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Bridging the Gap: A Bibliometric Analysis of Differentiated Learning Research in Indonesia and Global Contexts

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Abstract

The implementation of differentiated learning in Indonesia plays a strategic role in improving the quality of education by addressing the needs and potential of each student. However, in practice, differentiated learning still faces various challenges. This study aims to analyse the gap between research on differentiated learning in Indonesia and global research using a bibliometric approach. Data were obtained from the Scopus database and analysed using Biblioshiny and VOSviewer software. The analysis covers research productivity, international collaboration, and research topic trends. The main findings show that the significant contribution of Indonesian authors to differentiated learning studies is not matched by the global impact of their research. Indonesian researchers tend to focus on the implementation of differentiated learning within the context of national policies. In contrast, global research encompasses broader focuses, including the use of technology, parental perspectives, and differentiated learning for students with special needs. This study provides new perspectives for Indonesian researchers to broaden and deepen their research focus by exploring new areas such as the use of artificial intelligence technology, long-term impacts on achieving the Pancasila Student Profile, and more comprehensive and contextual studies related to differentiated learning. Increasing international publication collaboration is also necessary so that publications from Indonesia can make a significant impact on global differentiated learning studies.

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INTRODUCTION

Differentiated learning is an approach that gives students freedom to learn, paying attention to their physical and mental comfort (Ruhimat & Darmawan, 2020). In Indonesia, the concept could be seen in the implementation of the Pancasila Learner Profile. Chandra Handa (2019) emphasizes the importance of pedagogical compatibility between principals and teachers, further education for both, and effective leadership to support differentiated learning in schools. This aspect of pedagogy was closely related to students' social conditions and learner identity in the context of educational values (Raveaud, 2005).

Optimising the implementation of differentiated learning, Hidayat and Patras (2024) and Marlina et al. (2024) suggest improving the education ecosystem through various trainings. This training aims to help educators understand students' learning styles, multiple intelligences, learning readiness, as well as students' emotional, social, and cultural aspects. This approach was in line with the ideas of Da Silva et al. (2012), who emphasize the importance of a diversity of learning scenarios to reflect different interpretations of the value of education. In a practical context, Mok (2012) proposed a tiered implementation of practical learning in laboratories to improve students' acceptance, competence, and motivation. Meanwhile, at the tertiary level, Living Learning Programmes (LLPs) in Residential Colleges (RCs) help students develop leadership, learning skills, and a sense of belonging (Selvarajan et al., 2022). Initiatives such as the student-led Community Engagement Festival (CE Fest) also benefit all participants, demonstrating the application of differentiated learning in a broader context. While the approaches demonstrate the potential of differentiated learning, its implementation in Indonesia still faces a number of significant challenges.

In an effort to improve the quality of education through differentiated learning, Indonesia faces three main challenges: difficulties in addressing student ability diversity, limitations in technology integration, and a lack of relevant local research. The Indonesian education system faces challenges in addressing students' diverse abilities in the classroom, with teachers finding it difficult to implement differentiated learning strategies due to a lack of adequate training and resources. Meanwhile, the integration of technology in education, including the implementation of differentiated learning, was still at an early stage in Indonesia. Further research has needed to understand how digital tools and platforms could be effectively utilised to support differentiated learning in different types of schools. Furthermore, there was a need to review the gap between research conducted at the global level and the local Indonesian context. The data generated from such research was critical to building robust analyses that education policymakers and stakeholders can use to adopt and support Indonesia's future educational development.

The education system in Indonesia still faces significant challenges in implementing differentiated learning, which was an important component in improving the quality of education to achieve the Sustainable Development Goals (SDGs) 2030. Although learning should ideally help students achieve their maximum potential through various activities tailored to individual needs, as stated by Ruhimat and Darmawan (2020), the reality on the ground shows that many teachers in Indonesia still experience difficulties in implementing this differentiated learning strategy. Research by Shareefa et al. (2019) and Gibbs (2023) revealed that the main obstacles in implementing differentiated learning include limited resources, time, support, and knowledge, as well as large class sizes and teacher reluctance. Furthermore, Sofiana et al. (2024) highlighted additional factors that affect teacher readiness in implementing differentiated learning, including minimal special training opportunities and limited time to plan diverse

learning activities. This situation illustrates the complexity of the challenges faced in implementing differentiated learning in Indonesia, which requires a comprehensive approach and systematic support to improve teacher competence and provide the necessary resources. In this context, technology integration in education emerges as a potential solution that could help address some of the challenges in implementing differentiated learning in Indonesia.

However, the integration of technology in education, including the implementation of differentiated learning, was still at an early stage in Indonesia. Although technology has opened up new opportunities to create more engaging and effective learning experiences, its utilisation in the Indonesian educational context still requires significant improvement (Maritsa et al., 2021). The use of technology in the learning process has become increasingly common, both by educators and learners, to increase learning motivation, facilitate access to information, and create a more dynamic learning environment (Amelia & Solikhah, 2024; Sari et al., 2022). Optimising on the potential of technology in differentiated learning, an in-depth understanding of the latest technological developments and their implications for the education system was required.

The rapid development of technology should be accompanied by the evolution of a responsive education system. Ezechil (2011) emphasises the need for diverse evaluation models related to technology-based learning. Tomei (2006) proposes the KA-RPE (Knowledge, Application, Research, Practice, and Evaluation) model as the basis for comprehensive technology learning, which aims to apply a set of competencies in each of the educational fields. In line with this, Fontenelle-Tereshchuk (2023) highlights the importance of parents' role and support in educating children in virtual learning environments, as well as the need for adaptation of pedagogical practices ranging from curriculum design to differentiated learning. The integration of these technologies opens up new opportunities for differentiated learning but also poses new challenges in its implementation.

The utilisation of digital technology in differentiated learning offers various benefits and challenges for students and educators. ter Horst et al. (2024) point out digital media could help students choose the difficulty level of tasks, providing a learning experience that could be further developed. Powell and Wimmer (2014) observed that while computer programming was challenging for students, it had a positive impact on their experience and knowledge through structured learning. Kopeyev et al. (2020) exemplified the use of Google Classroom as a tool to bridge the knowledge gap in computer science. Furthermore, Aljowaysir et al. (2019) suggested use of Mixed Reality (MR) and Artificial Intelligence (AI) technologies to enhance teaching complexity and strategies. While these technologies offer great potential, their effectiveness depends on teachers' readiness and ability to integrate them into learning practices.

