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Project Based Learning (PjBL) Model in Physics Learning: Bibliometric Analysis

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Abstract. This research was conducted to map research trends, authors, countries and journals that contribute to research on the influence of the Project Based Learning (PjBL) model on physics learning, especially in Indonesia, so that the latest trends and research opportunities on the topic can be obtained. This research method was conducted through bibliometric analysis. In the search for articles Vosviewer is used on the Scopus database. The search results consist of 522 published documents in 2019 to 2023. The results of the analysis show that the publication of project-based learning model articles in the last four years has developed, which means there is still potential for research, with topics that are rarely used including "block-based programming, game design, and natural networks" that can be used as further research topics. With linked authors having published at most 6 publications, further research on this topic is still developing. Based on the ranking results, Indonesia ranks second, so Indonesia is superior in developing this research than other countries. And the journal that contributes the most research is the Journal of Physics Conference Series.

1. Introduction

The 21st century is now known as the century of knowledge. The 21st century is marked by the rapid development of technology and information in all aspects of life, as a result, this century has experienced quite significant changes in various areas of life. one of them is in the field of Education [1]. Education is a process of training and teaching someone, with the aim of developing one's own potential in learning, including knowledge, insight and the ability to develop skills possessed. Education is expected to be able to develop one's competence in their field along with the development of technology and knowledge. The learning system in the 21st century is actually no longer teacher-centered learning, but student-centered learning [2]. Teachers play an important role in producing generations with skills that are in line with the demands of the 21st century [3]. While the principles of learning must be applied to create students who are ready to become superior and noble human resources [4].

The development of the times in the era of globalization is related to learning so that 21st century skills increase [5]. 21st century skills are a set of knowledge that must be mastered by students in order to remain able to survive facing the changes and demands of the times [3]. In the 21st century, schools need creative thinking, critical thinking and problem solving, communication and collaboration skills, which are commonly called 4C abilities [6]. 4C abilities (critical thinking, communication, creative thinking, and collaboration) are essential skills that must be possessed by students in the 21st century in order to improve their competence [7].

Project Based Learning model emphasizes students as innovative learning centers in carrying out a project and the educator's position here as a facilitator in learning related to everyday life. The use of project-based learning is able to guide students to solve the problems given and emphasize the products produced [8]. Learning media that is integrated in information technology can be an attraction and provide a passion for learning in students [9]. Oneway educators can be creative and innovative is to utilize information technology as a learning tool [10].

Through projects given by the teacher, students will be more active and able to work well together during learning. Through collaboration ideas are collected and analyzed together to create new products. Through projects, students are also able to prove the truth of physics and relate it to everyday life. Project based learning is able to develop students' conceptual understanding and creativity significantly [11]. In line with that, the application of project-based models can increase students' creativity on the subject of

geometric optics. Creative and innovative thinking skills do not just understand concepts, facts, or physics principles, but are more inclined to expertise in using a technological science tool that can produce a valuable and realistic product [12].

The project-based learning model is a teaching method that focuses on problem solving and learning from various sources. This is a time-consuming process which can be useful when combining concepts from various fields of knowledge [13]. Project based learning model can train critical thinking skills, creative and problem solving in everyday life. The use of this learning model as learning can help students form polite language characters, express opinions well, improve analytical skills, and increase motivation in the learning process.

Based on this statement, it is considered necessary to carry out research related to the development of the Project Based Learning model on physics learning with the aim to be achieved in this research is to map research trends, authors, countries and journals that contribute to research on the influence of the Project Based Learning model in physics learning uses Vosviewer visualization to describe the distribution map so that it can be used as a reference in conducting further research.

2. Methods

This research uses bibliometric analysis method. Data analysis was carried out in bibliometric research, namely using quantitative indices such as: author's name, year of publication, and keywords [14]. Bibliometric analysis is applied to quantitatively measure and analyze certain indicators in published literature in certain domains and to generate knowledge maps based on large databases [15]. In searching for data sources, researchers obtained data sources from the Scopus database from 2019 to 2023. This is because the Scopus journal is a center for literacy data and scientific quotations. Scopus is a part of an international scientific publication, namely Elsevier. In the Scopus database, about 22,000 titles from 5,000 publishers from around the world [16].

