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A Bibliometric Analysis of Implementation PjBL-STEAM Model Over Past 11 Years

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ABSTRACT

Objective: *This study analyzes the development trends of STEAM-based project-based physics learning research over the past 10 years using bibliometric methods to describe (1) Research trends over the past 10 years; 2) Publication developments reviewed by document type, subject area, and language; 3) Distribution of research publications by country, author, and funding sponsor; and (4) identifying novelty between studies.* ***Method:*** *Research uses bibliometric analysis with descriptive qualitative interpretation of Scopus metadata. The analysis was conducted on 31 articles from Scopus and 17600 Google Scholar sources, with article categories, abstracts, and keywords covering the period 2015 to 2025.* ***Results:*** *The results of this study indicate that: a) The development of PjBL-STEAM physics learning research from 2015 to 2025, which was indexed in Scopus, was highest in 2024 with 10 publications. b) Various types of publication documents, namely conference reviews, conference papers, articles, and book chapters, with the dominant language used being English. c) Indonesia is the dominant country in conducting research publications, with Malang State University as the main contributor, along with the Malaysian University of Technology. d) Research on STEAM-based PjBL continues to experience innovations in accordance with the times. It leads to 21st-century skills and is applied in learning on topics such as physics applications, static fluids, and others.* ***Novelty:*** *Findings study in the first decade-scale (2015–2025) bibliometric analysis of PjBL-STEAM that integrates and compares data from Scopus and Google Scholar can improve quality education.*

INTRODUCTION

21st-century education currently demands a learning system that can prepare students to meet various needs, address challenges, and maximize existing opportunities in line with current developments and the dynamics of technology and information (Dewi et al., 2021). Education in the 21st century packages learning to ensure that graduates not only focus on academic knowledge but also on the skills needed to adapt, innovate, and succeed (Abdullah & Munawwaroh, 2024; Purwanto et al., 2023). 21st-century skills are broken down into several elements, such as critical thinking, innovative education, creativity, effective communication, and collaboration (Fahri et al., 2024; Jamaluddin et al., 2020; Khansa et al., 2026).

In realizing Indonesia Emas 2045, the Indonesian government's role in the world of education is certainly significant, including improving the quality of existing education by preparing the nation's next generation to possess and master 21st-century skills. However, the demand for 21st-century skills has not yet been implemented in Indonesia's

education system (Madhakomala et al., 2022; Setiyaningsih, 2025). One indicator of this is the Program for International Student Assessment (PISA), organized by the Organization for Economic Co-operation and Development. According to the Organization for Economic Co-operation and Development (OECD), Indonesia ranks 69th out of 80 participating countries. Indonesia's scores remain low in mathematics, literacy, and science (Fauzan et al., 2025; Wijaya et al., 2024).

In the process of change and development in science and technology, the human qualities needed to meet current and future conditions, in the form of 21st-century skills, need to be developed (Sari & Prasetyo, 2021). One of the skills, namely problem-solving, is very important and necessary for students to reason about or visualize problems, describe them, analyze them, plan solutions, make choices, evaluate each item, and reflect on activities (Adeoye & Jimoh, 2023; Hendriani et al., 2021; Wrahatnolo, 2018). Based on research conducted by Ringo et al. (2019) in Malang City on problem-solving skills, students' problem-solving abilities are still relatively low, with an average score of 48.88 on a scale of 0-100. These results indicate that the learning remains ineffective; this may be influenced by several factors, one of which is that the applied learning model is not appropriate for students and the goals to be achieved. The learning models used in the study include Problem-Based Learning, Project-Based Learning, Inquiry, and other models. When conducting research using a learning model, it must be adapted to students' characteristics and the objectives to be achieved (Hasibuan et al., 2024; Qorib, 2024).

The Project-Based Learning (PjBL) model has been widely used in research and is an alternative approach that encourages students to be actively involved and to relate real-world contexts to the problem (Halimah et al., 2020; Sari et al., 2018). Furthermore, PjBL has the potential to improve 21st-century skills, including students' thinking skills, by engaging them in problem-solving related to everyday life (Busnawir et al., 2025; Phelia et al., 2024). This aligns with Article 3 of Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System, which sets out the objectives of national education and emphasizes the development of student potential. In its implementation, the PjBL is associated with the use of the Science, Technology, Engineering, Art, and Mathematics (STEAM) approach (Mahabatis & Hardianti, 2025; Monika et al., 2023). This is done to make learning more meaningful and to encourage students to solve problems, think critically, and think innovatively (Sakdiyah, 2024; Arifin, 2024; Widiastuti et al., 2023). In learning, one subject closely related to critical thinking and problem-solving skills is physics. Hidayat et al. (2023) stated that problem-solving skills and physics cannot be separated from process skills for solving phenomena in the world. Physics is a fundamental science concerning matter, space, and time that has, until now, been a driving force behind technological progress, including submarines, airplanes, and high-speed trains (Dewi et al., 2021; Ficoń et al., 2022).

Conducting research using the PjBL-STEAM model in physics learning requires careful consideration of previous studies. Bibliometric analysis is necessary to provide an overview and references for researchers conducting further research on the subject

(Kumar et al., 2023). Previous bibliometric studies have analyzed the PjBL and STEAM models, but they were treated as separate and unrelated. The topics in previous bibliometric analyses were also general and did not address applications in physics or engineering physics. Furthermore, the research analyzed was relatively long, for example, the bibliometric analysis of PjBL-STEAM by Putri (2023) and Ulmi (2024). Therefore, a more recent bibliometric analysis is needed to analyze research linking PjBL-STEAM to physics learning within the past year. This bibliometric analysis can significantly contribute to the identification of research trends in specific fields (Kurdi & Kurdi, 2021; Suliyanah et al., 2021). Through bibliometric analysis, the relationship between authors and scientific publications can be identified, driving research progress (Wang et al., 2022). Furthermore, bibliometrics can provide more accurate insights into the evolution of project-based learning using the STEAM approach by identifying novelty and shifts in keywords over time. Specifically, the objectives of this study are: 1) To analyze research trends; 2) To analyze documents, countries, and languages used in research; 3) To analyze the distribution of research publications over the past 10 years; 4) To identify novelty among research studies during the period 2015 to 2025.

