Review of Trends Project Based Learning (PjBL) Integrated STEM in Physics Learning

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Abstract. For physics teachers, how physics should be taught is an important question. This study, examines project based learning (PjBL) integrated in Science, Technology, Engineering and Mathematics (STEM). The aims of this study is to identify trends in PjBL integrated STEM in physics education. The method used is a bibliometric analysis method. 80 articles were collected from the literature of scholarly journals, both nationally and internationally through the Publish or Perish (PoP) application. The articles collected were analyzed using the VOSviewer application to obtain information. After analysis, information on the trend of PjBL integrated STEM was obtained by further analysis and by synthesizing it. The result of this study is that in recent years, Project Based Learning (PjBL) integrated STEM has become one of the trends and has become an option in implementing physics learning in schools. This can be seen from the many research, studies and discussions about PjBL integrated STEM in physics education. Based on the results of this literature study, several recommendations for future research were also obtained, namely so that PjBL integrated STEM can be better, it needs to be tried by adding various learning media in it, especially on-line learning media.

1. Introduction
For teachers of physics subjects, the question of how physics should be taught is an important issue. Various studies were conducted to present the current situation, advantages, challenges, limitations and trends in the use of models and approaches in learning. Until now, in the field of science education, research studies that look at trends are still often carried out [1]. Trends in physics education can be seen by revealing what topics researchers have studied from the past to the present, what topics have received more or less attention, and how changes in interest have occurred over time. Recent physics education, research shows a sharp increasing trend in the topics of learning models, PCK, assessment, and gender [2].

The learning model used in schools, of course, must be in accordance with the demands of the applicable curriculum. Implementation of the 2013 curriculum in learning is to use a scientific approach [3]. The strategy of the scientific approach is discovery learning, project based learning and problem based learning. Project Based Learning (PjBL) is understood as a promising approach to improve student learning. Empirical studies on project based learning have been reviewed with a focus on student outcomes. Affective results, namely the perception of the benefits of PjBL and the perception of the experience of PjBL were the most widely applied, as measured by questionnaires, interviews, observations, and self-reflection journals [4]. Project Based Learning (PjBL) is an innovative learning that encourages students to conduct investigations, work collaboratively in researching and creating projects that apply their knowledge of discovering new things, proficient in the use of technology and able to solve problems. Projects should challenge students to do and...
complete them. In implementing project based learning, the learning environment must be designed in such a way that students can conduct investigations into real problems, including deepening a material from a subject topic and carrying out other meaningful tasks [5]. The learning steps in project based learning developed by The George Lucas Educational Foundation in [5] consist of: (1) Starting with essential questions; (2) Planning of project work rules; (3) Make a schedule of activities; (4) Monitoring student project progress; (5) Assessment of student work; (6) Evaluation of students’ learning experiences.

In its development PjBL can be integrated with other approaches, such as the STEM (Science Technology Engineering and Mathematics) approach. The word STEM was launched by the US National Science Foundation in the 1990s as the theme of the education reform movement in these four disciplines to grow the workforce in STEM fields, develop STEM literate citizens, and increase US global competitiveness in science and technology innovation. STEM education provides an opportunity for teachers to show students how concepts, principles, and techniques from science, technology, engineering, and mathematics are used in an integrated manner in the development of products, processes, and systems that are used in their daily lives [6].

One pattern of integration that might be implemented without restructuring the primary and secondary education curriculum in Indonesia is to incorporate engineering, technology, and mathematics content in science learning based STEM [6]. From research [7], it is known that both male and female students showed positive and happy responses to the implementation of PjBL STEM. According to students, learning is interesting and motivating, can help understand teaching materials, form creative attitudes, and students are increasingly aware of the importance of protecting the environment. Students feel happy to work in groups so they want PjBL STEM learning to be re-applied to other materials. Even an experiment showed that after carrying out learning, the use of the project based learning integrated STEM model (PjBL-STEM) could improve student learning outcomes (cognitive and psychomotor aspects) and students’ creativity in solving problems compared to the use of the PjBL model [8].