2.1 Keyword search

This study uses filters to search for titles, abstracts and keywords as follows: Project-based learning models in physics learning or Physics Project Based Learning, within the 2019 to 2023 limits.

2.2 Getting Initial Search Results

The data source is taken from the Scopus database in the last four years 2019 to 2023.

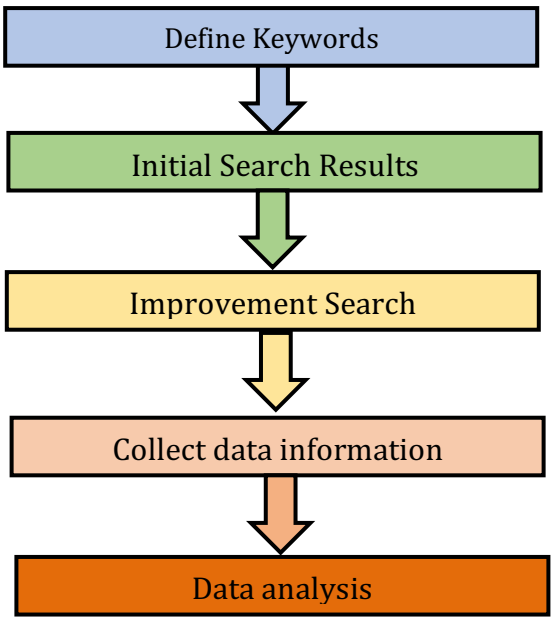

Figure 1. Five Steps in Conducting a Bibliometric Analysis [17], [18], and [19]

Sorting Search Results and Data Analysis

The results of bibliometric mapping from the Vosviewer software are used to analyze, visualize, and evaluate information related to the publications collected, such as the author's bibliographic partner, country, institution, journal, and the appearance of the author's keywords [20]. Vosviewer is software that makes it possible to create network visualizations of terms commonly used in a particular field. This software is very useful and popular in bibliometric analysis [21]. Vosviewer is not only used to create network visualizations, but is also used to analyze developments in certain fields by using common terms used [22]. Vosviewer can also be used to build a network of scientific publications, scientific journals, researchers, research organizations, countries, keywords or terms. Items in this network can be linked by co-authoring, co-occurrence, citations, merging bibliographies, or co-citation links. To build a network, data from Web of Science, Scopus, PubMed, RIS, or Crossref JSON files can be used [23].

3. Results and Discussion

This research was carried out using a literature study using the bibliometric analysis method which is based on research conducted in the 2019 to 2023 range by describing topic developments, such as number of publications, year of publication. And countries that have published journals related to learning physics with a project-based learning model. The data source was obtained from the Scopus database using the keyword "Physics Project Based Learning" with the range of years used in the research, namely 2019-2023. Based on the search results for research sources, 522 documents were obtained with the topic of project-based learning models in physics learning, the research data obtained was analyzed using Vosviewer to determine search keywords that are often used. From the Scopus database with the keyword "Physics Project Based Learning". Then the results of mapping data from Vosviewer are obtained, the articles are sorted systematically based on the most relevant keywords until the articles with the highest relevance appear.