RESEARCH METHOD

This research includes library research to analyze the physics learning model PjBL-STEAM from 2015 to 2025 using bibliometric and qualitative approaches. The bibliometric method was used to analyze the development patterns in the implementation of the PjBL-STEAM model (Prasetyawati & Astuti, 2025; Wang et al., 2022). The bibliometric research flow diagram can be presented in Figure 1.

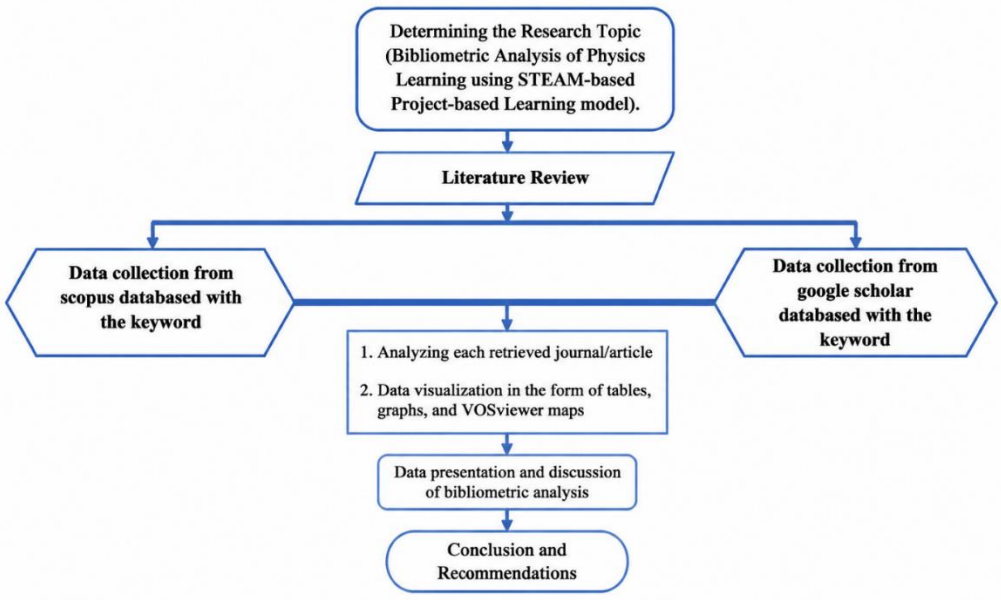

Figure 1. Flowchart

The PjBL-STEAM model is objectively supported by visualization tools, such as graphs, to simplify the results of complex data networks (Arifin, 2025). Bibliometrics also plays a strategic role in identifying research gaps amid massive collections of scientific data (Ghauts & Asmara, 2026). The qualitative data results are secondary data

descriptions from the Scopus database. The data used are sourced only from Scopus and Google Scholar because they provide broader filtering options and are suitable for bibliometric analysis that requires clean, consistent, and standardized data (Nowakowska, 2025). The data search was carried out initially; the author found 32 documents using keywords in Search documents: TITLE-ABS-KEY ("PROJECT" AND "BASED" AND "LEARNING" AND "STEAM" AND "PHYSICS" AND "EDUCATION"). Then, the publication time limitation was applied from 2015 to 2025, so that 31 documents were found with the keywords TITLE-ABS-KEY ("PROJECT" AND "BASED" AND "LEARNING" AND "STEAM" AND "PHYSICS" AND "EDUCATION") AND PUBYEAR > 2015 AND PUBYEAR < 2025.

Then the data search was conducted on Google Scholar using the keyword "Project Based Learning STEAM" and a time filter of 2015–2025, yielding 46,500 documents. Then another search was carried out using a more specific keyword, namely "Project Based Learning STEAM Physics Learning or Education," and a time limitation of 2015–2025, resulting in 17,600 documents, which were then analyzed with VOSViewer. The obtained database will be analyzed further. To visualize the data into tables, graphs, or maps, analysis from the Scopus web is used. The data obtained is mapped into several categories, namely: (1) Publication trends related to PjBL-STEAM, (2) Based on document type, (3) Countries, Institutions, and funding sponsors that are included in the top ten publications related to PjBL-STEAM, (4) Titles and updates during the period 2015 to 2025. (5) Analysis with VOSViewer from Scopus and Google Scholar sources.

RESULTS AND DISCUSSION

Publication Results, Subject Area, Document Type and Language

Based on data obtained from the Scopus journal database using the keywords "Title-Abs-Key ("Project" AND "Based" AND "Learning" AND "STEAM" AND "In" AND "Physics" AND "Learning"), there are 31 documents related to physics learning using the STEAM-based project-based learning model in the period 2015 to 2025. The complete results of research publications on STEAM-based project-based learning from 2015 to 2025 are shown in Figure 2.

