

TECHNOLOGY-ENHANCED BIBLIOMETRIC ANALYSIS OF DIDACTIC TRANSPPOSITION IN MATHEMATICS EDUCATION

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ABSTRACT

This study analyzes the trend of didactic transposition research in mathematics education for the period 2014–2024 using a bibliometric approach with data from Scopus processed through VOSviewer and RStudio. Didactic transposition plays an important role in transforming scientific knowledge into materials that can be taught and understood by students, bridging the gap between academic theory and learning practice. The results of the analysis show an increase in publications in the past decade, with major journals such as *Discrete Applied Mathematics*, *ZDM–Mathematics Education*, and *International Journal of Science Mathematics Education*. China is the country with the largest research contribution in this field. In addition, bibliometric mapping identifies themes that are still rarely researched, such as Anthropology of Theory Didactic, algebra, cultural transposition, and calculus, which have the potential to be the focus of further research. This study provides insights for academics and education practitioners to understand the development of didactic transposition research and direct future research. By identifying research gaps that are minimally explored, the results of this study are expected to encourage the development of more effective teaching strategies, especially in mathematics learning, and strengthen the adaptation of didactic transposition-based curriculum.

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INTRODUCTION

In the digital era, technology has played a crucial role in enhancing the effectiveness of bibliometric analysis, including in the field of mathematics education (Hwang & Tu, 2021; Chen et al, 2022). Didactic Transposition, which describes the process of transforming mathematical concepts from the scientific domain into educational contexts, can now be studied more comprehensively with the aid of technology. Technology-enhanced bibliometric methods, powered by artificial intelligence, big data processing, and visualization tools such as VOSviewer and RStudio, enable the identification of research trends, citation patterns, and conceptual relationships in didactic transposition studies (Kemeç & Altınay, 2023). By leveraging these technological advancements, researchers can uncover how the theory of didactic transposition evolves, is adopted, and implemented across various mathematics education contexts worldwide.

Didactic transposition is a concept that explains the process of transforming scientific knowledge into teachable knowledge, and then into knowledge that is understood by students (Lombard & Weiss, 2018). This process involves adapting materials to suit the educational context and students' needs, so that learning becomes more effective and meaningful. Didactic transposition plays an important role in bridging the gap between academic knowledge and classroom teaching implementation (Bosch et al, 2021; Mouali et al, 2024). Along with the development of research in the field of education, it is important to understand how didactic transposition has been researched and applied. Bibliometric analysis is an effective method for mapping and analyzing research trends in a field of science. Using software such as VOSviewer and RStudio, bibliometric analysis can identify publication patterns, collaborations between researchers, and the most researched topics (Kemeç & Altınay, 2023). Bibliometric analysis can help researchers understand the development and direction of research in a particular field (Donthu et al, 2021). In the context of mathematics education, research

on didactic transposition is becoming increasingly relevant as it helps teachers structure the presentation of subject matter in accordance with students' abilities and levels of understanding.

Several previous studies have shown that didactic transposition has an important role in education, both at the elementary school level and in the education of prospective mathematics teachers. A deep understanding of didactic transposition can help teachers design more effective teaching strategies (Atalar & Ergun, 2018; Karaduman et al, 2021). Meanwhile, research by Prihandhika, Fatimah, and Sujata (2023) highlighted the importance of understanding didactic transposition for prospective teachers so that they can adjust the material taught to the level of student understanding. However, although there have been many studies on didactic transposition, Fauzi and Suryadi (2020) noted that there are still limitations in related research, especially in the context of inequality. Therefore, a bibliometric analysis is needed to reveal the trend of didactic transposition research more comprehensively. By analyzing existing publications, research trends, the most frequently discussed topics, and collaborations between researchers and institutions can be identified. The use of software such as VOSviewer and RStudio allows for more effective data visualization in mapping didactic transposition research. Based on this, this study aims to determine the trend of writing didactic transposition articles between 2014–2024, journal ranking classification, journal country of origin, and mapping in searching for international scientific publication trends using the Scopus database. Thus, the results of this study are expected to contribute to the academic community and provide insight for researchers and educators in developing teaching strategies based on didactic transposition.