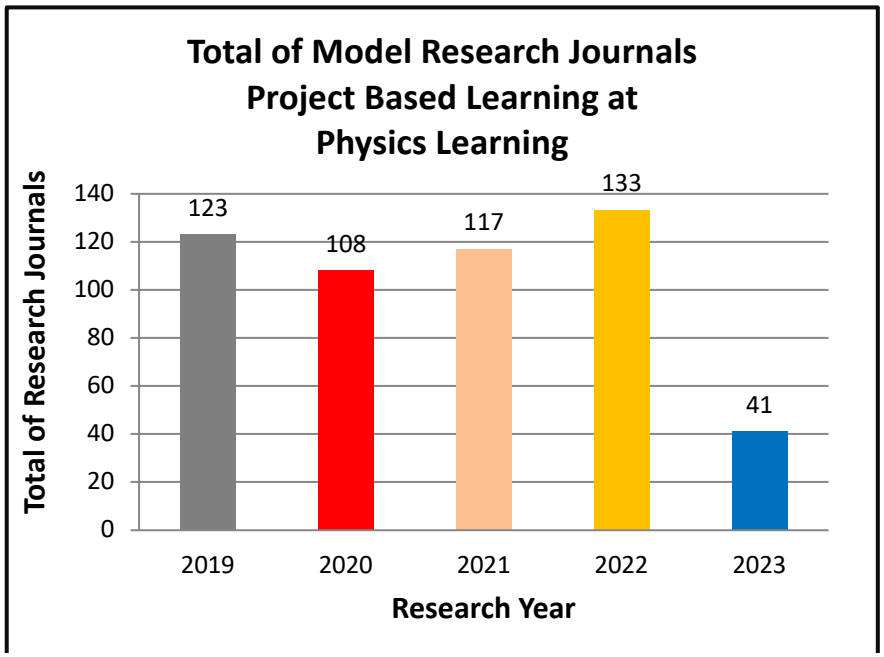

Figure 2. Graph of the Total of Research Journals of Project Based Learning Models in Physics Learning.

Figure 2 graph of the total of project-based learning research journals in physics learning obtained through Scopus the number of documents related to research in the last 4 years shows that relatively little progress has been made regarding this research. It can be observed that the number of studies in 2023 until May was with a total of 41 research journals and the most research was conducted in 2022 with 133 journals. It can be observed that from 2020 to 2022 the number of research journals will

continue to grow. This must continue to be developed because the project- based learning model is a learning model that is oriented so that students can learn independently in solving the problems they are facing so as to produce a real project or work [24]. Where this approach is very suitable to be applied to provide direct experience to students about what they learn [25].

Table 1 shows the selected journal sources in 2019 to 2023 with a minimum of 6 published journals, namely the Physical Review Physics Education Research journal with 67 citations and the American Journal of Physics journal with 238 citations. contributed research, namely the Journal of Physics: Conference Series with a total of 107 documents, with a total of 119 citations, then in second place, namely the journal ASEE Annual Conference and Exposition, Conference Proceedings with a total of 86 documents with 215 citations, and in third place the journal AIP Conference Proceedings a total of 39 documents and 31 citations. From the graph, these journals can be used as a place to publish current research journals and future research.

Table 1. Research journals that are most widely used in Physics Learning with the Project Based Learning model in 2019.

Journal	Total of Publications	Number of Citations
Journal of Physics: Conference Series	107	119
ASEE Annual Conference and Exposition, Conference Proceedings	86	215
AIP Conference Proceedings	39	31
Proceedings of SPIE - The International Society for Optical Engineering	19	23
Physics Education	17	192
European Journal of Physics	15	106
ASEE Annual Conference Proceedings	13	53
Physics Education Research Conference Proceedings	12	17
Physics Teacher	11	236
CEUR Workshop Proceedings	10	20
Physical Review Physics Education Research	6	67
American Journal of Physics	6	238

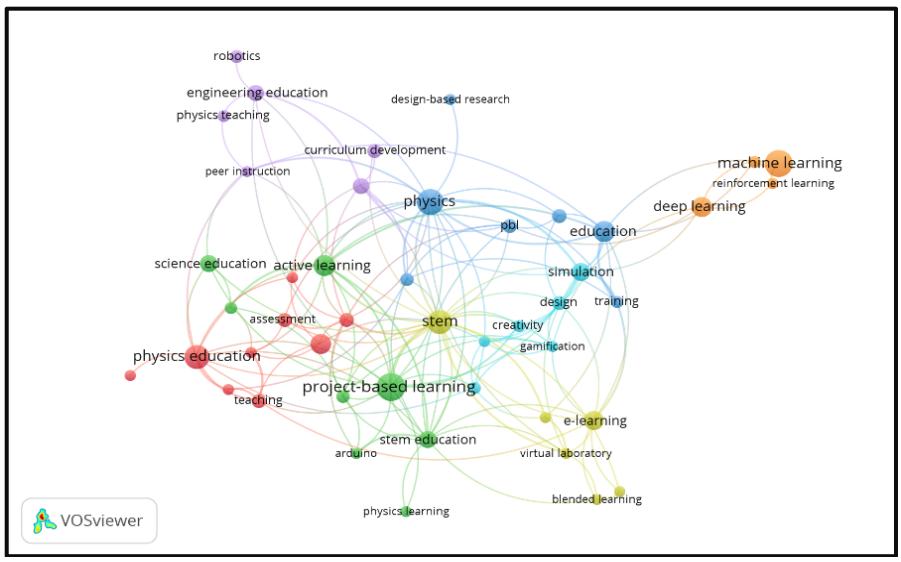

Figure 3. Network Visualization Physics Project Based learning.