Based on the explanation that has been presented, the author tries to do a literature study. This study examines research trends in the field of physics education, particularly PjBL Integrated STEM with bibliometric analysis. Organizing and examining research trends can help us identify interesting trends from the past as well as become milestones for future research directions [1]. First, researchers can examine important issues in the field of physics education by identifying the extent to which these issues are addressed in pedagogical research. Second, information about trends in physics education research can be obtained by studying how interest in a topic has changed over time. Third, topics can be explored that have been relatively marginalized or neglected and can then be used in determining future research topics.

The review of trends PjBL integrated STEM was carried out by collecting the results of the scholarly journals literature. Representative articles were collected and data were taken using the Publish or Perish (PoP) application. The data are in the form of a collection of titles, abstracts and other data that is searched based on keywords and restrictions on the time span of the search. Once collected, the data is then processed using the VOSviewer application. VOSviewer is software for creating maps based on network data and for visualizing and exploring these maps. VOSviewer can be used to build a network of scientific publications, scientific journals, researchers, research organizations, countries, keywords, or terms. The items in this network can be linked by co-authoring, co-occurrence, citations, bibliographic merging, or co-citing links. To build a network, data from Web of Science, Scopus, PubMed, RIS, or Crossref JSON files can be used [9]. VOSviewer is used to see the relationship between documents. This trend review significantly contributes to the literature, listing articles individually and categorizing them by features. This review also discusses articles with an inductive approach by focusing on the current situation, advantages and challenges associated with STEM integrated PjBL in physics education.

In short, this study examines PjBL integrated STEM with the aim of identifying trends in PjBL integrated STEM in physics education. The method used is a bibliometric analysis method. Bibliometric analysis is applied to quantitatively measure and analyze certain indicators in the published literature in a particular domain and to generate knowledge maps based on large databases.
[9]. This allows researchers to summarize published information regarding the distribution of articles by year, author, institution, journal, and discipline, collaboration between authors and institutions, and co-word analysis. The results of this study are expected to provide various information to physics teachers about the trend of PjBL integrated STEM, so that educators can find new ideas in improving the quality of learning in schools.

2. Method
This type of research is library research using bibliometric analysis methods. Bibliometric analysis is carried out by looking at the distribution of publications to evaluate the contribution of articles to the advancement of knowledge of various literatures using a statistical approach and can provide a broader understanding of the entire discipline [10]. The data collection technique of this research used secondary data. The research data is in the form of research articles related to Project Based Learning (PjBL) integrated STEM in Physics Learning. Data collection was carried out using the Publish or Perish (PoP) application with the keywords "Project Based Learning (PjBL) integrated STEM in physics learning" and the limitation of the search time span for the year of publication of the last 5 years, namely between 2017 and 2021. Then carried out data collection and obtained 719 articles. The data is then selected with a limit of articles in the form of Article, Journal, so that 80 articles are obtained to be analyzed. The data for these articles is exported in RIS format and will be processed using the VOSviewer application. VOSviewer application is a software that has the ability to visualize and explore the results of bibliometric studies.

The data analysis technique in this study refers to the results of bibliometric mapping from the VOSviewer application that applies Co-Occurrence calculations. Co-occurrence analysis reveals the research topic statistically, with the condition that the more frequent pairs between two keywords, the closer the relationship between these keywords [10]. In this analysis, VOSviewer extracts the titles and abstracts of articles obtained by the binary counting method, meaning that each word found related to either one or more topics will be considered one. The minimum number of occurrences of a term is 5, meaning that the words that will be displayed are words that have 5 relatedness. Therefore, of the 674 words found, only 31 words meet the threshold. The following is the flow of data collection and processing methods that have been carried out:

