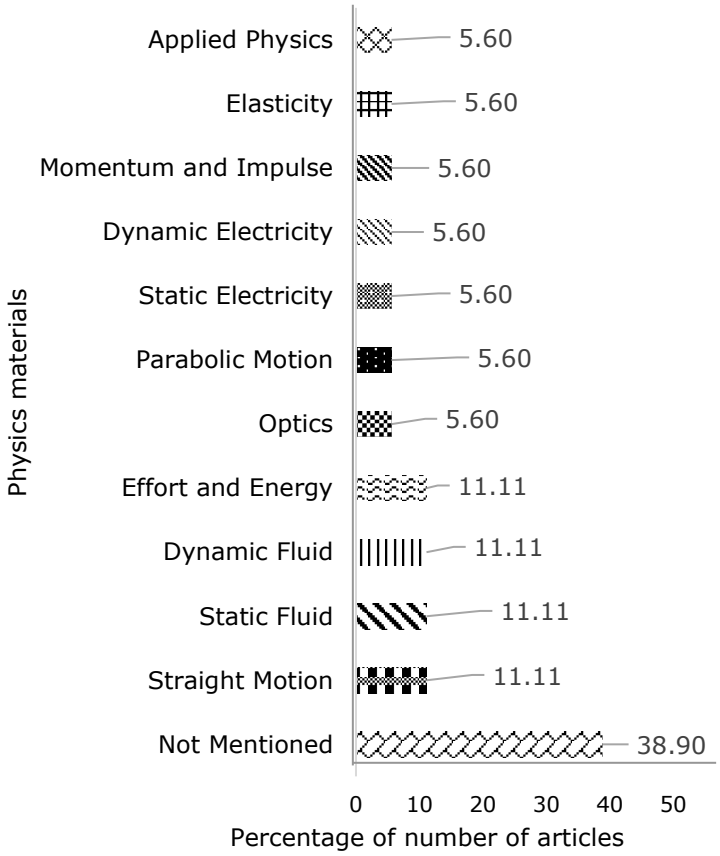

Figure 6. Distribution of Physics Material

Figure 6 reveals that some physics topics are not covered in the articles because the research focuses on literature reviews and surveys. However, topics such as linear motion, fluids, and work and energy receive more attention within the context of PjBL. This focus on fluids is due to their strong relevance to everyday life, as students often struggle to understand the concepts and their real-world applications. For other physics topics, school learning often remains limited to rote memorization of formulas without a deep understanding of their applications. This approach fails to develop 21st-century skills, such as critical thinking, scientific process skills, and creativity, which should be emphasized in physics education. Therefore, learning models that address these weaknesses, such as PjBL, are deemed necessary. Supporting research includes studies by Novianto et al. (2018), Rezeki et al. (2023), and Umamah & Andi (2019). Additionally, there are several physics topics that have not been extensively researched, such as Newton's Laws, Thermodynamics, Temperature and Heat, Magnetism, Light, and Waves. These topics have significant potential for investigation using PjBL approaches, which could open new opportunities for developing more relevant and effective physics curricula and instruction.

Analysis of scientific articles based on the variables measured can be seen in the Figure 7.