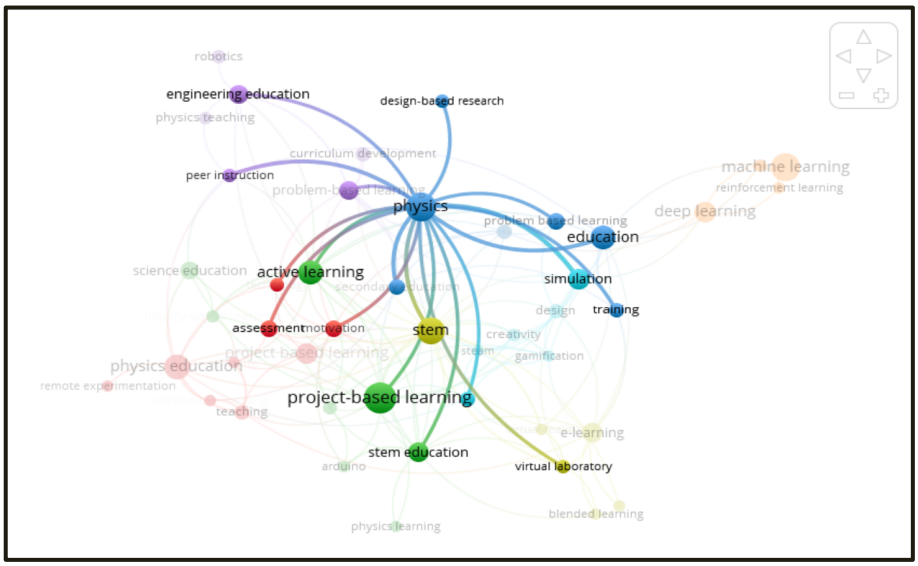

Figure 4. Network Visualization Physics.

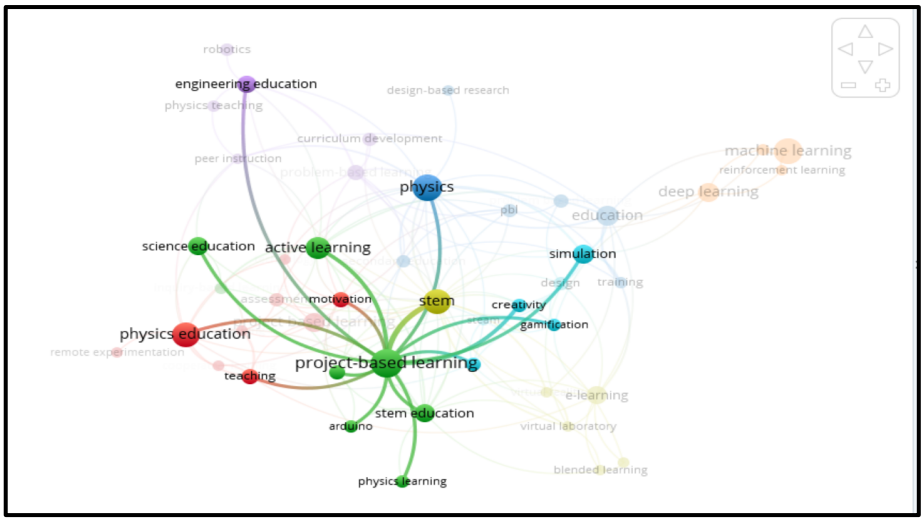

Figure 5. Network Visualization Project Based Learning.

From the results of data mapping through Vosviewers, Figure 3 is obtained, which is a visualization of the relationship related to all the keywords used, namely "Physics Project Based Learning". Figure 4 shows that physics and project-based learning are closely related. In addition, active learning and stem also have a close relationship. This can be seen in the figure where active learning, stem and physics show a large circle and have a strong relationship. Figure 5 shows that project-based learning has a close relationship with physics and stem. Project based learning or project-based models can train students in 21st century skills, such as motivation to learn mathematics and science, critical thinking skills, and cognitive abilities [26].