The role of teachers and principals was crucial in optimising the use of technology for differentiated learning. Wangid et al. (2020) highlighted the differences in teaching efficacy between teachers in Indonesia and Malaysia, emphasising the importance of understanding the factors that influence teacher efficacy. This study highlighted the important role of instructional and distributed leadership by principals in teacher professional development. Overcoming the challenges and improving the quality of learning, Purnasari and Sadewo (2021), Fatanah (2021), and Widyastuti and Haerudin (2022) suggested using strategies such as innovative learning, blended learning, problem-based learning, and limited face-to-face learning. Amzat et al. (2022) emphasise the vital role of principals in providing instruction, curriculum development, training, evaluation, and monitoring of diverse learning. However, the implementation of these strategies requires systemic support and appropriate policies

from the government and education stakeholders.

Based on the previous explanation, it appears that differentiated learning in Indonesia faces a range of complex challenges. Although research has been conducted at global and national levels, there are still significant gaps in the Indonesian context. Therefore, research was needed to provide a critical and comprehensive analysis of the current state of research in Indonesia. This will serve as an empirical foundation for policymakers and practitioners, encourage international research collaboration, and contribute to achieving the 2030 SDGs, particularly Goal 4 on Quality Education. Such research could act as a catalyst for improving the quality and relevance of differentiated learning research in Indonesia while also supporting efforts to enhance the overall quality of education. Accordingly, this study aims to analyse the gaps between differentiated learning research in Indonesia and global research through a bibliometric study approach. The novelty of this research lies in the systematic mapping and comparison of trends, focus areas, and findings between the Indonesian and global contexts. The primary goal was to identify gaps between Indonesian and global research in the context of differentiated learning, analyse contributing factors, and formulate recommendations that can help bridge these gaps.

METHODS

The Scopus database was chosen for its excellence in providing broad coverage of various disciplines, quality articles through rigorous review, and impact analysis tools such as citations. The user-friendly interface supports reference searching, multidisciplinary research, monitoring of current trends, and scientific collaboration, making it a highly beneficial resource for researchers. Thus, the Scopus database was an appropriate choice for conducting the bibliometric analysis of this study. The PRISMA framework (Page et al., 2021) was used as a search strategy using logical operators and keywords to tighten and filter search results in the Scopus database. Figure 1 provides a comprehensive visual overview and summary of the systematic approach adopted to conduct the literature search and select the publications that were finally included in the analysis.

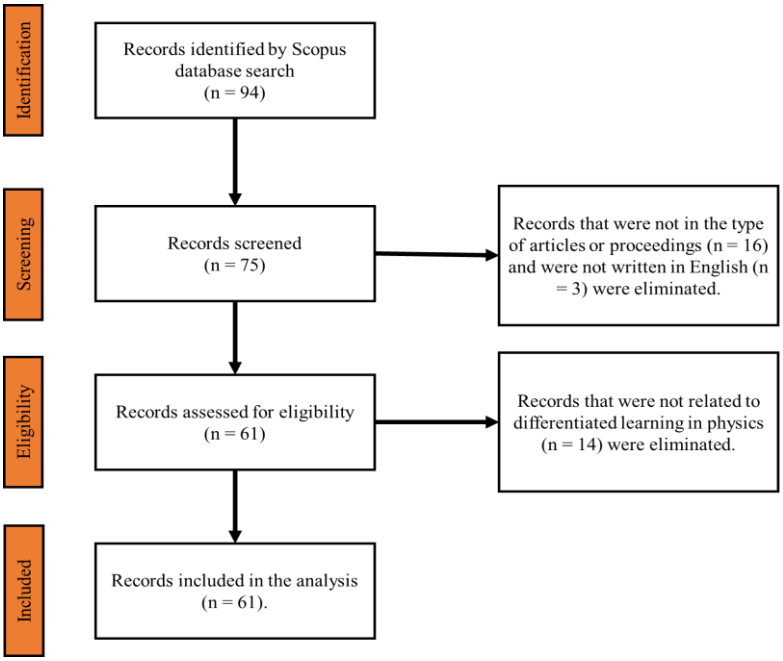

Figure 1. Flow of publication selection from the Scopus database with the PRISMA method

A comprehensive search was conducted on May 28, 2024, utilising the Scopus database to identify Scopus publications relevant to the study. The search strategy used a combination of specific keywords and logical operators, retrieving articles with "differentiated learning" or "differentiated instruction" as keywords and article titles, resulting in 94 documents. We screened by eliminating publications that were not in the form of articles or conference papers, as well as those that were not in English. Further screening retained the documents, followed by a rigorous evaluation of eligibility by examining the focus of the study. The studies that did not have direct relevance to differentiated learning were eliminated, eliminating 14 documents that did not fulfill the criteria. The remaining 61 publications, considered highly relevant to the research topic and addressing differentiated learning, were included in the analysis.

Data analysis techniques

Data analysis was facilitated by Biblioshiny and VOSviewer software to analyse and visualise data from the publications analysed in this study. Biblioshiny, a web-based application in the bibliometrix package in R, facilitates bibliometric analysis and generates data matrices, allowing exploration of co-citation networks, collaboration patterns, and co-word analysis. It processes data from the examined publications to generate informative images such as plots, keyword analysis, authorship analysis, and document analysis, enabling a comprehensive examination of bibliometric characteristics (Aria & Cuccurullo, 2017). VOSviewer excels at building bibliometric maps, network visualisations, overlays, and density visualisations, facilitating the analysis of topics associated with specific keywords and mapping keyword co-occurrences to provide an informative representation of relationships and patterns (van Eck & Waltman, 2010). Biblioshiny and VOSviewer were combined in the analysis. This enabled a comprehensive citation, distribution, and text analysis of the selected publications carefully aligned with the research questions of this study.

