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Bibliometric Analysis of Physics Learning Studies: Focus on Differentiation and Problem Solving Strategies

Rahmatta Thoriq Lintangesukmanjaya[1*], Dea Ramadhana Zsa Zsa Alifah[1], Dwikoranto[1], Sallimah binti Hj Mohd Salleh[2], Iwan Wicaksono[3]
[1]State University of Surabaya, Surabaya, Indonesia
[2]University of Brunei Darussalam, Bandar Seri Begawan, Brunei Darussalam
[3]University of Jember, Jember, Indonesia

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ABSTRACT

Objective: *Analyzing the potential of differentiation learning to create problem-solving strategies is essential. This aims to evaluate the shortcomings and advantages to become findings in future research.* ***Method:*** *This research was conducted using bibliometric analysis and systematic review methods. The use of these two methods is carried out in order to obtain in-depth analysis through qualitative and quantitative data.* ***Results:*** *Based on the research that has been conducted, it is known that the trend of physics learning research with a differentiation approach through problem-solving strategies in educational articles over the past 10 years has continued to increase every year.* ***Novelty:*** *In accordance with the findings of the bibliometric analysis, it was obtained that one of the experience-based learning that can be integrated with the differentiation approach is the PBL (Problem Based Learning) learning model. It is recommended for future researchers to integrate PBL learning in physics with a differentiation approach as a strategy to improve problem-solving skills according to the global trend in adapting innovative learning through interactive methods.*

INTRODUCTION

The rapid development of the digital era has created its own demands in increasing skill capacity (Anggraeni et al., 2022; Le et al., 2022). One of the most important skills is problem-solving skills (Triana et al., 2020). In solving problems, a person has the ability to analyze, evaluate and provide relevant solution ideas (Dwikoranto et al., 2023; Maulyda et al., 2019). Problem solving is one of the high-level thinking skills that can guarantee a person in solving problems logically and analytically (Nurmeidina et al., 2025). Indicators of problem solving are understanding the problem, making a plan, implementing the plan, reviewing, and concluding the results. Problem-solving skills are always needed in any aspect and activity, because a good solution can solve problems well.

Based on international research data, students' problem-solving skills are still relatively low (Dangkulos et al., 2025; Nabilah et al., 2025; Rahmadita et al., 2021). This also occurs in science learning, especially in physics learning. Many studies have found low problem-solving skill profiles due to inappropriate learning activities (Shofiyah et al., 2024). There are various factors that cause low student skills, and one of the main causes is the lack of psychological understanding of students who tend to consider physics as a difficult subject (Lintangesukmanjaya et al., 2024). The difficulty in learning physics is caused by its nature which emphasizes abstract concepts and the use of complicated mathematical formulas and logic. In addition, physics, which is often associated with contextual phenomena, demands high cognitive abilities from students. Therefore, the learning approach used should be able to reduce the discomfort felt by students during the learning process.

The problem is that the application of the learning methods used is still monotonous, without any relevant differences to the learning styles developed. So far, the use of learning media in several institutions has mostly used conventional media (Susilawati et al., 2023). The lack of approach in the learning process is also another factor in influencing monotonous learning. As a result, learning cannot be implemented optimally considering the heterogeneous students. This is the main problem in the lack of problem-solving skills of students due to a less than optimal learning approach. Therefore, it is necessary to implement a more optimal learning approach as an alternative for heterogeneous students. One of them is through a differentiation approach in learning physics to accommodate learning methods and models that are tailored to students (Jarnawi et al., 2025; Suhirman et al., 2021). Differentiated learning has the principle that every child learns in a unique way, and one-way learning for all will not be effective for all students (Wibowo et al., 2025). However, the lack of knowledge of the methods and impacts of implementing differentiated learning in physics learning to solve problems is one of its shortcomings. So the analysis of the potential of differentiation learning to create problem-solving strategies is very necessary. This aims to evaluate the shortcomings and advantages to become findings in future research. Analysis of findings globally can be a new breakthrough in creating efforts to implement a systematic, feasible and competent learning approach in the 21st century today and in the future.

