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Bibliometric Analysis: Using E-Modules Based on Project Based Learning in Physics Learning

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ABSTRACT (10 PT)

E-modules or electronic modules are modules in digital form, consisting of text, images, even both containing digital electronic material accompanied by simulations that can and are suitable for use in learning. The aim of this research is to see the extent of the development of research on e-modules based on project-based learning in Physics subjects. The research method used in this article is bibliometric analysis using VOSViewer software. The publication data comes from searches on the Publish or Perish software based on relevant keywords in Google Scholar indexed journals. There are 200 articles that are relevant to the keywords entered. Research on E-modules based on project-based learning needs to be improved to determine the level of success of students in mastering Physics lessons and project-based learning study topics have great potential to be explored and can be combined with various fields to make this research unique.

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INTRODUCTION

Education is an important aspect in individual development. In the 21st century, education does not only revolve around providing information, but also aims to develop practical skills and deep understanding. According to Philip W. Jackson in his article "What Is Education?", education is not only limited to formal activities in the classroom, but also includes various forms of learning that occur in everyday life (Chazan 2021). Education is not only serves to prepare individuals for professional life, but also to develop their capacity as responsible citizens and contribute to society. Learning implementation is designed to provide quality, interactive and contextual learning (Badan Standar, Kurikulum, 2022). Therefore, learning is directed by innovative learning models that enrich students' knowledge and skills.

A lot of kinds of innovations are carried out by teachers to support the learning process,

one of which is teaching materials (Ramadhanti et al, 2023). Teaching materials are a set of subject matter that refers to the curriculum used in order to achieve predetermined competency standards and basic competencies (Lestari., 2013). E-modules or electronic modules are one of the innovations in the development of teaching materials which were previously only print-based (Ningrum, 2023). E-modules or electronic modules are modules in digital form, consisting of text, images, even both containing digital electronics material accompanied by simulations that can and are suitable for use in learning (Herawati & Muhtadi, 2018). E-modules can also be collaborated with other variables, one of which is the Project-Based Learning variable or project-based learning which is able to influence student learning outcomes (Herawati & Muhtadi, 2018).

Project-Based Learning (PBL) is a learning model that places students at the center of the learning process by involving them in real projects that are relevant and challenging. Students is not only learn theoretical concepts, but also how to apply them in real-world situations (Bell, 2010; Krajcik & Mun, 2014). This helps students to see the direct link between education and life outside of school. Project-Based Learning (PjBL) or project-based learning is one of the most prominent innovative learning models. This Project-Based Learning (PjBL) learning model emphasizes direct experience, active student involvement, and application of knowledge in real-world contexts.

In project-based learning, students become more actively motivated. In project-based learning, students play an active role in completing project tasks and are responsible for solving problems with various activities in the project work process to improve students' abilities (Sobral, 2021). Project-based learning also combines science, technology, history, and society, to direct students in investigating problems in society and foster enthusiasm for more effective learning (Sudirman et al, 2023). Looking at the advantages and benefits of both, e-modules that are collaborated with project-based learning will be able to provide a new atmosphere for students and support the learning process optimally (Ningrum, Nuryadin, & Hidayat, 2023).

Studies regarding E-modules based on Project-Based Learning (PjBL) will be handled using the Publish or perish software application and VOS Viewer to provide bibliometric analysis. VOSviewer software is used to display and assess trends using bibliometric mapping (Krisnaningsih, et al., 2021). This tool has become very popular among researchers due to its ability to map bibliometric data in an intuitive and informative way (Jing et al. 2023). VOSviewer software can display bibliometric mapping in three ways: Network Visualization, Overlay Visualization, and density visualization based on networks (co-citation) that connect existing items. The use of VOSviewer allows researchers to identify research clusters and network visualization based on data from various academic databases such as Scopus and Web of Science. With this tool, researchers can create network maps that show the relationships between authors, institutions, keywords, and journals. One of the main applications of VOSviewer is in the analysis of co-citation, co-authorship, and co-occurrence of keywords.

Bibliometric analysis is a method used to evaluate and analyze scientific output based on bibliographic data. This technique helps in identifying research trends, scientist productivity, journal influence, as well as collaboration patterns among researchers. Bibliometric analysis often involves using tools such as Web of Science, Scopus, and Google Scholar to collect data. Scopus, for example, is known as one of the most comprehensive and high-quality databases for bibliometric analysis. Several studies on bibliometric analysis in the field of education, Inclusive Education, Scientific output in social sciences (Hajar & Karakus,

2022), e-learning (Djeki, Dégila, Bondiombouy, & Alhassan, 2022), learning in the Covid-19 Pandemic (Sreenivasan, 2023)(, Science Teaching (Marín-Marín, Moreno- Guerrero, & Dúo-Te, 2021).