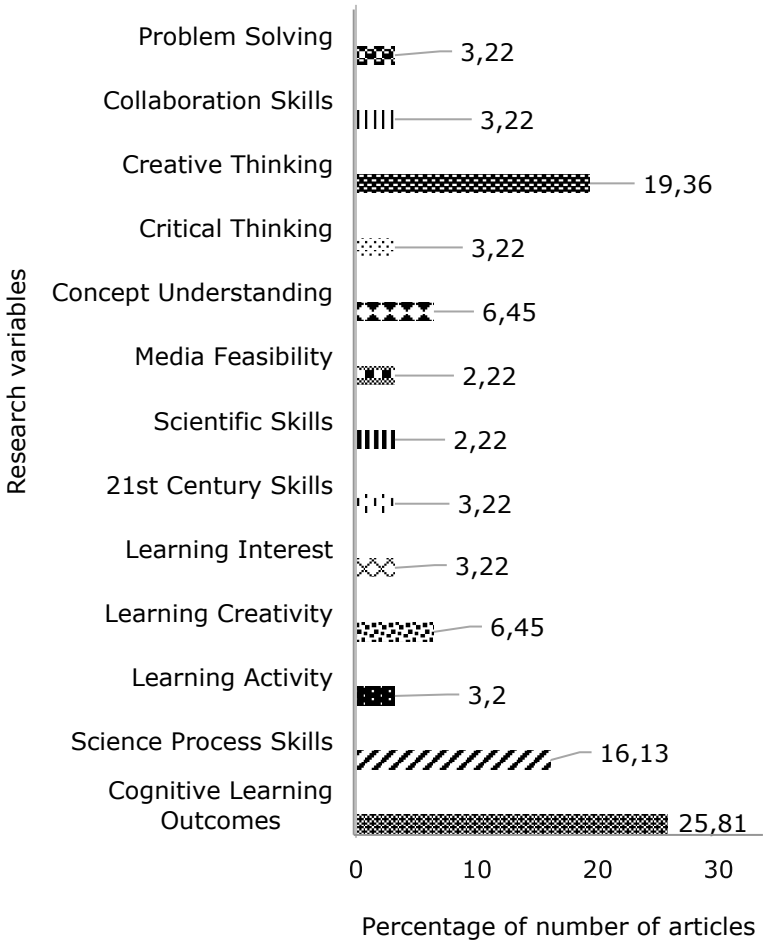

Figure 7. Article Distribution Based on Measured Variables

Figure 7 shows that various experimental studies have highlighted some of the variables tested in the context of physics learning. The findings consistently show the positive impact of implementing a PjBL model on the measured variables. The implication is that learning using this model can positively influence diverse aspects of physics learning as well as the range of materials taught. As such, the PPA model is a highly recommended option to be implemented in a classroom setting. In addition, the research also highlighted the interrelationships between the various variables studied. For example, learners who show high learning outcomes tend to have high interest in learning, developed creative skills, and active engagement in the science process ((Kurniasari & Ruwanto, 2017; Oktadifani et al., 2017; Roziqin et al., 2018; Syamsuddin & Salmawati, 2023). By strengthening the relationship between these variables, a deeper understanding of the dynamics of physics learning can be better realised, providing a more holistic view in designing effective learning strategies.

Several variables commonly measured in the context of education include cognitive learning outcomes and creative thinking skills. Research shows that the PjBL model can be effective in developing both of these aspects in students, with positive implications for their cognitive learning achievements (Ismail, 2022; Saefullah et al., 2021). However, there is a variable that is rarely given attention in measurements, namely problem-solving skills. Docktor et al. (2015) emphasize that physics learning requires students to have strong problem-solving skills, as they need to analyze and

understand various problems that arise in the context of physics lessons. Recent research by Rezeki et al.,(2023) reinforces the importance of this ability, showing that problem-solving skills are not only important but also essential for students in finding solutions to physics problems presented in the learning process.

PjBL has also been integrated with several approaches and media aids to support its implementation in the learning process. Figure 8 shows the distribution of the integration of PjBL with models and media in physics learning.

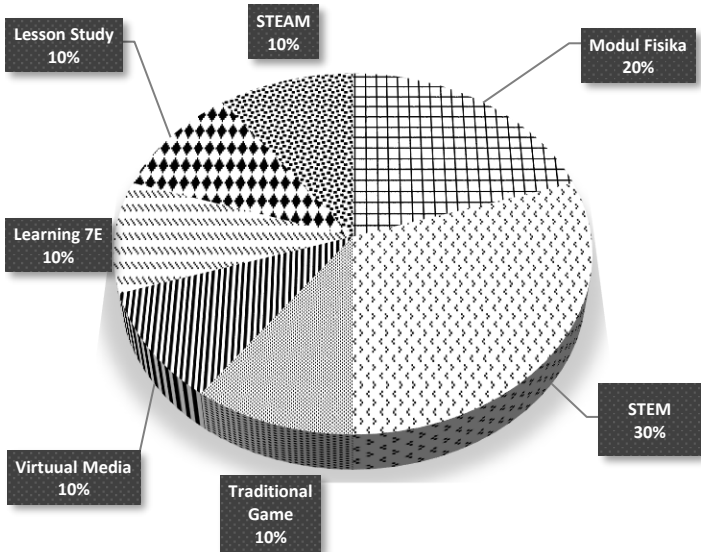

Figure 8. Distribution of articles based on their integration with other learning approaches/models

Figure 8 illustrates the integration of various learning approaches with the PjBL model in the context of physics education. One of the approaches depicted is PjBL-STEM. This approach allows students to actively engage in learning through real-world problem-solving. In the PjBL-STEM model, students identify, propose, and select the best solutions to problems, then create and test prototypes based on relevant issues. This process not only develops problem-solving skills but also deepens students' understanding and critical thinking abilities (Devanda et al., 2023). In this study, PjBL-STEM was implemented using a simple water wheel as a visual aid. This model enabled students to explore physics concepts such as hydrostatic pressure and the law of conservation of energy through hands-on activities. The approach helped students design, build, and test water wheel prototypes, allowing them to apply learned theories in real-world scenarios. As a result, this model proved effective in enhancing students' understanding and scientific skills, reinforcing the integration of theory and practice in physics education.