RESEARCH METHOD

This research was conducted using bibliometric analysis and systematic review methods (Amiruddin et al., 2023). Combining statistical analysis through qualitative descriptive obtains accurate data (Prahani et al., 2022). The results of bibliometric analysis can be obtained and evaluated in accordance with scientific and research developments. The Scopus database used for 10 years (2014-2024) was obtained online on May 7, 2024. The keywords are 'differentiation AND learning AND physics AND problem AND solving'. The stages of this research are depicted in Figure 1,

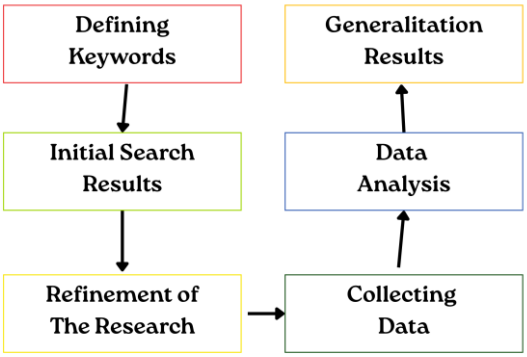

Figure 1. Bibliometric analysis process

Based on the results using the VOSViewer application to visualize the database that has been obtained. The keywords used in the Scopus database search are: "TITLE-ABS-KEY (Critical Thinking AND Virtual Simulation OR Education". The search resulted in 80 articles. Then, the articles were reduced to the publication years 2014-2024 (the last ten years) so that the number became 78. Furthermore, filtering was carried out using the abstract so that 78 articles were obtained. The 78 documents obtained were then mapped using the VOSViewer application to observe the distribution map,

visualization, and relationships between words. From the available data, the source of the document, the most dominant affiliation, the number of research citations, country of origin, field of study, the most prominent title source, authorship, and keywords used will be identified. Furthermore, an analysis was carried out on the ten articles with the highest number of citations based on the data that has been collected.

RESULTS AND DISCUSSION

Results

Based on the distribution of data obtained by VOSViewer analysis with a total of 78 articles. The results of data mapping obtained with the keywords "differentiation AND learning AND physics AND problem AND solving" get a relationship with each other. The following is a picture of the research mapping found in 2014-2024.

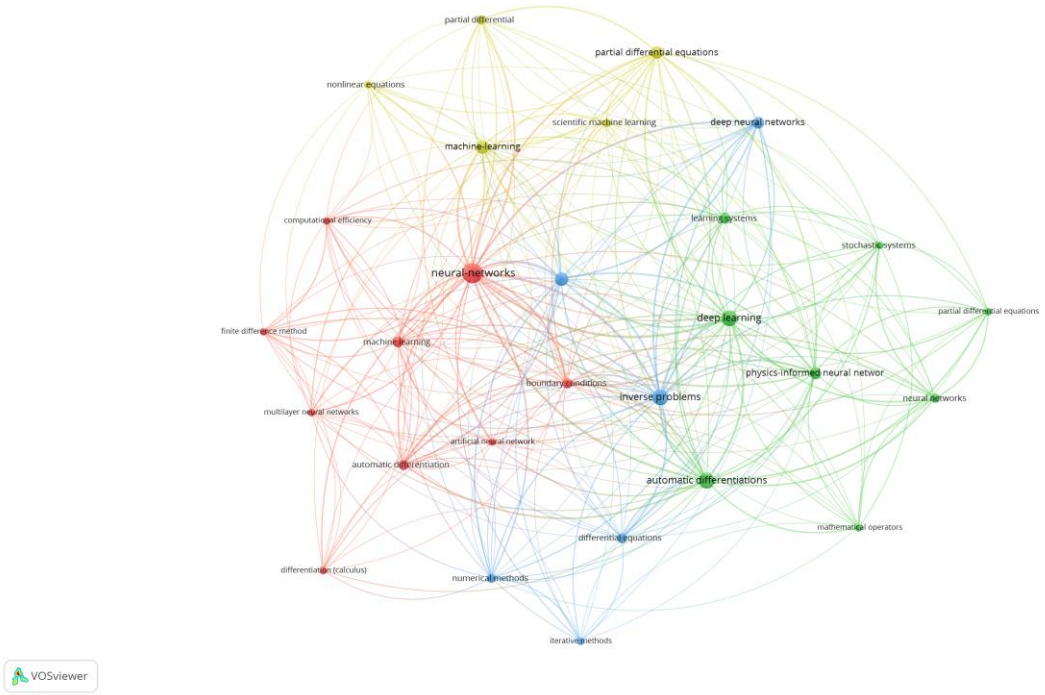

Figure 2. Result of bibliometric analysis

Analysis on differentiated learning by improving problem solving is found in research relationships through several other related keywords. Such as in-depth learning, science learning, automatic differentiation, inverse problem and so on. More clearly can be seen in Figure 3 below,