As research in education develops, it is important to understand how didactic transposition has been researched and applied. Bibliometric analysis is an effective method for mapping and analyzing research trends in a field of science. Using software

such as VOSviewer and RStudio, bibliometric analysis can identify publication patterns, collaborations between researchers, and the most researched topics. Pauji, Kusharyadi, and Khotimi (2023) emphasize that bibliometric analysis can help researchers understand the development and direction of research in a particular field. One relevant study is a study conducted by Sari, Supriyadi, and Suryadi (2023), which analyzed didactic design in elementary schools. They found that a deep understanding of didactic transposition can help teachers design more effective teaching strategies. These findings indicate the importance of further research in the field of didactic transposition to improve the quality of education.

In addition, research by Prihandhika, Fatimah, and Sujata (2023) highlighted didactic transposition in the context of mathematics teacher education. They emphasized the need for prospective teachers to understand the didactic transposition process to ensure that the material taught is in accordance with the level of student understanding. This shows that didactic transposition is not only relevant to students but also important in teacher education. However, despite its importance, research related to didactic transposition is still relatively rare. Fauzi and Suryadi (2020) noted that a bibliometric analysis of mapping and clustering research trends showed a lack of focus on didactic transposition, especially in the concept of inequality. This gap indicates the need for further research to explore and understand didactic transposition in various learning contexts.

Bibliometric analysis can provide insights into how didactic transposition has been researched over time. By analyzing existing publications, we can identify research trends, the most frequently discussed topics, and collaborations between researchers and institutions. This approach allows researchers to understand the research landscape of didactic transposition comprehensively and identify areas that require further exploration. The use of software such as VOS viewer and RStudio in bibliometric analysis allows for more

effective data visualization. VOSviewer, for example, can be used to map collaboration networks between researchers or institutions, as well as identify the most frequently occurring keywords in publications related to didactic transposition. Meanwhile, RStudio can be used for more in-depth statistical analysis, such as publication trends over time or the geographical distribution of research.

By understanding the trends in didactic transposition research through bibliometric analysis, researchers and educators can identify gaps in the literature and determine future research directions. In addition, this analysis can help in identifying the most effective methods or approaches in implementing didactic transposition. The importance of didactic transposition research is also reflected in efforts to improve the overall quality of education. By understanding how scientific knowledge can be transformed into materials that can be taught and understood by students, educators can design more effective curricula and teaching strategies. This will ultimately improve students' understanding of the subject matter and their learning outcomes. In addition, bibliometric analysis of didactic transposition research can help in identifying collaborations between researchers and institutions. By knowing who is active in this field, opportunities for research collaboration can be increased, which in turn will enrich and expand the scope of didactic transposition research.

In a global context, understanding the trend of didactic transposition research is also important to ensure that educational practices in Indonesia are in line with international developments. Thus, educators and researchers in Indonesia can adopt and adapt best practices from various parts of the world to improve the quality of education in the country. Overall, this study is expected to contribute. The theme of didactic transposition is certainly interesting because several studies that have been written reveal the importance of didactic transposition in mathematics education. Research themes related to didactic transposition can be analyzed using bibliometrics. In addition, investigations into didactic transposition in

the field of mathematics education related to bibliometric analysis in scientific discourse in the last 10 years are still lacking. Bibliometrics, a statistical method used to evaluate and measure the development of publications in a particular research domain (Fellnhöfer, 2019; Khodabandelou et al., 2019).

Bibliometric analysis has demonstrated its efficacy as an indispensable instrument for examining research phenomena and progress in various academic fields and has recently gained increasing support for its potential to reduce subjectivity and associated bias (Jiang et al., 2019).