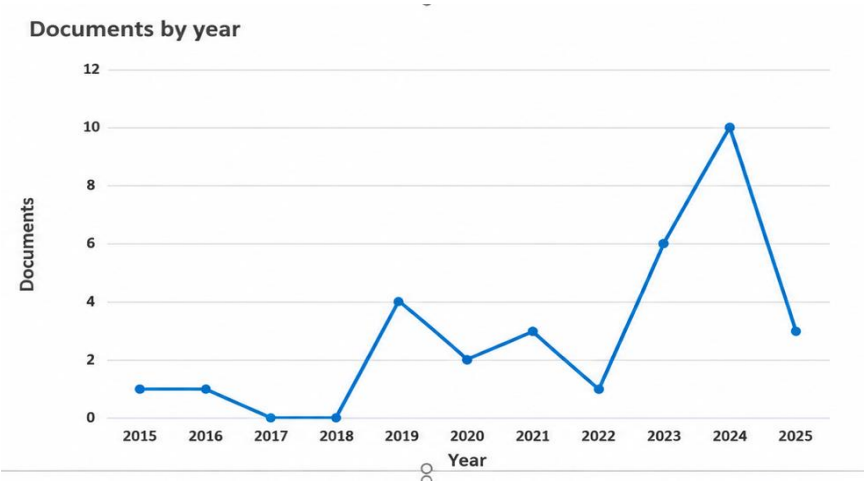

Figure 2. Graph of number of publications per year from 2015 to 2025

From 2015 to 2025, the number of research publications related to PjBL-STEAM fluctuated significantly. In the last 10 years, the fewest research publications were in 2017 and 2018, with no publications in either year. The most research publications were in 2024 with 10 documents, and there was a decline in 2025 with only 3 publications. This is in line with the results of research by Solihin (2025), which stated that research publications in the field of project-based learning increased after the pandemic in 2022, then declined in 2025. Research publications on PjBL-STEAM models between 2015 and 2025 spanned many disciplines, necessitating subject-area mapping. The distribution of research results by subject area is shown in Figure 3.

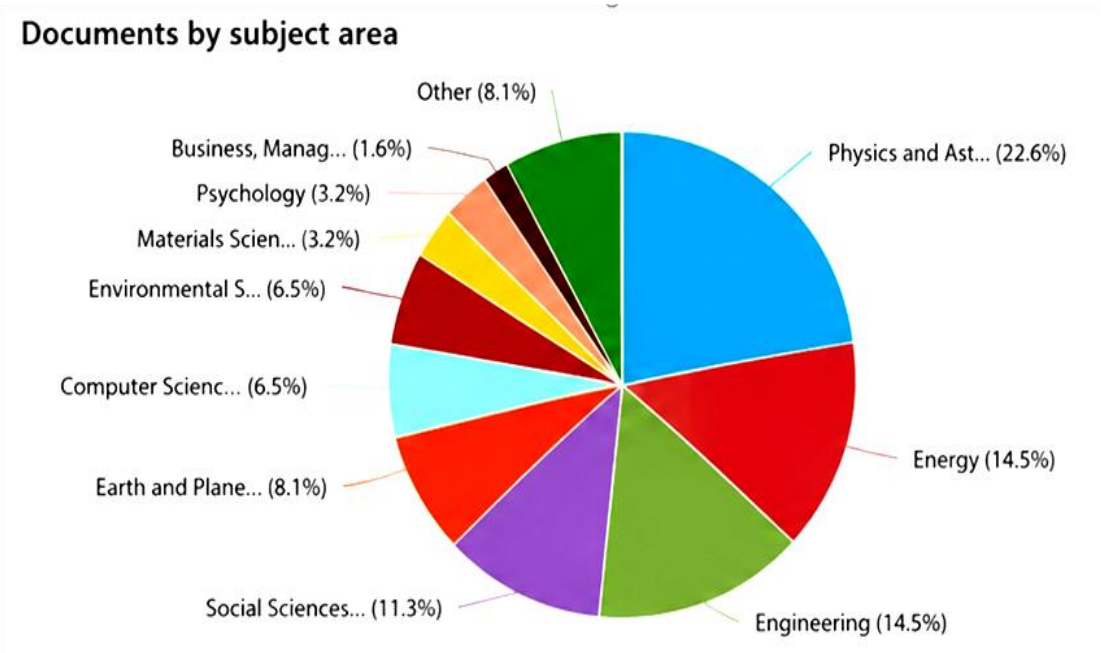

Figure 3. Distribution of research results related to project-based learning by subject area

Based on Figure 3, research related to PjBL-STEAM in physics from 2015 to 2025 accounted for 22.6%. This result is higher than in other fields, such as psychology, business, and management, in the same year period. This shows that physics learning requires real-world, hands-on activities through experiments or projects that relate to everyday life. Physics concepts need to be taught using a model that requires students to engage in direct, interactive activities so they can imagine, internalize, and connect them to everyday life. In addition, research by Ristiani et al. (2025) stated that there is a need for a learning model that can bridge the abstraction of physics concepts and real experiences relevant to students. One model that can be used is project-based learning. The distribution of research by document type overall is shown in Figure 4.

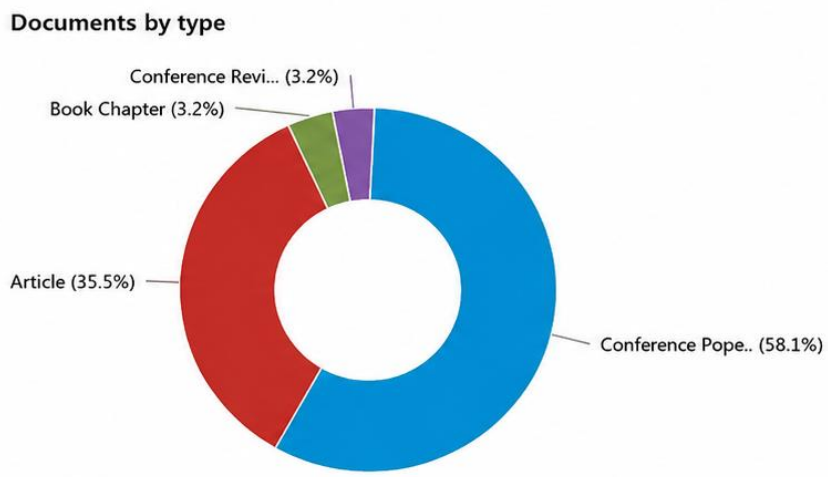

Figure 4. Publication distribution by document type.