RESULTS AND DISCUSSION

General Information

The main information in the database was loaded into the bibliometric program shown in Figure 2. The distribution has 61 documents from 56 different sources related to differentiated learning. Another metric was the annual growth rate, which shows the increase in documents compared to the previous year, which was recorded at 10.78%. The study involved 164 authors, of which 12 were single authors. About 11.48% of the collaboration consisted of authors from different countries. There were a total of 228 keywords/themes that directly relate to differentiated learning. Additional information could be obtained relating the average number of citations for each document, which is 7,197 citations per document.

Figure 2. Main Information

Bibliometric analysis of primary data revealed many important findings regarding differentiated learning. Publications (61) from 56 sources indicate that this topic has expanded across the scientific community. An annual growth rate of 10.78% indicates a moderate but consistent increase in scientific production, indicating the potential for additional investigation and progress in this area. The participation of 164 authors, with only 12 authors contributing to multiple publications, underscores the large number of researchers involved in this field. However, the relatively small percentage of international/country collaborations (11.48%) suggests the need for increased worldwide collaboration and knowledge sharing to accelerate progress in this interdisciplinary field. A citation rate of 7,197 citations per document indicates moderate impact and recognition within the broader scientific community. This metric could be seen as a measure of the likelihood of research findings being disseminated and adopted and an opportunity for future research to expand and enhance the current knowledge base. Overall, the bibliometric findings emphasize the need for increased focus on establishing international collaborations, expanding the research community, and increasing the visibility and impact of scientific production in this area. Bibliometric analysis is used to map collaborative networks between researchers and identify the contributions of various countries in a research topic. This shows the expansion of the research community geographically and across disciplines (Judijanto & Syamsulbahri, 2024). Tupan (2020) showed that bibliometric analysis of open access journals revealed the importance of international collaboration in increasing research productivity and visibility.

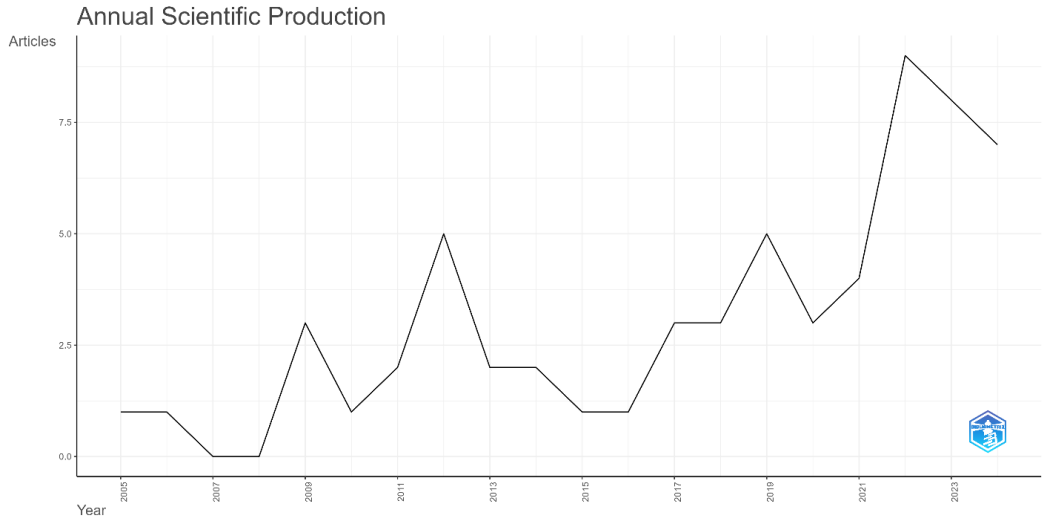

Figure 3. Annual Scientific Production

The scopus result graph showed the number of articles published each year (see Figure 3). The time span used in this study is from 2005 to 2024. The number of articles published each year varies greatly, with some years showing no publications in 2007 and a sudden increase in 2009. The graph shows another peak in the number of articles published around 2011, followed by a significant decline and then a slight increase in the following years. The publication of articles each year has been relatively low and stable for several years, with a slight increase in 2019. Based on the graph, there is a significant increasing trend in the number of articles published from 2020, then reaching its highest peak around 2022 before declining in 2023. Azmy and Fanny (2023) showed an increased focus on differentiated learning, especially after the implementation of the Merdeka Belajar Curriculum, which began around 2020. This is in line with the statement about the significant increase in the number of differentiated learning articles published starting in 2020. The general trend described in the studies shows an increase in interest and focus on differentiated learning in recent years among Indonesian researchers and educators (Fitriyah & Bisri, 2023; Septyana et al., 2023).

Most influential affiliates

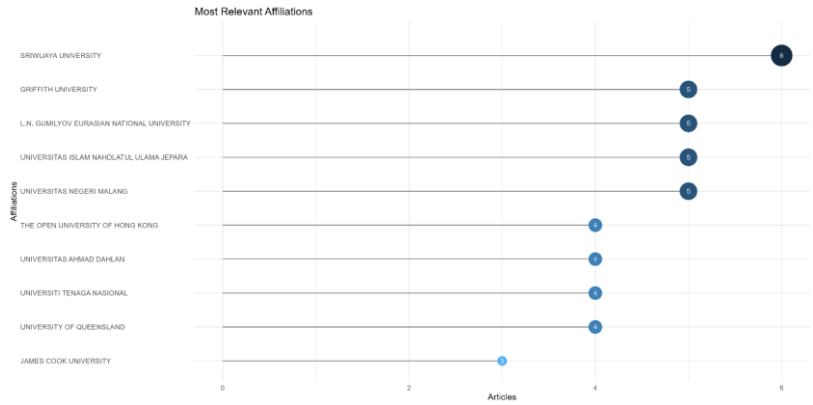

Figure 4. Most influential affiliations

Figure 4 shows the number of authors categorised by most influential SCOPUS affiliation. Ten universities have the highest number of records. Sriwijaya University tops

the list with six authors with the most influential affiliations. The next position was followed by Griffhith University, L.N. Gumilyov National Eurasian University, Jepara Nahdlatul Ulama Islamic University, and the and the State University of Malang, with a total of 5 authors from each university. Then the Open University of Hong Kong, Ahmad Dahlan University, National Power University, and Queensland University have a total of 4 authors from each university. In the next position, there were 3 authors from James Cook University. Among the universities, four Indonesian universities showed significant contributions to differentiated learning research, with diverse research focuses relevant to the national education context.