This study aims to provide substantive contributions to the intellectual community by providing insights for researchers to ponder, especially in the context of formulating research themes, with a particular focus on didactic transposition in mathematics education. Thus, it is expected to provide a comprehensive picture of the development of didactic transposition research, identify research gaps, and provide recommendations for future research. This analysis will focus on publications related to didactic transposition in the context of mathematics education, considering the importance of this concept in facilitating students' understanding of the material being taught.

This study has a novelty in mapping the research trend of didactic transposition in mathematics education using bibliometric analysis based on the Scopus database in the period 2014–2024, which has not been explored systematically before. By utilizing VOSviewer and RStudio software, this study not only identifies publication patterns, collaborations between researchers, and keyword trends, but also reveals research gaps that still receive minimal attention, especially in the application of didactic transposition to inequality material. The bibliometric approach used allows for a more comprehensive visualization of the research network, thus providing new insights into the development and direction of didactic transposition research at the global level. With the results obtained, this study is expected to be a basis for the

development of further research and provide recommendations for academics and education practitioners in optimizing teaching strategies based on didactic transposition.

METHOD

The methods described in this section are scientific in nature and should allow the reader to repeat the experiments that the researcher did (reproduced). Established methods can be explained by citing references. Published methods should be indicated by appropriate reference in the bibliography section. If there are relevant modifications, they should also be explained. In writing formulas and equations using equations accompanied by numbers as in formula (1).

The research method used is bibliometric analysis related to didactic transposition in mathematics education. Bibliometrics is the application of statistical and mathematical methods to books and other communication media (Karaboğa et al., 2020). The bibliometric analysis used is descriptive bibliometrics which describes the characteristics or features of a literature. Bibliometric analysis is used for various reasons, including revealing trends that emerge in articles and journals (Donthu et al., 2021). Bibliometrics as a methodology requires a methodical examination of data extracted from the bibliographic components of scientific publications, using rigorous quantitative analysis and using statistical methodology (B. U. Zan, 2019). The unit of analysis in this study is scientific articles. The data source, namely scientific articles on didactic transposition, was obtained from the Scopus database. The reason for choosing Scopus was determined purposively with many considerations such as its quality and reputation which have been recognized globally, which is known as a place to store high-quality scientific works that have gone through a peer-review process and are internationally recognized by both universities and research institutions.

The research design includes exploration, visualization, identification and verification phases that offer a path from the initial exploration of related articles to the

subsequent characterization of the clusters formed by the terms, based on their frequency of occurrence (Wang & Lu, 2020).

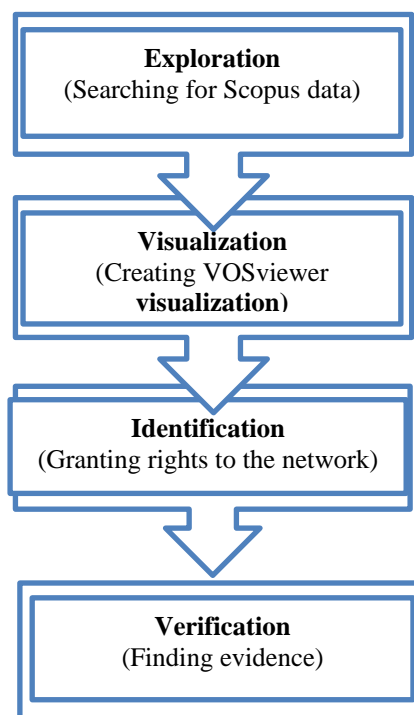


Figure 1. Research design of the current study

Data collection was conducted using the Scopus database with the keywords "transposition didactic" AND "mathematics" the initial search resulted in

409 documents. These documents then received secondary screening in the second step.