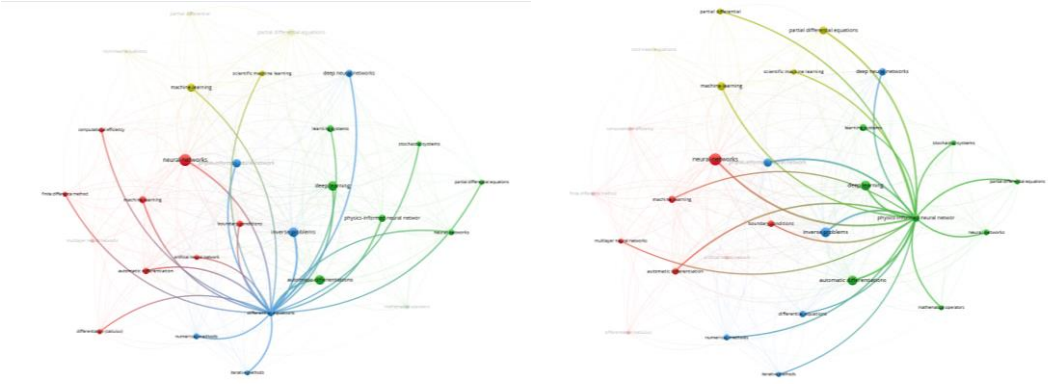

Figure 3. The results of learning findings with differentiation in physics

The findings of this bibliometric research were obtained from more than 40 primary sources. Strong basic analysis is one of the requirements in a literature review to examine previous research findings (Hernández-Torrano & Courtney, 2021). Based on the results of the analysis, it was found that there were findings (Maryanti et al., 2022), differences in sources obtained from a certain period of time,

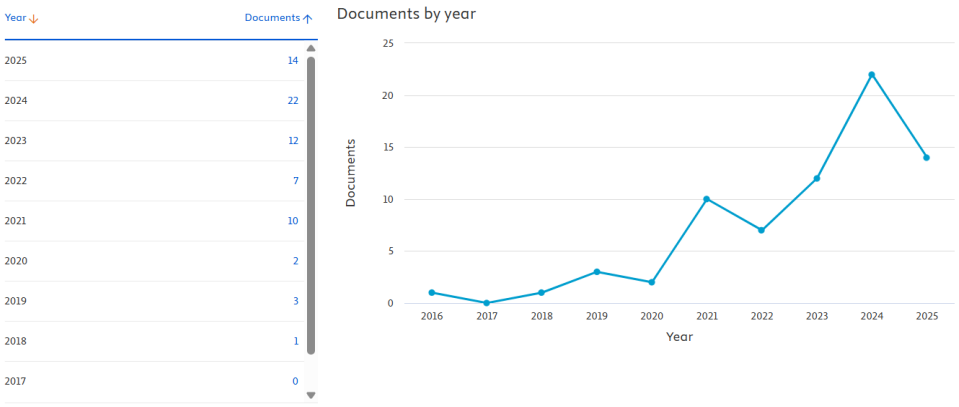

Figure 4. Difference in year of data acquisition

The most documents were in 2024, with a total of 23 documents while the lowest documents were in 2014-2015 which resulted in a total of 0 documents related to differentiation, problem solving and physics learning. The documents found came from various sources, with the largest source 79.2% coming from the following article sources,