Project based learning can improve students' collaboration skills in learning physics. In the study, students were given a collaborative project and then assessed on the collaboration skills they demonstrated in the project [27]. In addition, project-based learning requires students to learn and produce a product, so that it can increase the activity or active learning of students to learn [28]. The application of PjBL-STEM can improve collaboration skills [29].

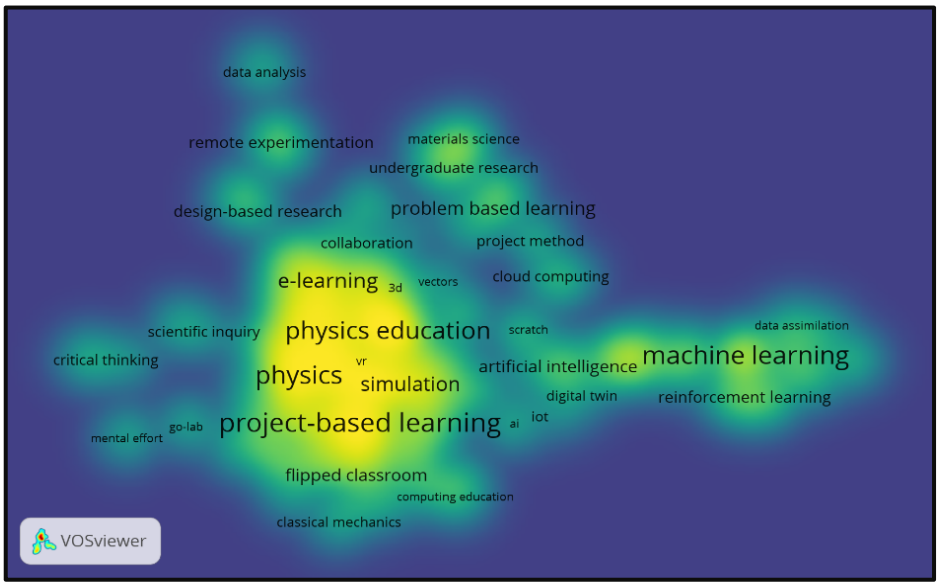

Figure 6. Density Visualization Physics Project Based learning.

Based on Figure 6 above, the analysis is carried out with a density visualization, which is an item (label) that is marked the same as the item that is visible. Each item point has a color that depends on the density of the item at that time. It identifies that the color of a point on the map depends on the number of items associated with other items. This section is very useful for obtaining an overview of the general structure of a bibliometric map by paying attention to the items considered important for analysis. Through this worksheet, we can interpret the most used keywords in a publication [30]. Density will show the density emphasis on the research group. Density can also be used to see parts of research that are rarely done.

Figure 6 above shows the density map which is the result of an analysis using all articles on the development of physics learning research using the project-based learning method, both related and unrelated. The more yellow, the tighter or there have been many studies using that topic, and the greener, the rarer the research using that topic. Where topics that are often used are physics, physics education, project-based learning, and e-learning, while topics that are rarely used include block-based programming, game design, natural networks, and virtual learning environments. Research with topics that are rarely carried out can be used as suggestions and considerations for conducting further research. In the figure there will be 46 clusters if sorted by keywords.

Based on bibliographic data extraction on the type of co-authorship analysis using the full counting method and the minimum number of document authors is one, it was found that 30 major authors linked together published articles on this topic, as shown in Figure 7 below. The figure shows that several groups of writers from around the world are discussing this topic. In the first cluster with a red node with a total of 12 items, the second cluster with a green node with a total of 11 items. The third cluster with a blue node with a total of 4 items, and the last cluster with a yellow node with a total of 3 items.