METHODS

This research is research that uses bibliometric analysis methods. Methods in bibliometric analysis involve a series of systematic steps to collect, analyze, and visualize bibliographic data. This approach allows researchers to evaluate research trends, scientist productivity, collaboration between institutions, and the impact of scientific publications. This method was chosen because it can accurately measure and analyze articles in the specified database. This approach can find, categorize, and evaluate published documents related to a selected subject (Chan et al, 2022).

This research uses Harzing's Publish or Perish software to collect data. PoP can be downloaded and accessed easily by almost everyone. Furthermore, PoP also provides metric quotes to make the information obtained more comprehensive. The first step is to use Publish or Perish software to search for articles. The search was carried out by setting the publication year filter in the 2019-2023 range and produced publication data for 200 journal articles. After searching for articles, the data that has been collected is exported into two types of files, namely Comma Separated Values (.csv) or comma separated values format and Research Information Systems (.ris) or managed file research information systems."

There are several criteria that need to be considered when searching for articles, including: 1) containing the term Project based learning in the title, 2) being a research article, and 3) articles published in Sinta or Scopus indexed journals. The data that we have obtained is then processed using VOS Viewer software. First install the VOSviewer application for free from the VOSviewer web. Next, select the Create menu in the action panel column, then click Create a map based on text data. Set the data source to "read data from reference management files". Then input the file in RIS format. Finally, select the selected terms, choose words that are relevant and not relevant to the research. Search results in Publish or Perish are saved in RIS format before being entered into the VOS Viewer. The file is imported into VOS Viewer, and the color, shape, and display size are adjusted before being saved in PNG format. The third stage is selecting articles based on the previous criteria. CSV files are quite useful for reviewing research data produced by POP. The final step is to understand and analyze the results of VOS Viewer and Microsoft Excel.

RESULTS AND DISCUSSION

Results

The results of literature screening using the Publish or Perish application on the Google Scholar (GS) database found 200 published documents based on data collection "E-module, Project Based-Learning, and Physics" sourced from books, journals, conferences and proceedings, as well as other documents in range from 2019 to 2023. The total citations from search results on the Publish or Perish software from 200 relevant articles was 1040 citations. The number of citations for all papers in this research was 1040, the number of citations per year was 208.00. An example of the data used in the VOSviewer analysis of this research is shown in Table 1. The data sample consists of the top 10 publications with the most citations.

Table 1. Article Finding rom Searches via Publish or Perish

No	Cites	Authors	Title	Years
1	278	V Serevina, I Astra, IJ Sari	Development of E-Module Based on Problem Based Learning (PBL) on Heat and Temperature to Improve Student's Science Process Skill.	2018
2	27	M Afriyanti, A Suyatna	Design of e-modules to stimulate HOTS on static fluid materials with the STEM approach	2021
3	22	RD Kurniati, D Andra, IW Distrik	E-module development based on PBL integrated STEM assisted by social media to improve critical thinking skill: A preliminary study	2021
4	20	M Matsun, VS Andrini, TW Maduretno…	Development of physics learning e-module basedon local culture wisdom in Pontianak, West Kalimantan	2019
5	20	NFR Laraphaty, J Riswanda…	Pengembangan Media Pembelajaran Modul Elektronik (E-Modul)	2021
6	19	E Nursa'ban, M Masykuri…	Improving student learning outcomes in science subjects through the implementation of PBL-based module	2019
7	18	N Nazifah, A Asrizal	Development of STEM Integrated Physics E-Modules to Improve 21st Century Skills of Students	2022
8	12	S Mahmudah, T Kirana…	Profile of Students' Critical Thinking Ability: Implementation of E-Modul Based On Problem-Based Learning	2022
9	10	S Maghfiroh, I Wilujeng, J Jumadi…	Development of Physics E-Module Based on Discovery Learning to Improve Students' Scientific Literacy	2023
10	10	R Roslina, A Samsudin…	Effectiveness of Project Based Learning Integrated STEM in Physics Education (STEM-PJBL): Systematic Literature Review (SLR)	2022

Table 1. Is sample data from articles that will be analyzed using the bibliometric analysis method. Data shown in table 1. This is data from the ten articles with the most citations from 2019 to 2023. The most citations were in 2018, with 278 citations. The fewest citations in 2023 are 10 citations.