Based on document type, the number of project-based learning research publications is dominated by Conference Papers, at 58.1%, followed by article types at 35.5%, and book chapters and conference reviews at 3.2% each.

Country, Author, Institution and Funding Sponsor

From 2015 to 2025, numerous publications on physics learning using the PjBL-STEAM model were published by researchers from various countries. The overall distribution map of countries of origin for physics learning research using the STEAM-based project model is shown in Figure 5.

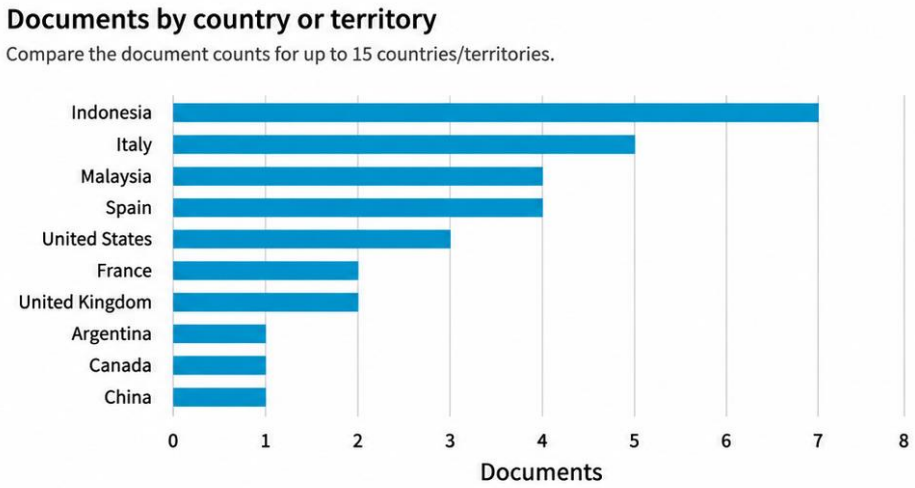

Figure 5. Distribution of research publications related to PjBL-STEAM models in physics learning by country.

Indonesia became the country with the most research output compared to other countries such as Italy, Malaysia, and France. Indonesia produced publications from 2015 to 2025 on physics learning using the project-based model, totaling 7 documents. Based on data from the SCImago Journal & Country Rank, Indonesia had the highest number of citable publications, namely 64,393, including those in the field of project-based learning. (SCImago Journal and Country Rank, 2026). The number of publications is still

relatively small, although the highest among several other countries. This is evidence that research on PjBL-STEAM in physics learning remains limited and warrants further study in future research. This is in line with the findings of Darmaji et al. (2018), who stated that research is a key to national competitiveness, and with the Indonesian government's finding that research publications in Indonesia are relatively low compared to those in other Southeast Asian countries. Therefore, efforts are needed to continue publishing high-quality, Scopus-indexed research. One way is to provide incentives to researchers who successfully publish their research in reputable, high-quality journals. Based on Scopus data analysis from 2015 to 2025 on research related to the PjBL-STEAM model in physics learning, when viewed by author, Latifah and Parno are the authors with the most articles, namely 3 each.

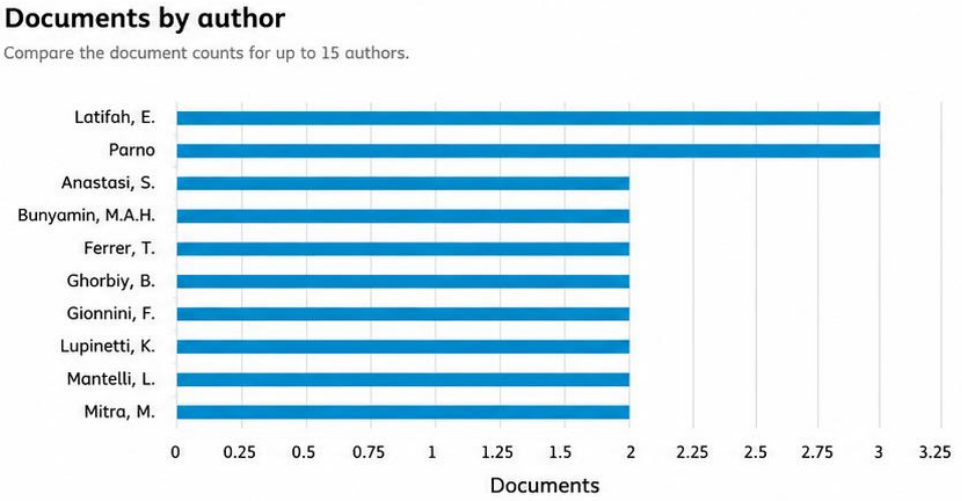

Figure 6. Publication distribution by author

Research on physics learning using the PjBL-STEAM model can also be mapped by affiliation or by the educational institution conducting the research. Between 2015 and 2025, the University Teknologi Malaysia and the State University of Malang produced the most research in this field, with three studies each. The distribution of research by affiliation is shown in Figure 7.