The four universities in Indonesia have research focuses on various aspects of differentiated learning, such as the implementation of differentiated learning in the independent curriculum, teacher readiness in implementing it, the relationship between teachers' pedagogical technology knowledge and implementation, and the development of conceptual models based on teacher experience. Sriwijaya University focuses on the implementation of differentiated teaching modules based on the independent curriculum, taking into account students' learning profiles, especially learning styles (Marlina et al., 2024). Nahdlatul Ulama Islamic University of Jepara examines teacher readiness in implementing differentiated learning in the context of English language teaching and the factors that influence it (Sofiana et al., 2024). Malang State University examines the relationship between English as a foreign language teachers' pedagogical knowledge of technology and their ecological agency in responding to differentiated learning policies in Indonesian secondary schools (Cahyono et al., 2023). Ahmad Dahlan University focuses on developing a conceptual model of differentiated learning based on the experiences of junior high school teachers in Indonesia (Hasanah et al., 2022).

Six other universities from outside Indonesia have research focuses on the implementation, challenges, perceptions, and strategies in differentiated learning, as well as the use of technology to support differentiated learning in various educational contexts. Griffith University (Australia) focuses on the challenges of implementing differentiated learning in secondary schools, teachers' perceptions and practices in implementing differentiated learning, and the use of differentiated learning for students with ADHD (Gibbs, 2023b, 2023c, 2023a). L.N. Gumilyov Eurasian National University (Kazakhstan) examines English teachers' perceptions of differentiated learning in heterogeneous classes, as well as use of personal learning styles and Google Classroom technology to bridge the knowledge gap in computer science (Akhmetova et al., 2023; Kopeyev et al., 2020). The Open University of Hong Kong conducted a comprehensive literature review on personalized learning features and trends over the past few years (Li & Wong, 2019, 2021). Universiti Tenaga Nasional (Malaysia) focused on differentiated learning design using the Moodle learning management system (Jamaluddin et al., 2022). The University of Queensland (Australia) examined the impact of teaching and learning audits on classroom learning differentiation, as well as related policy implementation in Queensland schools (Mills et al., 2014). James Cook University (Australia) examined supporting parents to co-create differentiated learning opportunities in mathematics (Daniel et al., 2022).

There were several significant differences that could be the basis for the development of Indonesian research in the future. Research in Indonesia tends to focus on implementation in the context of national policies such as the independent curriculum and the Pancasila student profile and places more emphasis on teacher perspectives and implementation in the classroom. Meanwhile, research abroad has a broader scope, including intensive exploration of technology use, parental perspectives, the impact of

school audit policies, and a focus on specific needs such as students with ADHD or certain subjects. Based on these differences, Indonesian researchers have the opportunity to expand and deepen the study of differentiated learning in the future. Some research directions that could be considered include the integration of technology in the implementation of differentiated learning, longitudinal studies to see the long-term impact on the achievement of the Pancasila Student profile, the application of differentiated learning for students with special needs in the context of inclusive education, parental involvement in supporting differentiated learning, evaluation of policies related to implementation at the national and regional levels, development of differentiated learning models that were appropriate to the Indonesian context, integration of differentiated learning in thematic or integrated learning, and assessment of the effectiveness of various teacher professional development models. By taking this research direction, it was hoped that Indonesian researchers could produce more comprehensive and contextual knowledge and make a significant contribution to improving the quality of education in Indonesia through the implementation of effective differentiated learning that was appropriate to local needs.

The most influential countries

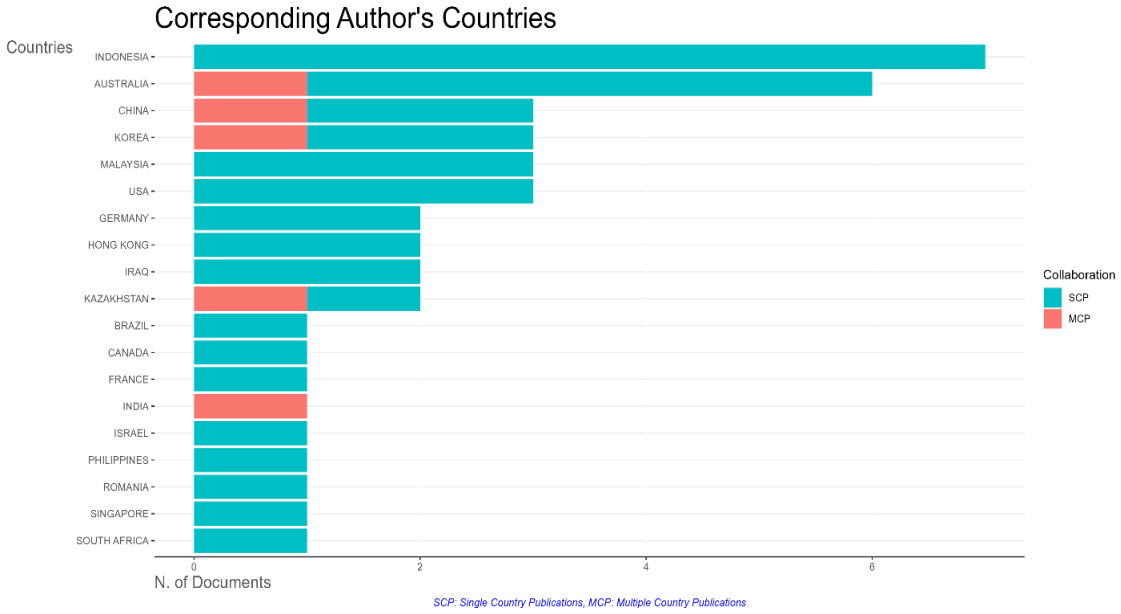

Figure 5. Country of origin of the author

Figure 5 illustrates the data categorized by country or region analyzed. This graph displays that 19 countries have a large number of documents based on the analysis conducted in this study. Scientific articles usually involve collaboration between authors, as evidenced by the results of the analysis showing collaboration between authors from comparable and different countries. The analysis conducted collaboratively reveals a complex pattern of author collaboration in differentiated learning. This diagram was divided into two types of collaboration, namely SCP (Single Country Publications) marked in blue and MCP (Multiple Country Publications) marked in red. It could be seen from the graph that authors from Indonesia have the highest number of documents, with only SCP collaboration of more than 6 documents. Furthermore, Australia, China, Korea, and Malaysia have a combination of SCP and MCP. Australia has more MCP than SCP. India and Kazakhstan each have several documents in MCP collaboration. While