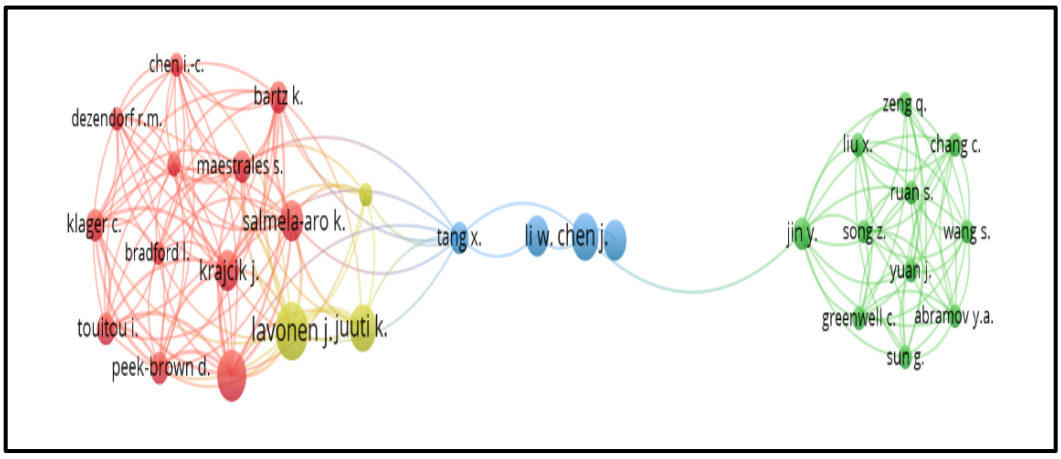

Figure 7. Authors co-authorship mapping with a minimum of 1 document.

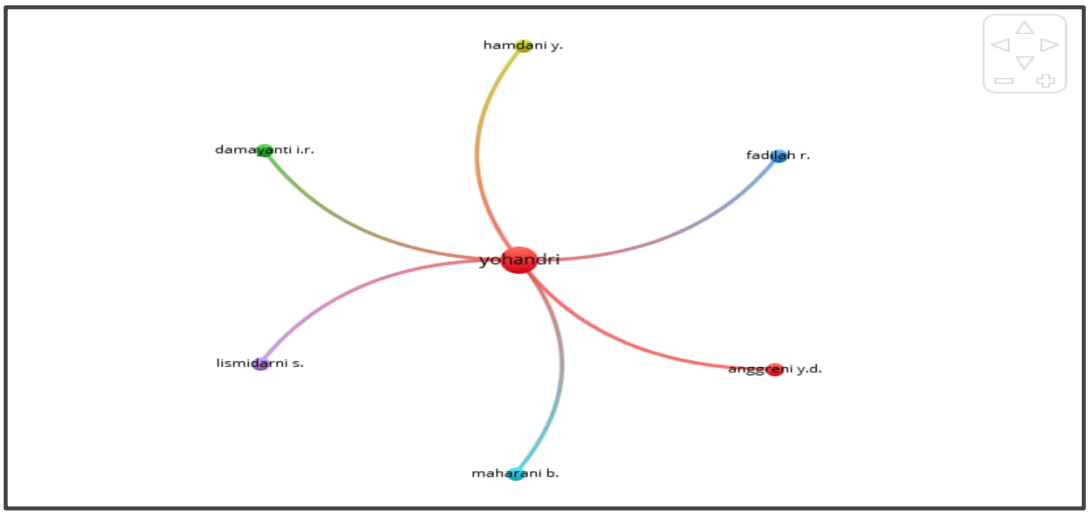

Figure 8. Mapping of co-authorships that are interconnected with one another.

If all authors are connected to each other, then there are 7 authors connected to each other, as shown in Figure 7. Based on the figure, it can be seen that there are six clusters with the top author "Yohandri" coming from "Universitas Negeri Padang" with a total of 6 documents with a citation count of 2. The author has connections with all the other authors on the map. The visualization of the co-authorship mapping shows that there are the most "Yohandri" writers among the other writers, so the strength of the relationship with other "authors" is so great. While the authors Damayanti i.r, Hamdani y, lismidarni s, and Anggreni y.d, only have 1 document and do not have citations, authors Fadilah r, and Maharani b, have 1 document and 1 citation. Therefore, the number of documents written shows that very few authors have continued research from previous publications on learning physics with using a project-based learning model.