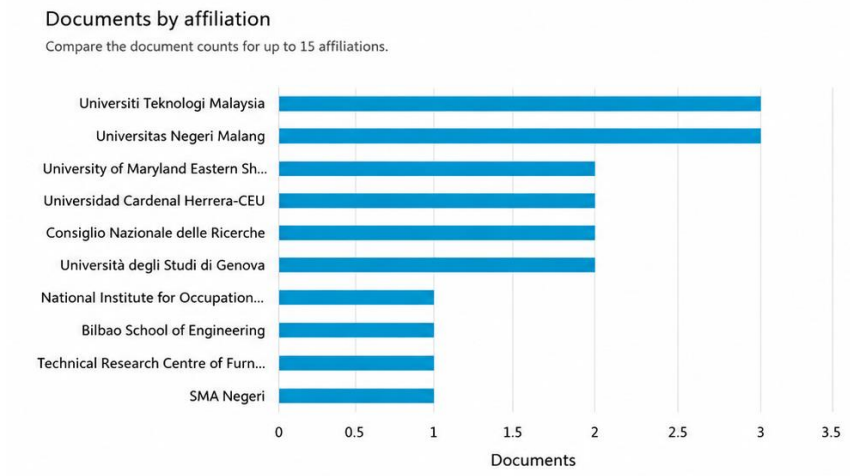

Figure 7. Publication distribution based on affiliation or institution

Furthermore, this study mapped research on PjBL-STEAM models by funding sponsor groups. The distribution of results by sponsor group is shown in Figure 8.

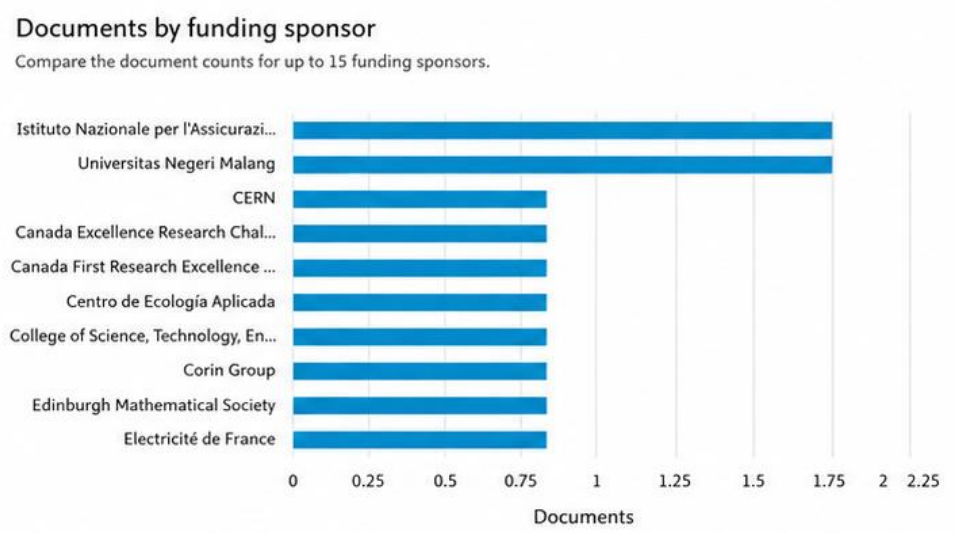

Figure 8. Distribution of publications by funding sponsor group type.

Figure 8 shows that several countries dominate research funding. Indonesia only has Malang State University as one of the largest funding sponsors, with two documents. These results indicate that sponsorship funding for research on PjBL-STEAM in physics in Indonesia remains insufficient and needs to be increased, particularly from several universities and other institutions.

Research Innovations from 2015 to 2025

Between 2015 and 2025, 32 studies were related to PjBL-STEAM. The full list of research titles published in Scopus-indexed journals is shown in Figure 9.