other countries, such as the USA, Germany, Hong Kong, Iraq, Brazil, Canada, France, Israel, the Philippines, Romania, Singapore, and South Africa, all only show SCP collaboration. This diagram provides insight into the scientific contributions of different countries in terms of SCP versus MCP. Overall, the majority of papers come from SCP collaborations. Only a few countries show significant collaboration in MCP, most notably Australia and China. Maryono and Surajiman (2017) showed that international collaborations received significantly more citations than other collaborations and individual works. This emphasizes the importance of establishing international collaborations to increase the impact and visibility of research.

Based on the findings showing the dominance of SCP in differentiated learning research in Indonesia, several recommendations were proposed to improve research collaboration. Indonesia needs to encourage the increase of MCP by initiating international collaboration, especially with countries that have shown a balance between SCP and MCP, such as Australia and China. Strengthening regional research networks, especially with Southeast Asian countries such as Malaysia, could be a strategic initial step considering the similarity of educational contexts. The government and higher education institutions can consider providing special incentives to encourage international collaboration, such as collaborative research grants or support for joint publications. The development of online collaboration platforms could also facilitate cross-country research collaboration, especially in an era where virtual interactions are increasingly common. By implementing these recommendations, it was hoped that Indonesia can increase the number of its MCPs, thereby broadening the perspective and impact of differentiated learning research at the global level while maintaining the strength of research in the local context reflected in the high SCP.

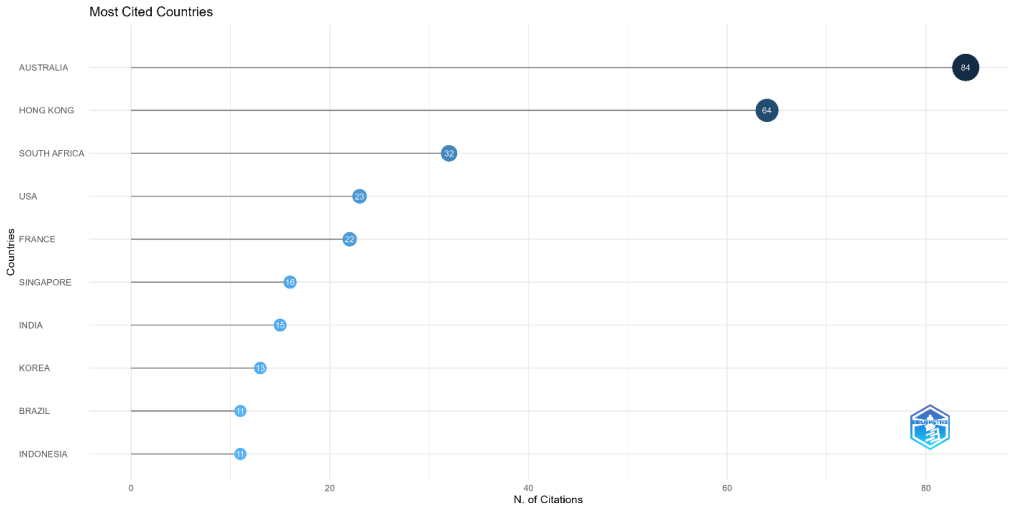

Figure 6. Most cited countries

Other data obtained regarding the most cited countries could be seen in Figure 6. The following data illustrates the order of the most cited countries. The most cited country was Australia with 84 citations. The next most cited countries are Hong Kong with 64 citations and South Africa with 32 citations. In fourth place is the USA with 23 citations, followed by France with 22 citations in fifth place. Singapore with 16 citations is in sixth place. Furthermore, 15 citations from India are in seventh place. Korea, Brazil, and Indonesia are in eighth, ninth, and tenth place with 13 and 11 citations, respectively.

Compared with previous findings, there is a significant gap between the number of

contributing authors and the number of most cited studies. This finding suggests that although Indonesia has many authors contributing to differentiated learning, their research has not been widely recognized or cited in the global literature. Factors that may contribute to this include limited access to international journals, a lack of collaboration with foreign researchers, and the quality and relevance of research that still need to be improved. To better understand and address the issue of research quality and relevance, an analysis of Indonesia's research focus compared to the two most cited countries, Australia and Hong Kong, will be conducted. This aims to identify areas that need improvement and formulate strategies that could increase global recognition of Indonesian research.

The research in Indonesia tends to focus on the implementation of differentiated learning in the context of national policies such as the independent curriculum and the Pancasila student profile. The research in Indonesia also examines teacher readiness, the development of conceptual models, and the relationship between teachers' pedagogical technology knowledge and the implementation of differentiated learning. Meanwhile, research in Australia discusses more about implementation challenges, teacher and principal perceptions, and the application of differentiated learning for gifted students and students with ADHD. Australia also examines the impact of teaching audits on the implementation of differentiated learning and parental involvement in mathematics learning. On the other hand, research from Hong Kong focuses more on a comprehensive literature review of personalized learning, including trends, features, and use of technology in its implementation. Based on the differences in research focus between Indonesia, Australia, and Hong Kong in the context of differentiated learning, Indonesian researchers have the opportunity to expand and deepen their studies in the future.