Table 1. Summary of Investigation Criteria

No	Criteria	Description
1	Data source	Scopus
2	Search term	"didactic transposition" AND "mathematics"
3	Publication period	2014-2024
4	Document type	Article
5	Language	English
6	Number of articles	409

Based on the results of the data search at this stage, there are 197 data that do not match the specified criteria. The next stage is 212 articles that continue to stage 3, namely the feasibility assessment. Then the data is stored in CSV format for use in

VOSviewer and Rstudio. In this third stage, the title and abstract are carefully checked. The final database of 76 articles and all are stored in CSV format for further bibliometric analysis.

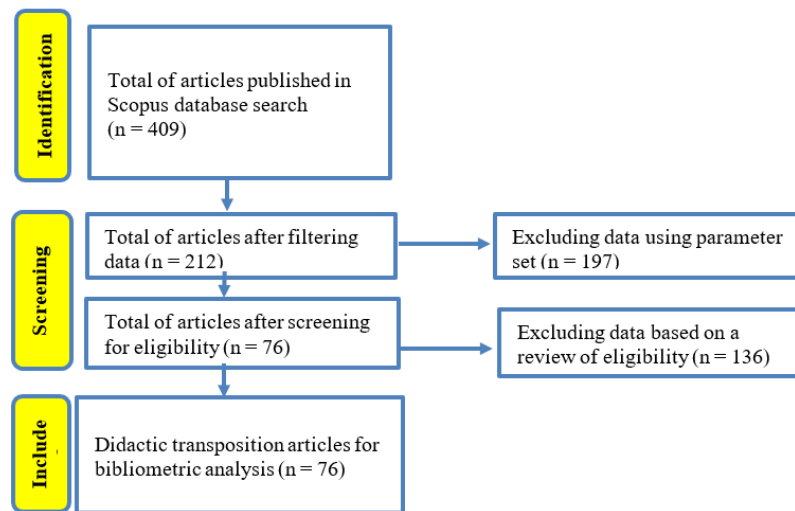


Figure 2. Preferred reporting items for systematic reviews and meta-analyses

Bibliometric analysis was carried out using the VOSviewer and RStudio applications, because these two software are very helpful in collecting, analyzing and visualizing bibliographic data (Guleria & Kaur, 2021). VOSviewer and RStudio are very popular and have characteristics in mapping various types of bibliometric analysis and support several major databases, using layout and cluster techniques; using advanced visualization features; using a visual labeling system; using overlay and density visualization. Following the criteria specified in the scope of this study, the data of 76 articles accessed from the Scopus database were transferred to the VOSviewer and RStudio software, the necessary bibliometric analysis was carried out and maps were created.

In this study, bibliometric analysis using RStudio was performed by utilizing the bibliometrix and biblioshiny packages. The bibliometrix package was used to perform quantitative analysis on scientific publications, including co-occurrence keyword analysis, source impact analysis, and country collaboration networks. The analysis was conducted using R scripts written specifically to process the CSV

dataset exported from Scopus. Visualization outputs, such as trend topics and thematic maps, were generated through biblioshiny, an interactive web interface of bibliometrix. The following steps were taken: data conversion using convert2df, analysis using biblioAnalysis and networkPlot, and visualization using plot and thematicMap functions.

These techniques enabled the identification of dominant research themes, collaborative trends among authors and institutions, and the evolution of key concepts over time. VOSviewer complemented this by mapping co-authorship networks and visualizing keyword clustering through overlay visualization. Both tools ensured analytical rigor and reproducibility of results, fulfilling the criteria of a robust bibliometric methodology.

RESULT AND DISCUSSION

Publication Distribution by Year

Based on a search using Scopus, using the keywords "didactic transposition" AND "mathematics" in the last 11 years from 2014 to 2024, 76 articles were obtained.