Based on bibliographic data extraction on the type of co-authorship analysis and country unit analysis using the full counting method and the minimum number of documents in each country is 1, with the acquisition of 84 mapping data items as shown in Figure 9 below. The figure shows 15 clusters, with the main cluster being the United States colored in yellow. In addition, cluster 1 also has a line of kinship with several other clusters such as China red, cluster 1, Spain light yellow, cluster 13, Taiwan purple, cluster 7, Italy blue, cluster 3 and Germany green, cluster 11. In addition to these clusters, several other clusters are connected to each other among other clusters.

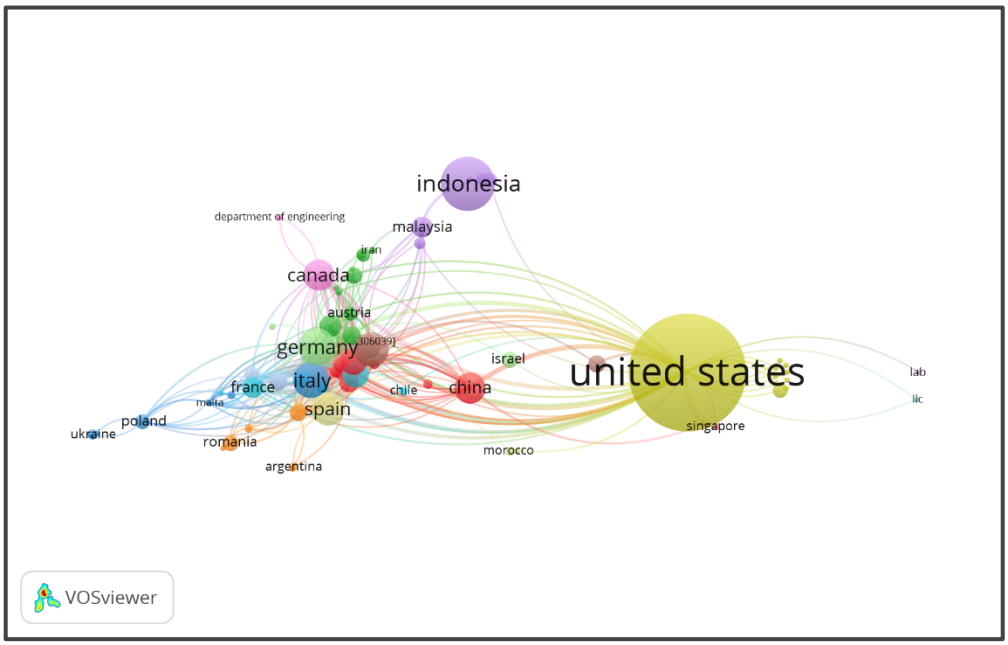

Figure 9. Mapping Results by Country.

Based on country-by-country mapping, it is clear that western countries, especially the United States, have very rapid development of Project Based Learning. This shows that the United States has the most documents. This is because project-based learning was first pioneered in that country, so it is very clear that research production continues to grow and increase [31]. Meanwhile, in Indonesia, the problems faced by secondary education are low ability in three main areas, namely mathematics, science, and literacy. This condition is illustrated in the measurement results of the Program for International Student Assessment (PISA) Indonesia is ranked 70th out of 78 countries surveyed in 2018 [32].

Meanwhile, when viewed from the side of the Global Innovation Index (GII) innovative map published by the World International Property Organization (WIPO) for 2021 which includes an educational component, Indonesia is ranked 87th out of 132 countries surveyed [33]. One of the government's efforts to improve these conditions is to reform national education through the concept of independent learning. So that with the concept of an independent learning curriculum, Indonesia is no less left behind in this field of research because the current school curriculum emphasizes physics learning using a project-based learning model.

4. Conclusions

Based on the results and discussion conducted on the research topic on mapping to map research trends, authors, and countries that contribute to research on the influence of the project-based learning model on physics learning, it can be concluded that physics learning using project-based learning for four years has shown progress. which means that this research is still being developed and has the potential to be carried out. On topics that are rarely used, including block-based programming, game design, natural networks, and virtual learning environments, they can be used as topics for further research. In addition, if all authors are linked to each other, the authors also published at most 6 publications. The country with the most research is the United States with 373 publications. The State of Indonesia with 95 publications as the second order. When compared to other countries, Indonesia excels in the development of this research. And the journal that contributes the most research is the Journal of Physics Conference Series with 107 publications and 119 citations.

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