Drawing inspiration from the Australian approach, Indonesian researchers could conduct in-depth studies on the challenges of implementing differentiated learning in various school contexts, including an analysis of the barriers faced by teachers and principals. Furthermore, following Australia's focus on students with special needs, research on the effectiveness of differentiated learning for gifted students or students with ADHD could be an interesting area to explore in Indonesia. The role of school leadership and parental involvement in differentiated learning were also topics worthy of further study, adapting similar research in Australia. Meanwhile, adopting the Hong Kong approach, Indonesian researchers could conduct comprehensive research on the use of technology in differentiated learning, including an analysis of trends, features, and effectiveness of various educational technologies in the Indonesian context. Longitudinal studies on the impact of differentiated learning on students' motivation, engagement, and learning satisfaction could also provide valuable insights. Furthermore, research on the changing role of teachers in implementing technology-based differentiated learning and the factors that support the success of differentiated learning in Indonesia could enrich the understanding in the local context.

By adopting this research direction, Indonesian researchers can enrich the understanding of differentiated learning within the local context while drawing lessons from the experiences and findings of studies conducted in Australia and Hong Kong. This approach was expected to make a significant contribution to the development of effective differentiated learning practices that align with the needs of Indonesia's educational system, as well as help address the gaps in the current research literature. International collaboration with researchers from Australia and Hong Kong could also be considered to enhance perspectives and research methodologies and to help identify best practices that can be adapted to the Indonesian context.

The most influential documents

Table 1. The ten most cited studies each year

R	Title	Author (s)	Year	TC/Y
1	Features and trends of personalised learning: A review of journal publications from 2001 to 2018	(Li & Wong, 2021)	2020	12.00
2	Stepwise training in rectal and colonic endoscopic submucosal dissection with differentiated learning curves	(Iacopini et al., 2012)	2012	6.15
3	Differentiated learning: from policy to classroom	(Mills et al., 2014)	2014	5.36
4	A differentiated learning environment in domain model for learning disabled learners	(Thapliyal et al., 2022)	2022	5.00
5	Voices in practice: challenges to implementing differentiated instruction by teachers and school leaders in an Australian mainstream secondary school	(Gibbs, 2023c)	2022	3.50
6	Leading Differentiated Learning for the Gifted	(Chandra Handa, 2019)	2019	2.83
7	Guidelines to assist the implementation of differentiated learning activities in South African secondary schools	(De Jager, 2013)	2011	2.67
8	How Learning Has Been Personalised: A Review of Literature from 2009 to 2018	(Li & Wong, 2019)	2019	2.67
9	Conceptual Model of Differentiated-Instruction (DI) Based on Teachers' Experiences in Indonesia	(Hasanah et al., 2022)	2022	2.67
10	Using a Personalized Learning Style and Google Classroom Technology to Bridge the Knowledge Gap on Computer Science	(Kopeyev et al., 2020)	2020	2.00

The most frequently cited articles in the context of differentiated learning generally focus on comprehensive reviews of trends and features of personalized learning, the challenges of implementation at various educational levels, and the use of technology in supporting differentiated learning. They share a common focus on the practical aspects of implementing differentiated learning, including the challenges faced by teachers and school leaders, the role of technology in facilitating personalized learning, and the importance of professional development for teachers in applying differentiation strategies. Additionally, many of these studies emphasize the importance of understanding the diverse needs and characteristics of learners, including gifted students and those with special needs. These findings could be analyzed in contrast to the focus of Indonesian research on differentiated learning, as previously discussed.

There were several opportunities that could guide future research directions for Indonesian researchers. First, a comprehensive literature review on the implementation of differentiated learning in Indonesia could be conducted. This research would provide a holistic overview of the developments, trends, and specific challenges within the national education context. Second, longitudinal studies to observe the long-term impact of differentiated learning on learning outcomes, motivation, and student engagement within the context of the independent curriculum and the Pancasila Student Profile are still lacking. Third, although there was research on teachers' pedagogical technological knowledge, there was still room to investigate the use of advanced technologies such as artificial intelligence and virtual reality in supporting differentiated learning. Furthermore, research focusing on the role and perception of school principals in the implementation of

differentiated learning is still limited in Indonesia. Studies on how school leadership can effectively support differentiated learning could be an interesting area of research. Additionally, while Indonesia has initiated research on differentiated learning, a specific focus on its implementation for gifted students or students with special needs in the context of inclusive education still needs further exploration. In-depth research on the specific challenges faced in implementing differentiated learning in Indonesia, as well as effective strategies to overcome them, could also provide valuable practical insights. Finally, studies on effective professional development models to enhance teachers' ability to implement differentiated learning, particularly within the context of the independent curriculum, still need to be conducted. By pursuing these opportunities, Indonesian researchers can produce research that is not only relevant to the local context but also has the potential to gain broader recognition and citations in the international academic community.

Collaborative research network by differentiated learning researchers

Figure 7. Institution-Based Authors Collaboration Network

The subsequent data results illustrate the research collaboration network by differentiated learning researchers based on institutions. Based on the data obtained from institutional analysis, the collaboration network for authors was examined based on institutions. According to Figure 7, it was evident that Griffith University has more collaborations or partnerships compared to other universities. Griffith University collaborates with the University of Queensland. The next collaboration was between Amity University and Middlesex University, as well as the University of Petroleum and Energy Studies. Furthermore, there was collaboration between Carl von Ossietzky University of Oldenburg and Friedrich Schiller University Jena. Kwandong University collaborates with Ewha Womans University. Another collaboration is between Korea National University of Education and Jeonju University. Mustansiriyah University collaborates with the University of Kirkuk. Additionally, L.N. Gumilyov Eurasian National University collaborates with Abay Kazakh National Pedagogical University and Sh. Ualikhanov Kokshetau University. Lastly, there was a collaboration between Universitas Muhammadiyah Yogyakarta, Universitas Ahmad Dahlan, and Universitas Negeri Padang.

Based on the findings of collaborative research between institutions, the recommendation for research institutions in Indonesia is to strengthen and expand their collaboration networks with other universities, both domestically and internationally. Institutions such as Universitas

Muhammadiyah Yogyakarta, Universitas Ahmad Dahlan, and Universitas Negeri Padang, which have already been involved in collaborations, can enhance their efforts by forming strategic partnerships with universities that have high reputations and strong histories of collaboration, such as Griffith University or universities in Australia and Hong Kong. Additionally, it is important to identify complementary research areas and develop joint projects that can result in high-quality publications. Leveraging digital platforms and international conferences to facilitate communication and exchange of ideas could also help increase the visibility and impact of Indonesian research on the global stage.