Table 2. Distribution of Articles related to Didactic Transposition from 2014 to 2024

No	Year	Number of Articles	Citable Years
1	2014	2	12
2	2015	7	11
3	2016	7	10
4	2017	6	9
5	2018	8	8
6	2019	3	7
7	2020	8	6
8	2021	6	5
9	2022	5	4
10	2023	9	3
11	2024	15	2
Total		76	77

The search using Scopus with the keywords "*didactic transposition*" and "*mathematics*" from 2014 to 2024 yielded 76 articles, showing a fluctuating trend with a notable increase in recent years, particularly in 2024, which recorded the highest number of publications (15 articles). Compared to previous studies, such as those conducted before 2014, where research on didactic transposition in mathematics education was relatively limited, the growing number of publications suggests an increasing academic interest in this area. For instance, earlier studies primarily focused on

theoretical foundations, while more recent research explores practical applications and adaptations in diverse educational contexts (Baran, 2014). The rise in publications, especially since 2020, may reflect a shift towards integrating didactic transposition with contemporary pedagogical frameworks, including digital learning environments and competency-based curricula. This pattern indicates that didactic transposition remains a relevant and evolving topic, continuously adapting to the needs of mathematics education research (Brousseau et al, 2020).

Distribution of publications by country

Country Scientific Production

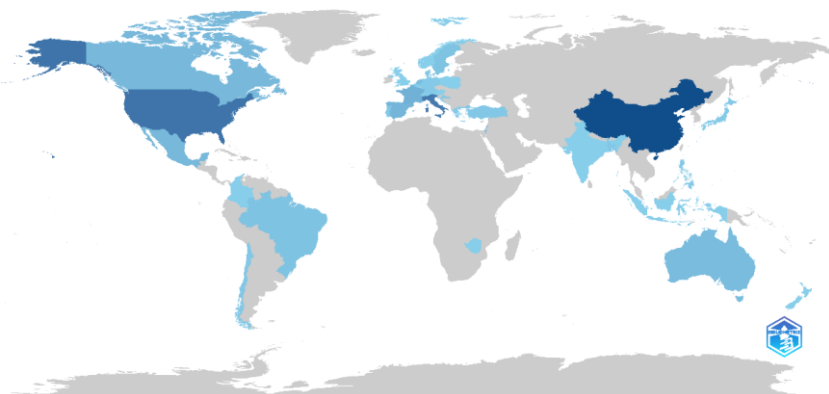


Figure 3. Distribution of articles related to didactic transposition by country

According to figure 3, the distribution of research articles on didactic transposition across various countries, as depicted in Figure 3, highlights significant regional

trends. China emerges as the leading contributor to didactic transposition research, indicated by the darkest blue color, suggesting a strong academic focus on this

area. This aligns with recent studies emphasizing China's growing engagement in mathematics education research and curriculum development (Bakker et al., 2021). Following China, the United States, France, Italy, and other countries such as Spain, India, Germany, and Brazil also show considerable contributions, albeit with a lower publication intensity. This trend reflects the global recognition of didactic

transposition as a critical theoretical framework in mathematics education (Biehler et al, 2024). However, countries like Indonesia exhibit relatively lower research output, indicating potential areas for further academic exploration and collaboration in integrating didactic transposition theories into local educational contexts (Solis & Isoda, 2023).