Figure 1. Data collection and processing methods

3. Results and Discussion
The results of the study obtained at the beginning of the gradual selection using the Publish or Perish (PoP) application obtained 80 articles on Project Based Learning (PjBL) integrated STEM in physics Learning. Figure 2 shows the publication of this research on physics learning in high school throughout 2017 to 2021. The number of Project Based Learning (PjBL) integrated STEM articles on physics learning throughout the year has increased. In 2021 the data seems to be declining because the data was only obtained for half a year (6 months). Articles on Project Based Learning (PjBL) integrated STEM in physics learning were most published in 2020, while the last was in 2017. This explanation shows that STEM integrated Project Based Learning (PjBL) in physics learning still has the potential to be investigated further.
The results of the research on Project Based Learning (PjBL) integrated STEM in physics Learning were obtained from keyword analysis of 80 research articles using VOSviewer software. This is done to find research variables regarding Project Based Learning (PjBL) integrated STEM in physics learning. Based on the VOSviewer mapping, it can be found several parameters of the relationship between variables, which are related to learning, including design, environment, development, approach, model, implementation, effectiveness and learning outcomes. It is interesting to note, related to learning media, it is only represented by the Student Worksheet (LKPD) variable. Figure 3 shows the mapping of the results of the similarity of article keywords, obtained 4 groups (clusters) according to each color with 31 related keyword terms regarding Project Based Learning (PjBL) integrated STEM in physics Learning. Selection of keywords is then carried out according to the research objective, namely to identify trends in STEM Integrated PjBL using bibliometric analysis methods.

Figure 2. Publications of Project Based Learning (PjBL) integrated STEM in physics Learning research for the period 2017-2021

Figure 3. Network visualization map of keywords
From the results obtained, the larger the circle on a keyword indicates that the keyword is widely used by article writers and has a strong relationship with other keywords. Figure 3 has the 4 largest circles for each cluster, namely project, STEM, STEM project and learning, which shows that there is a relationship between Project Based Learning (PjBL) and the STEM approach. Even the integration of PjBL and STEM approaches or STEM based PjBL have been widely applied or it can be said that Project Based Learning (PjBL) integrated STEM is one of the preferred learning models that can be implemented among existing learning models.

Figure 4. The relationship of learning media (worksheets) in Project Based Learning (PjBL) integrated STEM

Figure 4 shows one keyword, namely worksheets as learning media that can be used in Project Based Learning (PjBL) integrated STEM. Figure 4 also shows the use and the relationship of worksheet keywords as one of the media in learning. It can also be seen that the word worksheet was used around 2020. This worksheet as a learning medium is the only keyword found in the VOSviewer mapping. This shows that there are not too many studies in Project Based Learning (PjBL) integrated STEM that observe the influence of media in it. This is also an opportunity for further research to be able to try and find alternative learning media that can be used in Project Based Learning (PjBL) integrated STEM. Thus, the learning process and the expected results will be even better.

Learning media is a tool that can transfer messages or information from an educator to students which aims to facilitate the learning process in the classroom (Articles on media). By using learning media during the learning process in the classroom, it is hoped that the thoughts, feelings, concerns and interests of students can be raised and students can receive and understand the subject matter from the teacher well. In today’s digital era, especially during the COVID-19 pandemic, an educator must be an expert in creating creative and innovative learning media. Learning media that need to be developed mainly is online learning media for the distance learning process. The development of the times will make students creative in all things so that the educational process will be balanced.

4. Conclusions

Based on the results and discussions that have been carried out, identifying trends in PjBL integrated STEM using bibliometric analysis, it can be concluded that in recent years, Project Based Learning (PjBL) integrated STEM has become one of the trends and has become an option in implementing physics learning in schools. This can be seen from the many research, studies and discussions about PjBL integrated STEM in physics education.
Based on the results of the literature study, several recommendations for future research were obtained, namely so that Project Based Learning (PjBL) integrated STEM could be better, it needs to be tried by adding various learning media in it, especially on-line learning media.

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