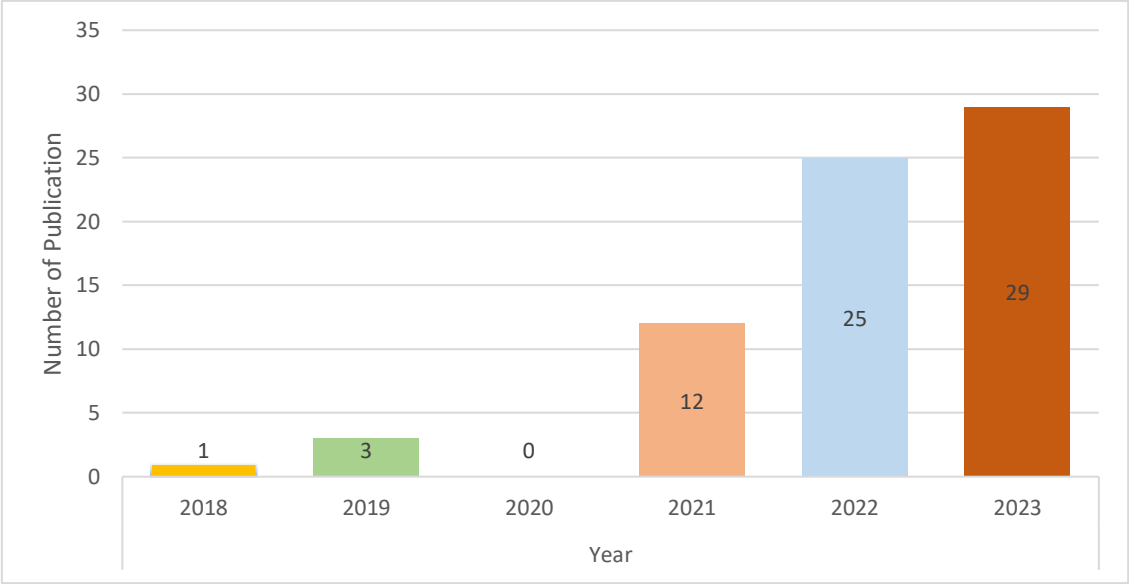

Figure 1. Distribution of E-Module and Project Based Learning Research in Indonesia Between 2019-2023

Figure 1 shows the development of research on e-module research topics based on project-based learning in journals indexed by Google Scholar in 2019, 2020, 2021, 2022, and 2023. In 2020 there were no published articles relevant to keywords. 2023 is the year with the highest number of articles relevant to keywords, namely 29 articles. There was one article that was relevant to the keyword in 2018. In 2019 there were 3 articles that were relevant and in 2022 there were 25 articles that were relevant to the keyword.

Based on the data in Figure 1 that has been collected, data interpretation shows that research related to e-modules based on project-based learning has become a trend starting in 2021 and continues to increase until 2023. The results of the analysis using VOSViewer software are in the form of visualizations which have their respective functions. The visualization analysis of mapping results is divided into three, namely Network Visualization, Overlay Visualization, and Density Visualization.

Discussion

Networking Visualization

The network visualization images presented depict the complex interactions and relationships between various elements in the network. Each point or node in this figure represents an individual entity, such as an author, document, or institution, while connecting lines or edges indicate relationships or interactions between those entities. By leveraging tools like VOSviewer, this visualization makes it easy to recognize collaboration patterns, citation influence, and significant research clusters. The beauty of network visualization lies in its ability to simplify complexity, allowing us to see the big picture as well as important details that may be hidden in the raw data like the Figure 2 bellow.