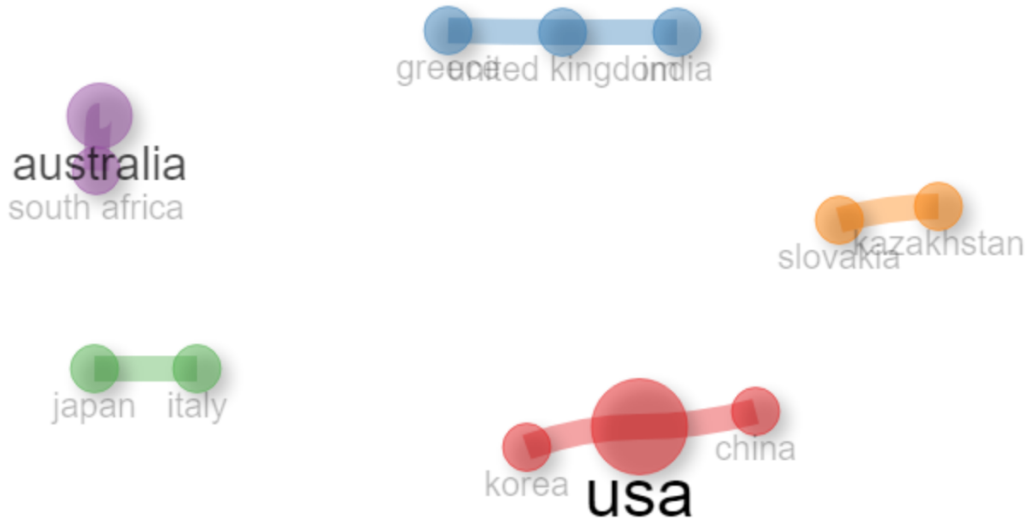

Figure 8. Author Collaboration Network by Country

The following findings illustrate the Writer Collaboration Network by Country, based on data collected from the analysis of the Writer Collaboration Network by Country as shown in Figure 8. The point for the USA was larger compared to other countries, indicating that the USA may have a greater influence or more connections within the context of the visualized data. International collaborations occur between the USA and Korea, China and Australia with South Africa, Japan and Italy, the United Kingdom with Greece and India, and Slovakia with Kazakhstan.

Based on findings that show the USA has a significant influence on research collaboration networks and the strong collaborations between countries like the USA with Korea and China, as well as Australia with South Africa, the recommendation for research in Indonesia is to enhance collaboration with countries that have extensive networks and significant influence in global research. Institutions in Indonesia should establish strategic partnerships with institutions in the USA, Australia, and other countries involved in strong multinational collaborations. Focusing on joint research in fields that were complementary and globally relevant, as well as active participation in international conferences and collaborative projects, could help increase the influence and visibility of Indonesian research. Leveraging international scholarship and grant programs to support this collaboration could also accelerate the progress and global recognition of Indonesian research.

Differentiated learning research trends in the world

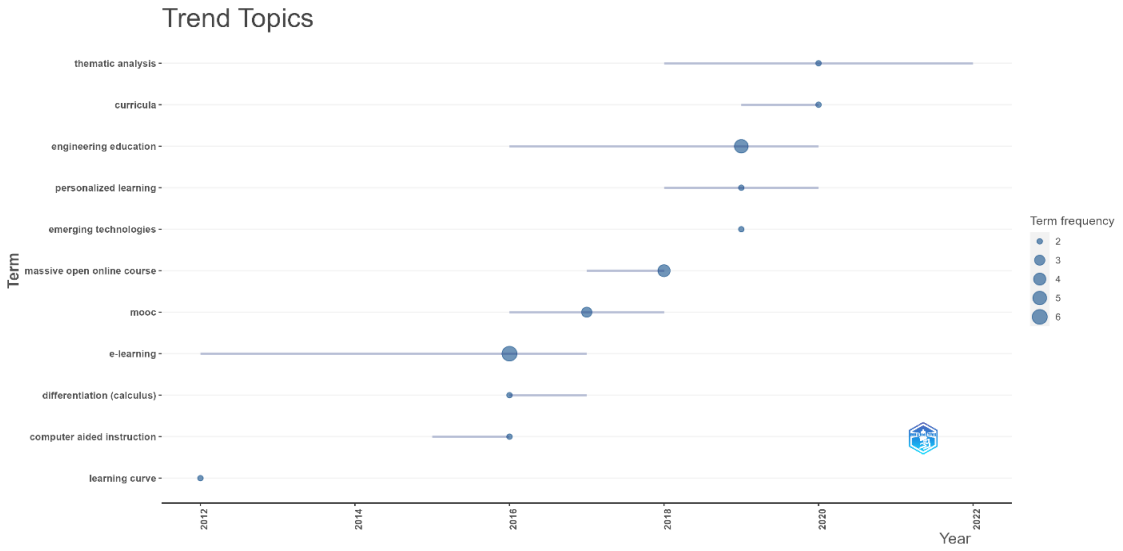

Figure 9. Topic trends

Figure 9 shows the trending keywords in the topic of differentiated learning from 2012 to 2022. This graph helped us identify when specific keywords emerged as trends, how their popularity changed over time, and compare trends across different topics. The x-axis represents the years, while the y-axis displays the trending keywords for each year. Each keyword was represented by a horizontal line, with dots indicating the peak frequency of that keyword in a given year. The longer the line, the longer the keyword remained a trend during the years shown.

From 2016 to 2020, there was a significant shift in research trends related to differentiated learning. In 2016, the primary focus was on the use of technology in education, such as computer-aided instruction and e-learning. The following year, in 2017, research topics shifted towards Massive Open Online Courses (MOOCs), which became highly popular as an alternative to conventional education. This trend continued into 2018 with deeper research into massive online courses. By 2019, research began to explore emerging technologies, personalized learning, and technical education, indicating a shift towards learning that is more tailored to individual needs. In 2020, research focused on curriculum and thematic analysis, reflecting a desire to understand and develop a curriculum that was more effective and relevant to diverse learning needs.