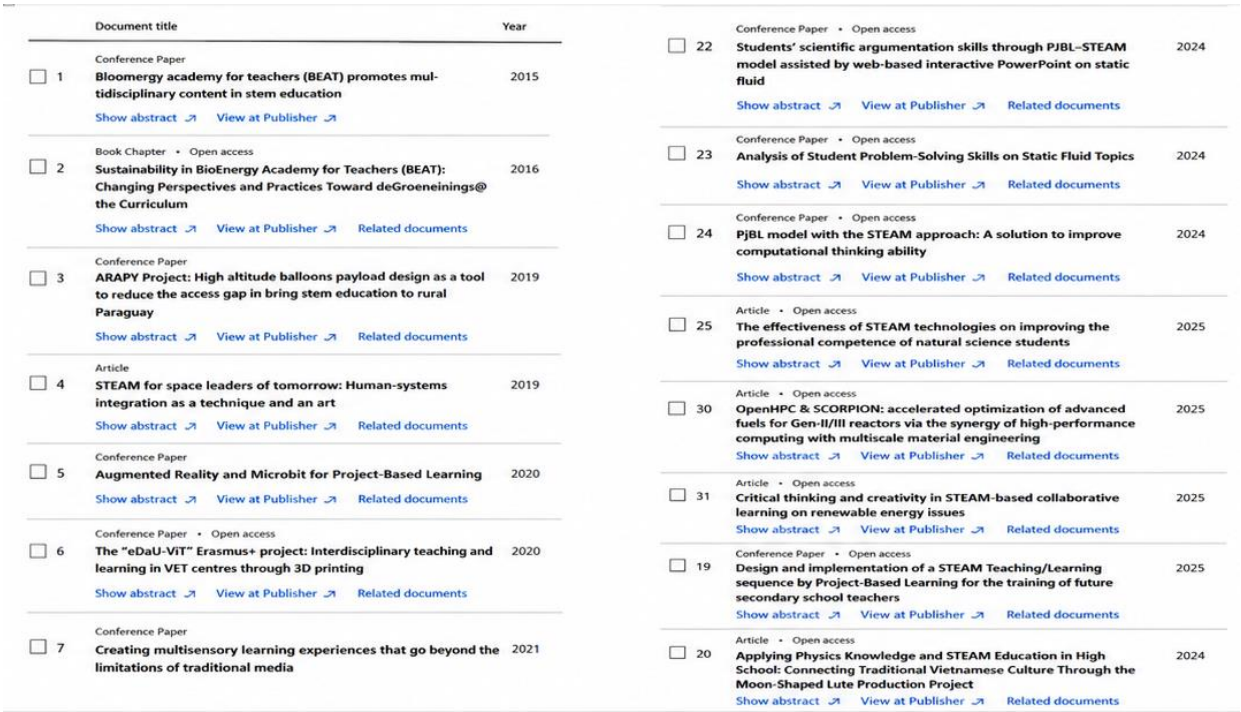

Figure 9. Research title related to PjBL-STEAM period 2015 to 2025

Based on Figure 9, the published research titles from 2015 to 2019 still focused on renewable energy sustainability, particularly in bioenergy. From 2020 to 2022, existing technology was implemented. It put more emphasis on the STEAM field, for example, such as STEAM education to teach engineering mechanics. Finally, from 2023 to 2025, the research used the latest technology. It focused on project-based learning to develop students' skills, especially 21st-century skills such as problem-solving, computational thinking, and critical thinking, for example, through PjBL-STEAM models on static fluids. Based on the Scopus dataset from 2015 to 2025, research on PjBL-STEAM continues to evolve as it adapts to developments in the field and the demands of 21st-century skills. This is consistent with research by Ringo et al. (2025), which reports that the PjBL model is effective at improving students' competencies across various domains. Therefore, PjBL needs to be implemented as a variation of classroom learning to improve 21st-century skills. In addition, it is necessary to explore the use of digital platforms to increase student creativity in PjBL.

VOSViewer Visualization of PjBL-STEAM in Physics Learning from Scopus Data

Based on VOSViewer visualizations of Scopus data obtained via co-occurrence analysis, analysis units were defined by keywords and the full counting method. The Network Visualization results show the relationships among units or elements in the research and among elements that frequently appear. Based on these results, project-based learning with STEAM still does not appear frequently in the literature compared to topics such as augmented reality systems and dynamic model actuators. The overall visualization results of the VOSViewer network visualization are shown in Figure 10.

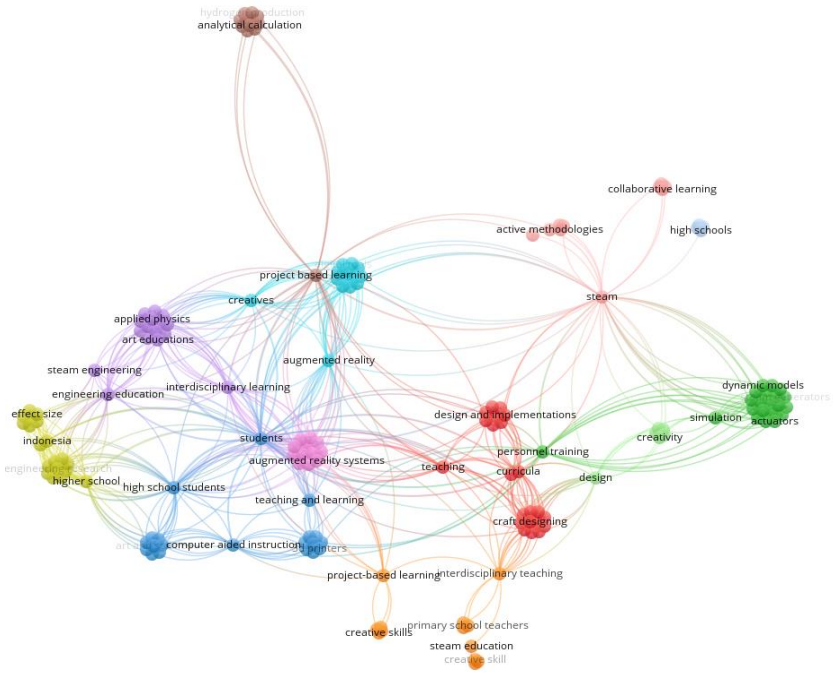

Figure 10. VOSViewer project-based learning STEAM network visualization results.

PjBL-STEAM also has a strong relationship, as shown by the bold line in the network visualization results and its placement in a single cluster (the same color; Figure 11).

According to Syarif et al. (2023), PjBL can be linked to STEAM because it involves completing real-life projects and requires critical thinking skills in problem-solving. PjBL-STEAM is key to driving innovation in science and technology, defined by the interplay of engineering and art.

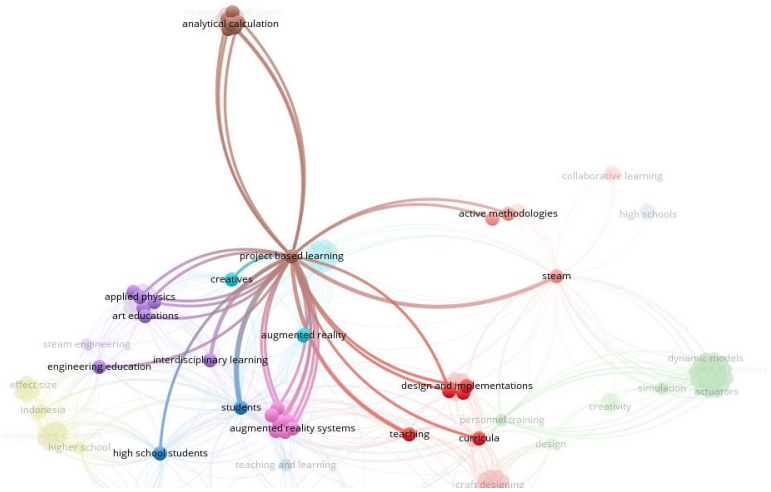

Figure 11. Network visualization results of the relationship between project-based learning and STEAM.