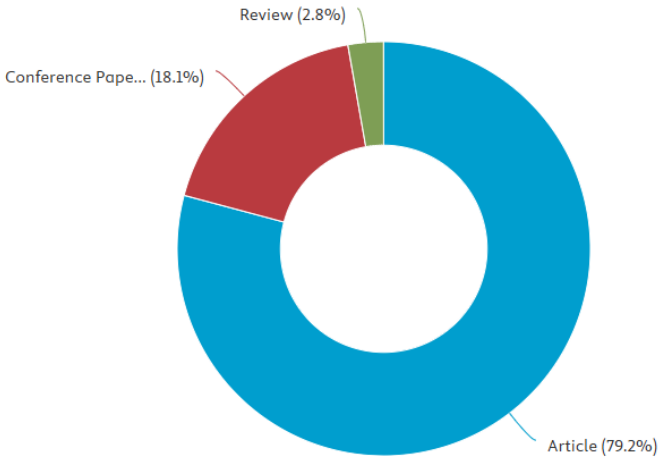

Figure 5. Comparison of source types

In addition, the results of the analysis also found differences in each affiliation and region with their respective total documents. The top 10 affiliate sources were obtained from the results of the review analysis.

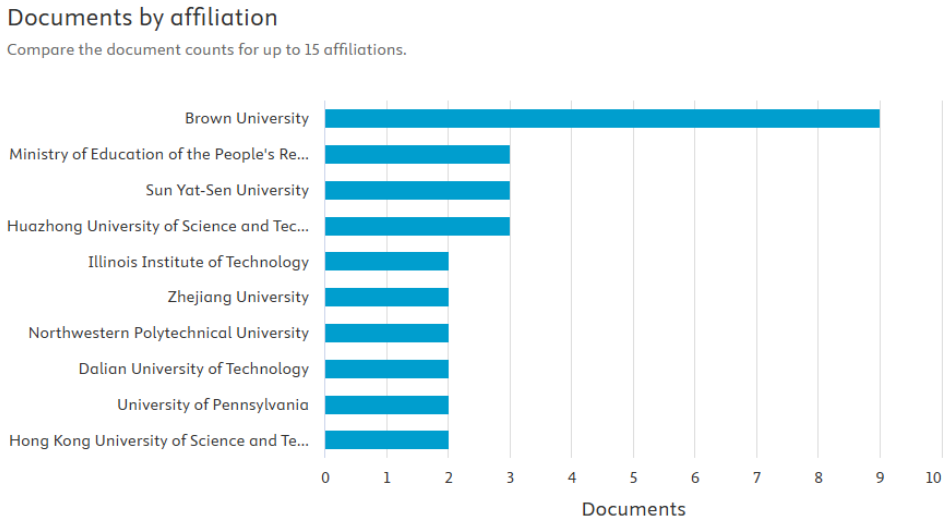

Figure 6. Top 5 highest affiliate results

Of course, from 78 documents with a fairly balanced affiliation comparison, it was found that they came from various countries. The results of the distribution of data and countries obtained from VOSViewer can be seen in Figure 7 below,

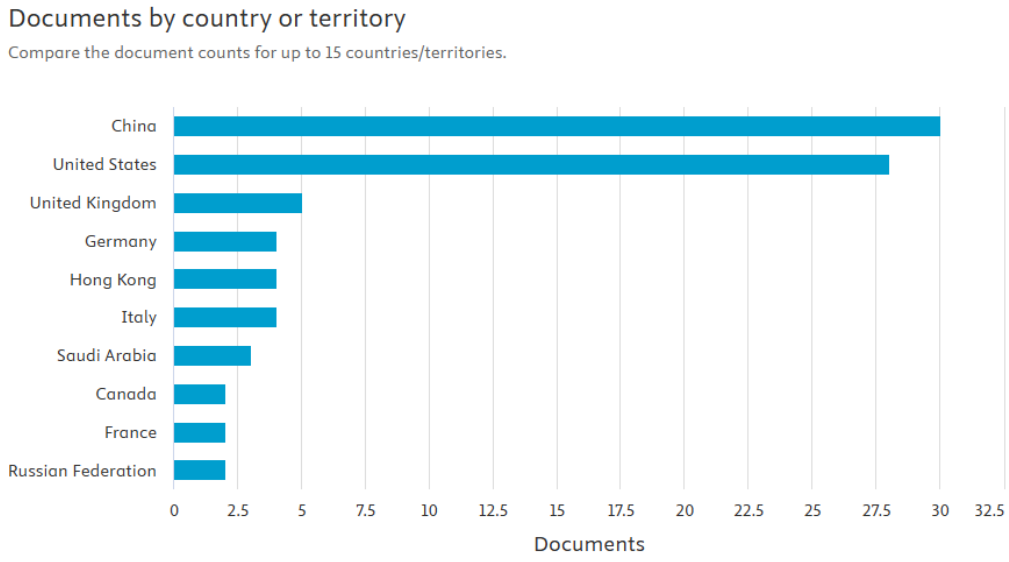

Figure 7. Distribution of data from each country

The country with the largest total data distribution is China with more than 30 documents and more than 110 citations. This explains the largest contribution in differentiation research on physics learning to improve problem-solving skills is still low.