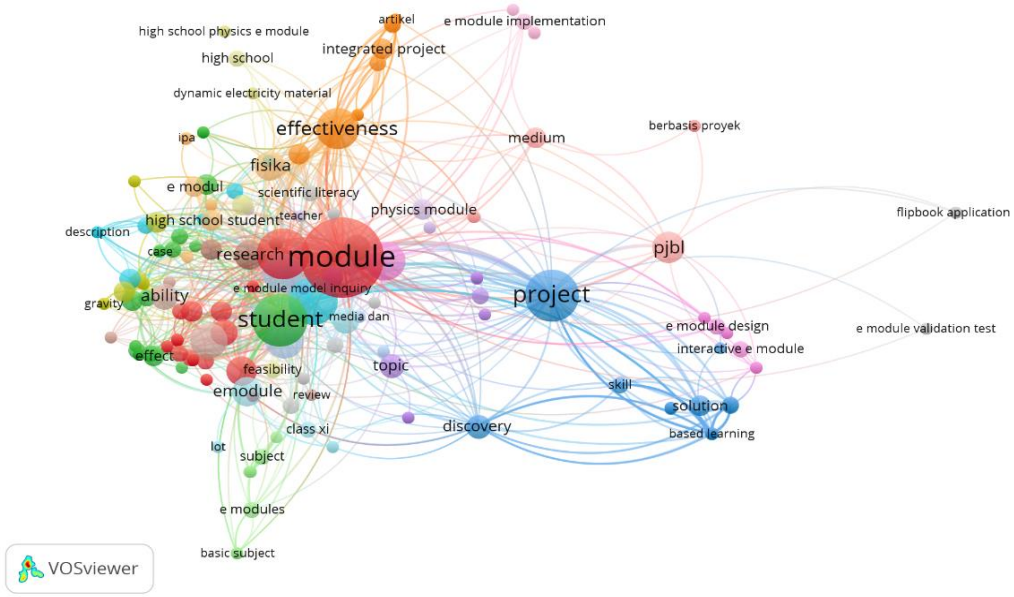

Figure 2. Network Visualization of E-module – Project Based Learning - Physics keyword

Figure 2 above shows the weight and how strong the relationship between items is. Each cluster has its own color. The writing and circles on the items reflect how much the item weighs. The larger the circle in the network visualization, the more items appear in the research topic. In addition, the line connecting two items also reflects how strong the relationship between the items is.

In Figure 2, it can be seen that the E-module has been widely studied by researchers. It can be seen that the E-module has been linked to various variables. For example, in the picture, it can be seen that there are already researchers who are examining the relationship between e-modules and project-based learning models. There are also researchers who have examined the relationship between e-modules and discovery learning models.

Overlay Visualization

Overlay visualization is a very useful tool in bibliometric data analysis and scientific research. This technique allows us to map the evolution and development of research over time in an intuitive and informative way. In the presented overlay visualization image, we can see how research trends are changing and how various scientific topics are related to each other**.** Overlay visualization combines historical data with current data, providing insight into research dynamics and transitions. We can see the overlay visualization on the Figure 3 bellow.