In addition to network visualization, VOSViewer produces overlay and density visualizations. The results of the overlay and density visualizations show that PjBL is a topic that has been researched for a long time and is very extensive and dense. However, STEAM is included among the newest topics and has not been widely researched in Figures 12 and 13.

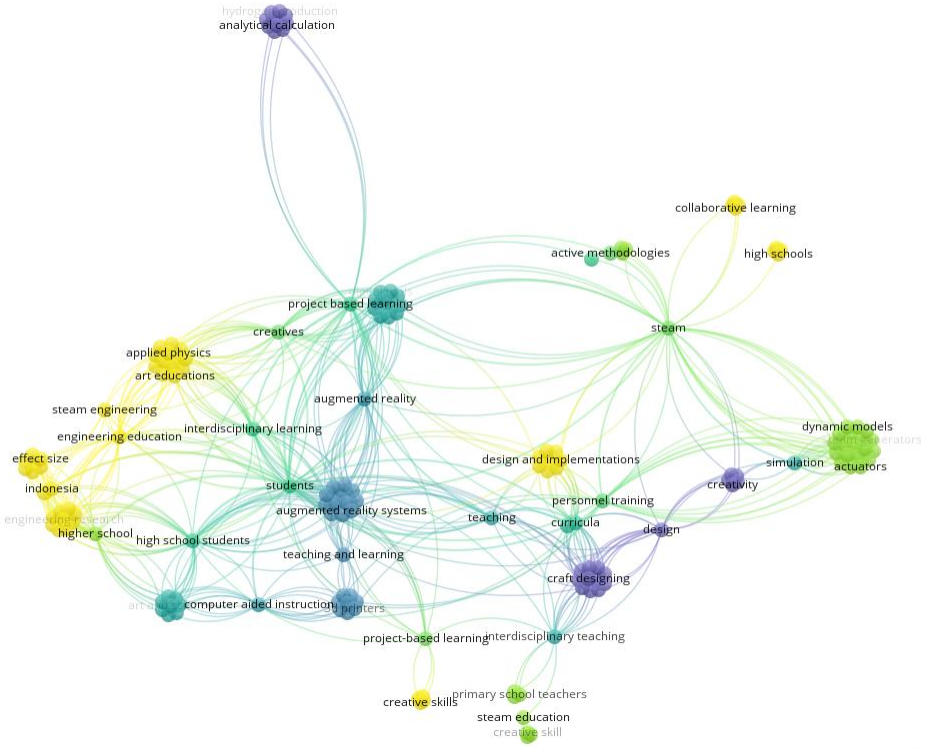

Figure 12. VOSViewer PjBL-STEAM overlay visualization results.

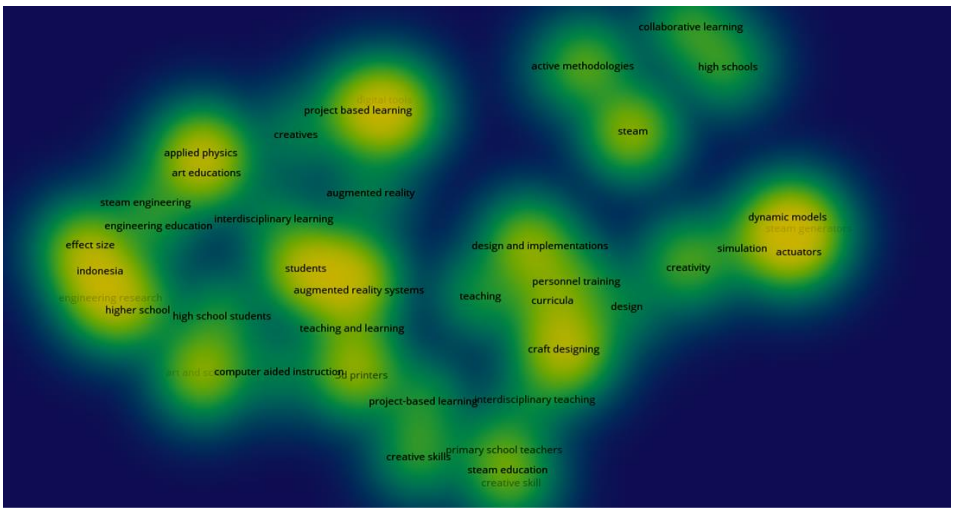

Figure 13. Density visualization results VOSViewer PjBL-STEAM.

Besides STEAM, the newest topics that are being researched and still lack research are related to engineering education and collaborative learning (Figure 14). One example in the field of STEAM Engineering is the material of static fluid. Therefore, in the application of PjBL, it can be combined with the use of the latest materials, such as static fluid.

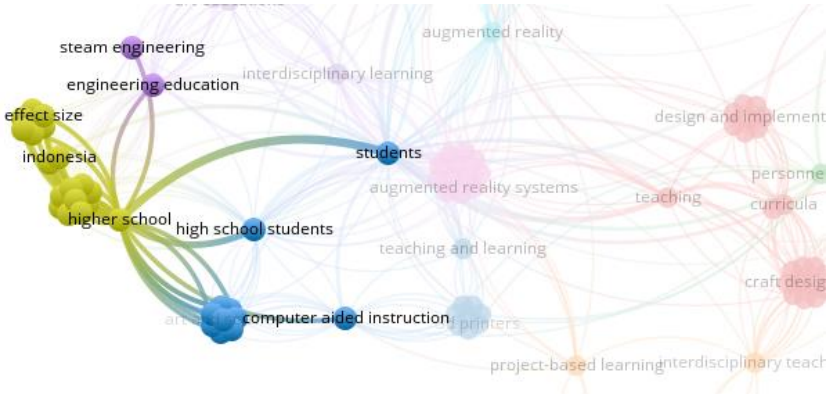

Figure 14. VOSViewer overlay visualization results showing recent topics

This is in line with the research of Zulyusri et al. (2023), which states that PjBL involves students more actively to develop creativity in designing and creating a project that develops their science process skills such as observing, using tools and materials, interpreting, planning projects, applying concepts, asking questions, and communicating well. Therefore, project-based learning can be applied to materials that require activities to create products or projects and are related to everyday life, such as physics applications, engineering physics, and others.