Discussion

The research results state that in the findings of the last 10 years, the research opportunities for differentiated learning in physics are very large. These results are reinforced by the analysis of preliminary studies related to differentiation and physics learning which are still relatively low. The mapping results in Figure 2 show that there is a relationship between differentiated learning and the approach in physics material. Meanwhile, in Figure 3, one of the impacts of differentiated learning can affect a

person's problem-solving skills. It is clear that differentiation also includes a deep learning approach in influencing the thinking process (Eikeland & Ohna, 2022), so that it can improve student learning outcomes.

The achievements obtained related to this physics material are also seen in Figure 3. From previous research, there are several physics sub-materials that are taught through the differentiation process such as mechanical engineering, partial physics, neural network physics, automatic physics (Eikeland & Ohna, 2022; Elkhatat et al., 2023). In line with physics which is considered as one of the groups of sciences that studies absolute, abstract and conceptual values, this is in line with the differentiation approach which provides different access to someone according to their abilities.

The differentiation approach can be linked to improving problem solving. Problem solving consists of understanding the problem, formulating the problem, designing a strategy, implementing the strategy and evaluating the results (Triana et al., 2020). Analysis of problem solving indicators is in accordance with the differentiation approach where in implementing and designing a strategy a person has their own innovation. Differences in understanding and ability affect their problem solving process (Rijal et al., 2025). This is the main point that the differentiation approach is a strategy to improve problem solving skills. Therefore, in further research editorial, it is necessary to study in more depth the relationship between problem solving indicators in differentiated learning syntax in physics. The findings of previous research can be literature for future research business opportunities to be more optimal. Other studies can also be a support for carrying out subsequent research activities.

CONCLUSION

Fundamental Finding: Based on the research that has been conducted, it is known that the trend of physics learning research with a differentiation approach in international publications (Scopus) over the past 10 years has continued to increase every year. **Implication:** Many studies can be studied from this topic as obtained from data mapping, including: in-depth learning, science learning, automatic differentiation, inverse problems. The most types of documents in this study were articles as much as 79.2% of publications. Then, the country with the most publications was China. In accordance with the findings of the bibliometric analysis, it was obtained that one of the efforts to improve problem-solving skills is through a differentiation approach. This effort is in line with the use of meaningful learning models both nationally and internationally. **Limitation:** This research is limited by the findings and keywords used in analyzing bibliometrics. **Future Research:** Based on the research that has been conducted, recommended for future researchers to integrating differentiated learning in physics to improve problem solving skills according to global trends in adapting innovative learning through varied methods.

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***Rahmatta Thoriq Lintangesukmanja (Corresponding Author)**
Afilliation: Universitas Negeri Surabaya
Address: Jl. Ketintang, Surabaya, Indonesia
Email: rahmattathoriq.20038@mhs.unesa.ac.id

Dea Ramadhana Zsa Zsa Alifah
Afilliation: Universitas Negeri Surabaya
Address: Jl. Ketintang, Surabaya, Indonesia
Email: 24031635006@mhs.unesa.ac.id

Dwikoranto
Afilliation: Universitas Negeri Surabaya
Address: Jl. Ketintang, Surabaya, Indonesia
Email: dwikoranto@unesa.ac.id

Sallimah binti Hj Mohd Salleh
Afilliation: Universiti Brunei Darussalam
Address: Jl. Tungku Link, BE1410, Brunei Darussalam
Email: sallimah.salleh@ubd.edu.bn

Iwan Wicaksono

Afilliation: University of Jember
Address: Jl. Kalimantan No. 37, Kampus Bumi Tegalboto, Jawa Timur, 60237, Indonesia
Email: iwanwicaksono.fkip@unej.ac.id