Additionally, the integration of PjBL-STEM plays a crucial role in honing students' creative and critical thinking skills. Through group activities, students are encouraged to collaborate, discuss, and solve problems together, which in turn enhances their learning interest (Sinurat et al., 2022; Saefullah et al., 2021). Students are also encouraged to be more independent in seeking learning resources and more active in the learning process, making their learning experience more meaningful and beneficial (Rezeki et al., 2023; Rohman, 2021). However, it is important to note that the implementation of PjBL requires thorough preparation. This includes adequate cost allocation and sufficient time to ensure that all aspects of learning are effectively executed (Nafiah et al., 2023). Inadequate preparation can hinder the effectiveness of learning and reduce the benefits that should be derived from this model.

The PjBL model creates a learning environment that encourages students to actively participate and develop their skills. In this model, students not only passively receive knowledge but also understand and internalize it through the design and implementation of their own projects. Students engage in real experiments conducted in groups, allowing them to directly experience the scientific process. This process not only facilitates theoretical understanding but also provides valuable practical experience. As students design projects and conduct experiments, they build knowledge based on real-life experiences, enhancing their capabilities in the scientific process. By participating in activities that promote exploration, collaboration, and practical application, students can develop better analytical and critical thinking skills, which are crucial in the field of science (Oktadifani et al., 2017.). This model also strengthens social and collaborative skills as students work in groups to complete projects. They learn to share ideas, resolve conflicts, and work together to achieve common goals. All these aspects contribute to the overall improvement of students' scientific process skills, making learning more effective and enjoyable (Prameswari, 2019).

The following suggestions are presented from the meanings of the scientific articles studied in Table 4.

Table 4. Article Distribution Based on Research Suggestions

Type	Advice	Total
Suggestions for future research	Integrating the PjBL learning model with other innovative learning approaches	3
	Develop a learning module as a guide for students in self-learning	3
	Creating modules with varied learning approaches and diverse content	1
	Apply PjBL to other physics materials	4
	Testing the effectiveness of the PjBL model in measuring other student skills (higher order thinking skills, literacy and others).	4
	Apply the product that has been developed based on PjBL	1
Further research technique suggestions	To measure the effectiveness of the PjBL learning model, two classes can be used to allow comparison of the results.	2
	In-depth enquiry into learners' prior knowledge of issues that arise in everyday life	1
	Using worksheet instrument to assess students' creative skills	1
	Observations were carried out in groups to make it easier for researchers	1
	The research subjects were not limited to either students or teachers	1
Suggestions for teache	The application of the PjBL model requires a longtime allocation, teachers must be able to manage time during learning.	2

	Teachers need to have a proper and thorough understanding of the components and stages of the PjBL learning model.	1
	Students are given guidance as they conduct experiments and deliver presentation results.	1
	Teachers need to conduct careful introspection to improve the effectiveness of the PjBL model to optimally achieve learning objectives.	1

Table 3 provides valuable insights into recommendations for further research on the application of the PjBL model in physics education. The main recommendation arising from this analysis is the application of PjBL to various physics topics that have not been extensively researched, as well as the assessment of students' physics abilities and skills across different domains. Previous research supporting this recommendation, as highlighted by Kurniasari & Ruwanto (2017), Rezeki et al. (2023), Saefullah et al. (2021), and Sinurat (2022), underscores the significant potential of PjBL in enhancing students' understanding of physics concepts and skills. PjBL, which involves challenging projects relevant to real life, can offer a more profound and applicable learning experience, but its implementation requires substantial time allocation.

This challenge requires teachers to manage time very carefully and to have a deep understanding of the components and steps of the PjBL model to apply it effectively. Research by Kristanti et al. (2017), Oktadifani et al. (2017), and Tain et al. (2023) indicates that teacher preparedness and a thorough understanding of PjBL are crucial for successful implementation. Teachers need not only to prepare the project materials and activities but also to guide students in completing projects in a way that facilitates active and reflective learning. Additionally, to support the effective implementation of PjBL, the presence of a comprehensive guide module is essential. This module serves as a tool that provides clear structure and direction throughout the learning process. Septi et al. (2019) emphasize that a well-designed module can assist teachers in designing and implementing projects, as well as help students understand the steps they need to follow. With a well-constructed module, the PjBL learning process can proceed in a more planned and systematic manner, minimizing potential obstacles that could disrupt the learning process.

Conclusion

Based on the literature review from 2017 to 2023, there has been a significant increase in the use of PjBL in physics education. Most of the analyzed studies employed experimental designs with high school students, focusing on physics topics such as static fluids, work, and energy, and measured cognitive learning outcomes and creative thinking skills. Additionally, some PjBL studies are often combined with other approaches such as STEM, Lesson Study, and other learning methods. Although PjBL has proven effective, effective time management is crucial for its success. Further research is needed to explore the application of PjBL to other physics topics such as Newton's Laws and Electromagnetism, as well as to assess its impact on students' cognitive, psychomotor, and affective skills for improved curriculum development.

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