VOSViewer Visualization of PjBL-STEAM Learning in Physics Learning from Google Scholar Data

The visualization illustrates the relationships among frequently occurring keywords, revealing the main research clusters, thematic connections, and dominant trends within the field. Figure 15 presents the VOSviewer visualization of research on the

implementation of the PjBL-STEAM model in physics learning based on Google Scholar data.

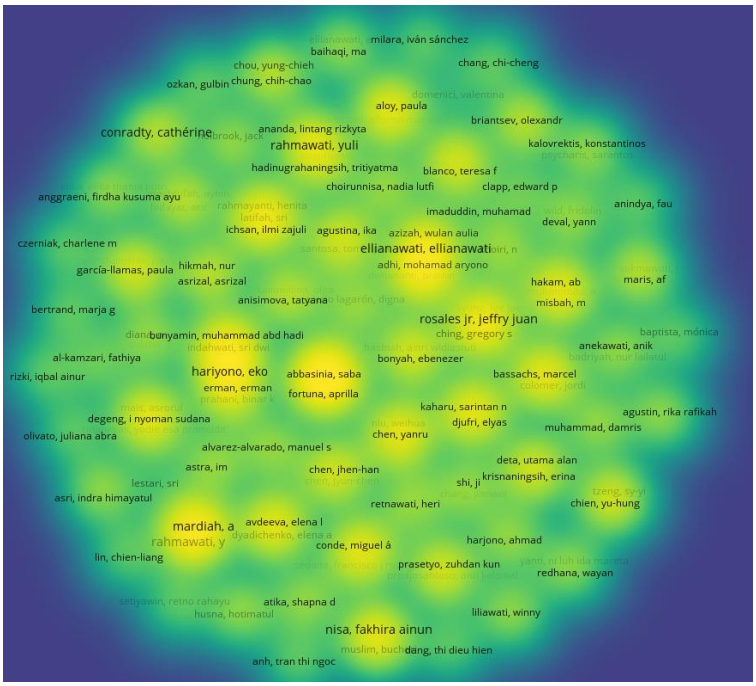

Figure 15. Density visualization on data sourced from google scholar and based on author names.

The density visualization results for the Google Scholar data are shown in Figure 15. VOSViewer analysis was also performed on data obtained from Google Scholar. The resulting visualization is a density visualization with the unit of analysis based on the author. The density visualization results indicate that the authors who frequently produce research related to the project-based learning stream in physics learning are Ellianawati, Eko Hariyono, and Yuli Rahmawati. This can be seen in the density visualization results, which show the yellow color and the boldest names of these authors.

CONCLUSION

Fundamental Finding: Based on the results and discussions that have been carried out, it can be concluded that: a) The development of research on PjBL-STEAM in learning physics models from 2015 to 2025 was indexed by Scopus as the highest in 2024, with 10 publications. b) The types of publication documents are diverse, namely conference reviews, conference papers, articles, and book chapters, with the dominant language used being English. c) Indonesia is the country that dominates in conducting research publications on PjBL-STEAM models, with Malang State University as the main contributor, along with the Malaysian University of Technology, totaling 7 publications. In terms of funding sponsors, it is dominated by several countries other than Indonesia. Funding or sponsorship from Indonesia is only from Malang State University, with 2 documents. d) Research related to PjBL-STEAM continues to experience novelty in accordance with the developments of the times and the demands of 21st-century skills. **Implication:** The implementation of the PjBL-STEAM model in physics learning has a broad correlation. This is evidenced by the results of VOSViewer, which show that there

are many links or networks (in one cluster), including creativity, high school students, simulation, Computer Instruction, augmented reality, crafts, art education, curriculum, and learning. Based on these results, it can be concluded that the relevance of applying the PjBL–STEAM model in the context of physics learning lies primarily in learning models and tools, as well as skills. The physics material taught relates to the application of physics and engineering (e.g., static fluids and space). Meanwhile, the most productive authors are Eko Hariyono, with 27 articles, and Ellianawati, with 13 articles. **Limitation:** the analyzed bibliometric trend covers only the last ten years, and the analysis was based on data from Scopus and Google Scholar databases. **Future Research:** For future researchers to continue analyzing PjBL-STEAM-based physics learning that emphasizes its connection with cross-cultural understanding and more than 10-year trends.

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AUTHOR CONTRIBUTIONS

Irda Sukmawati Dewi contributed to the conceptual framework, research design, and writing; **Binar Kurnia Prahani and Wasis** were responsible for review and editing; **Imam Syaroni** was responsible for proofreading and final editing. **Neisya Azaria Adinda** handled data management; **Noval Maleakhi Hulu** was responsible for sourcing references and drafting the manuscript. All listed authors have reviewed and approved the final version of this submission.

CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no conflicts of interest, either financial or personal, that may have influenced the content or outcome of this study.

ETHICAL COMPLIANCE STATEMENT

This manuscript complies with research and publication ethics. The authors affirm that the work is original, conducted with academic integrity, and free from any unethical practices, including plagiarism.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The authors acknowledge the use of digital tools, including AI-based technologies, as support in the research and writing stages of this article. Specifically, was assisted in translating the manuscript

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