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Indonesian researchers could take advantage of this global trend. One of these opportunities was the importance of integrating technology into education to support differentiated learning. By observing the development from computer-aided instruction to personalized learning, researchers could identify effective tools and methods to be applied in the local context.

Additionally, focusing on curriculum and thematic analysis highlights the need for in-depth research to develop a curriculum that responds to individual students' needs. Indonesian researchers could consider exploring how new technologies and personalized learning methods could be implemented in Indonesia to enhance student learning outcomes and make education more inclusive and adaptive to the needs of the learners.

Differentiated learning research topics in the worldwide

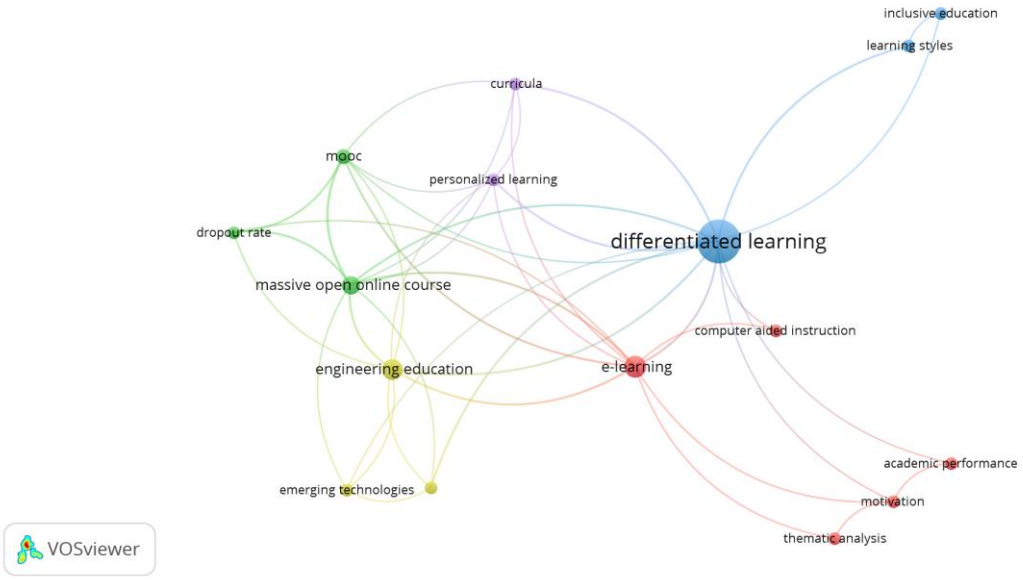

Figure 1. Network visualization

Table 1. Five research clusters formed in the topic of differentiated learning

Number of Cluster	Keywords	Name of cluster
1	Academic performance; computer aided instruction; e-learning; motivation; thematic analysis	Technology and motivation
2	Dropout rate; massive open online course; mooc	Open education and reducing dropout rates
3	Differentiated learning; inclusive education; learning styles	Diversified learning and inclusive education
4	Emerging technologies, engineering education; technology-assisted learning	New technologies and engineering education
5	Curricula; personalized learning	Personalized curriculum and learning

Based on co-occurrence analysis using VOSviewer, there are five global research focus clusters on differentiated learning. Cluster 1 (technology and motivation): This cluster includes research on academic performance, computer-aided instruction, e-learning, motivation, and thematic analysis. The research focus here is on how technology can be used to enhance students' academic performance through differentiated and student-centered learning. Thematic analysis is employed to understand the factors affecting student motivation in the context of using technology in education. Cluster 2 (open education and reducing dropout rates): This cluster covers topics related to dropout rates,

Massive Open Online Courses (MOOCs), and MOOCs themselves. The research focus here is on how open online courses can be utilized to reduce dropout rates by providing broader and more flexible access to education. Cluster 3 (Diversified Learning and Inclusive Education): This cluster includes differentiated learning, inclusive education, and learning styles. Research in this cluster focuses on strategies to accommodate individual differences among students within the context of inclusive education. This involves developing methods that support various learning styles and special needs to ensure all students can learn effectively. Cluster 4 (Emerging Technologies and Technical Education): This cluster encompasses emerging technologies, technical education, and technology-enhanced learning. The research focus here is on the use of new technologies in technical education to improve learning and teaching. This includes studying how technology can be used to simulate complex learning environments and support practical learning. Cluster 5 (Curriculum and Personalized Learning): This cluster includes curriculum and personalized learning. Research in this cluster focuses on developing flexible and adaptive curricula to meet individual students' needs. Personalized learning aims to tailor the learning process to each student's needs, abilities, and interests.

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Based on global research focus on differentiated learning, there were still several areas that have not been extensively explored by Indonesian researchers. One such area was the development and implementation of Massive Open Online Courses (MOOCs) as a strategy to reduce dropout rates, which has become a global research focus. Additionally, the use of new technologies in technical education to provide a more in-depth and practical learning experience also requires more research. Indonesian researchers also need to explore further flexible curricula and personalized learning to meet individual students' needs, as well as how technology could be used to support fairer and more accurate assessments in differentiated learning environments.

CONCLUSION

This study successfully reveals the gap between differentiated learning research in Indonesia and global-level research. Through bibliometric analysis, it was found that differentiated learning studies in Indonesia tend to focus on the implementation of national policies, such as the 'Merdeka Curriculum' and the Pancasila Student Profile, with a strong emphasis on teachers' perspectives and classroom applications. On the other hand, global research shows a broader focus, encompassing the use of technology, parents' perspectives, and inclusive education for students with special needs. Although there was a consistent upward trend in publications on this topic worldwide, differentiated learning studies in Indonesia still show limitations in terms of international collaboration, as evidenced by the low percentage of Multi-Country Publications (MCP). This highlights the importance of enhancing international cooperation to broaden and deepen research focus, thus enabling a more significant impact on global differentiated learning studies. Institutional affiliations indicate that several universities in Indonesia have made significant contributions to differentiated learning research, particularly in the context of national policies. However, a comparison with global research shows opportunities that could guide future research directions for Indonesian researchers. These include a comprehensive literature review on the implementation of differentiated learning, long-term studies on the impact of differentiated learning on student achievement in the context of the Pancasila Student Profile, and the utilisation of artificial intelligence to support differentiated learning.

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