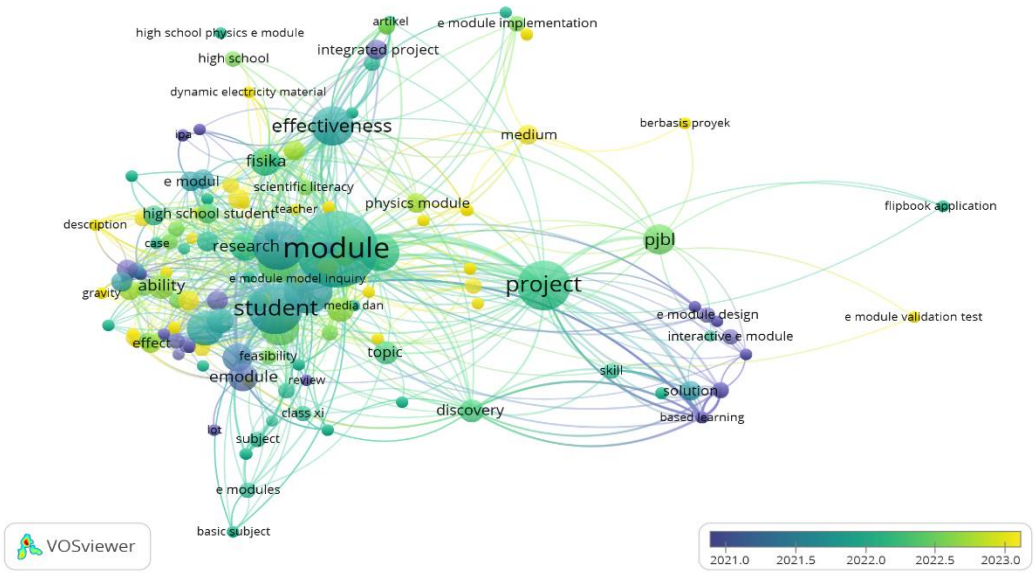

Figure 3. Overlay Visualization

Based on Figure 3, it can be seen that there is a spectrum of dark and light colors. The meaning of this color is that the darker the color displayed by the VOS viewer, it indicates that research using this term has been carried out for a long time and vice versa (Yu, et al., 2020)). In contrast, the bright colors displayed by the VOS viewer indicate that research on this term is still new (Durieux & Gevenois, 2010). This figure displays a network map with nodes representing entities such as articles, authors, or institutions, and edges indicating the relationships or connections between them. The color and size of nodes and edges can represent various attributes such as citation frequency, number of publications, or collaboration intensity. Through this visualization, we can identify main clusters and subclusters in research, see connectivity between topics, and understand the direction of scientific development in a field.

Density Visualization

Density visualization in bibliometric analysis allows us to understand the distribution of data density in research networks. This density visualization image depicts the relative concentration of research activity or the frequency of appearance of certain entities in a particular scientific field. This technique is very useful in identifying research hotspots, namely areas that have high research activity and great potential for further development as seen in Figure 4 below**.**

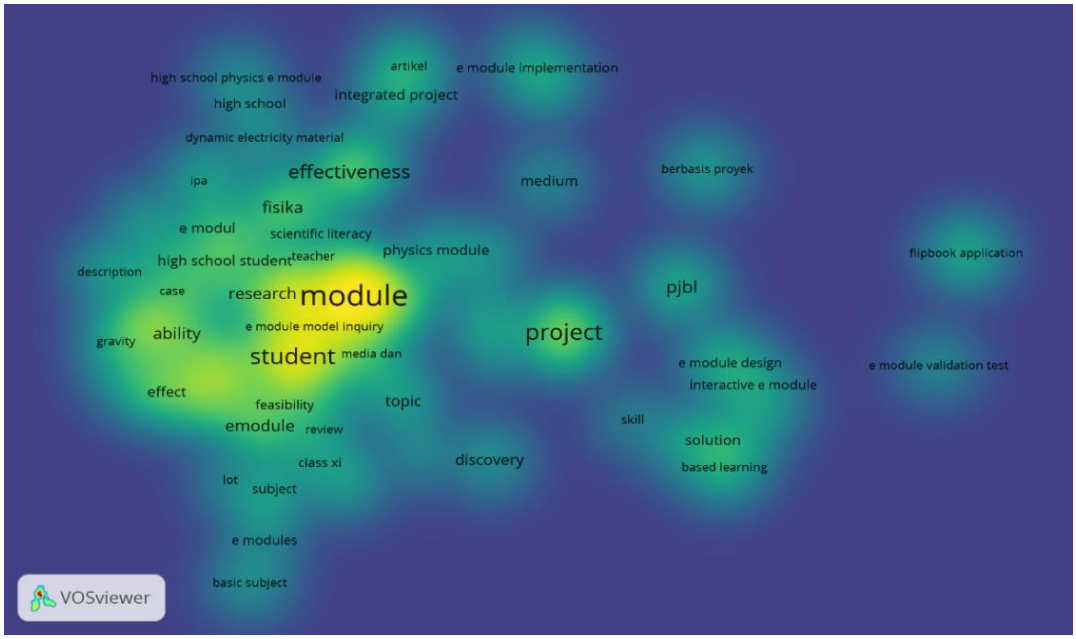

Figure 4. Density Visualization

In Figure 4, the latest research that is currently trending is regarding e-modules with scientific literacy, and also project-based e-modules. Meanwhile, research that is no longer trendy, in other words, has been carried out for a long time, is on e-modules with flipbook applications. This can be seen in the image where the circles are dark in color.

Based on Figure 3, terms that have a light and bright background color such as yellow indicate that research using these terms has been frequently researched, and vice versa (Blacer-bacolod, 2022). he density visualization display may show that the background colors are getting blurry, as shown by the VOS viewer in this term. This means that researchers still need to carry out further research, especially with the keyword project-based learning (PjBL).

CONCLUSION

Research on E-modules based on project-based learning needs to be improved to determine the level of success of students in mastering Physics lessons. Based on research that has been carried out starting from collecting data, processing data, carrying out bibliometric mapping using VOS Viewer software, analyzing and describing it, the results of the bibliometric analysis show that the development of research on e-modules based on project based learning is experiencing a trend in 2021 and continues to increase significantly every year . The keyword "e module" is the keyword most widely used in project based learning e-module research topics

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