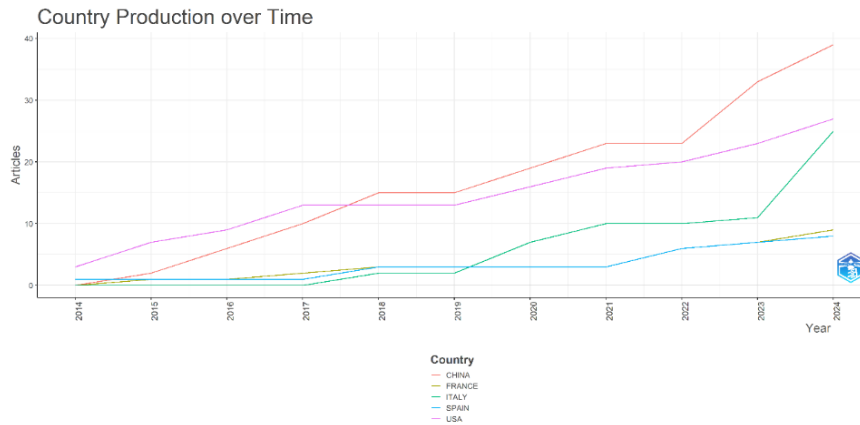


Figure 4. State Production related to Didactic Transposition

The data presented in Figure 4 highlights the leading countries in didactic transposition research in 2024, with China emerging as the most productive nation, contributing 11 articles. The United States follows with 6 articles, while Italy ranks third with 5 publications. Spain, with 3 articles, holds the fourth position. The increasing number of publications from these top five countries since 2014 indicates a growing academic focus on didactic transposition, likely driven by the need for innovative approaches in mathematics education (Scopus, 2024). This trend aligns with previous studies (Chevallard, 1985;

Bosch & Gascón, 2006), which emphasize the theoretical evolution of didactic transposition. China's dominance in publication output suggests strong institutional support and research funding in mathematics education, while the steady contributions from the USA, Italy, and Spain indicate sustained interest and application of didactic transposition in different educational settings. This upward trend underscores the global relevance of the topic and highlights potential areas for further research collaboration among countries with lower publication outputs.

Distribution of publications by source

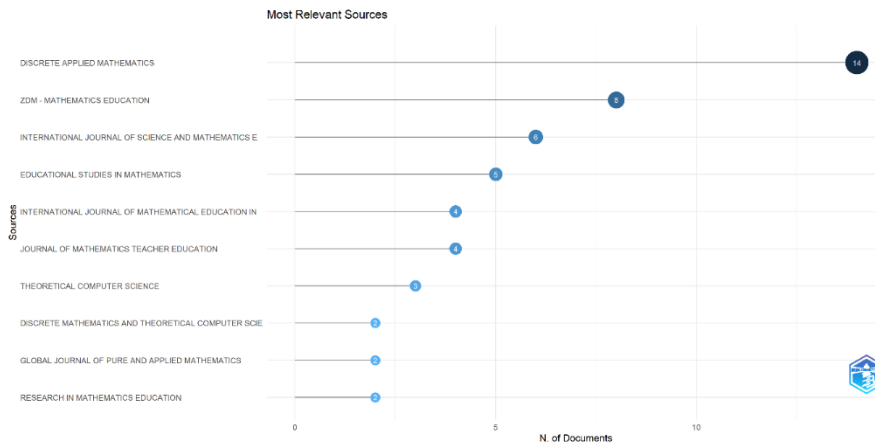


Figure 5. Production of Sources Related to Didactic Transposition

The distribution of sources for articles related to didactic transposition highlights the significant role of key academic journals in disseminating research in this field. *Discrete Applied Mathematics* emerges as the leading publication source with 14 articles, followed by *ZDM – Mathematics Education* with 8 articles, and the *International Journal of Mathematics Education* with 6 articles. These journals are well-regarded for their contributions to mathematical literacy and education research, reflecting the interdisciplinary nature of didactic transposition studies. The prominence of *Discrete Applied Mathematics* suggests a strong connection between didactic transposition and applied mathematical concepts, while *ZDM – Mathematics Education* and the *International Journal of Mathematics Education* indicate a growing interest in pedagogical perspectives and instructional strategies. This distribution underscores the

expanding academic engagement with didactic transposition across both theoretical and applied domains, reinforcing its relevance in contemporary mathematics education research (Saralar & Schoenberg, 2024).

Co-occurrence of author keywords

Data from Scopus is stored in CSV format which is then used in VOSviewer software to obtain bibliometric analysis results. After the CSV data is entered into the VOSviewer software, 483 terms are obtained with 9 closest terms. By selecting the minimum number of occurrences of repeated words used is 3 terms, this study uses three visualization schemes to analyze mapping, namely network visualization, overlay visualization, and density visualization. In network visualization, the relationship between terms is represented as a connection or line connecting one term to another. a display is obtained as in figure 6.

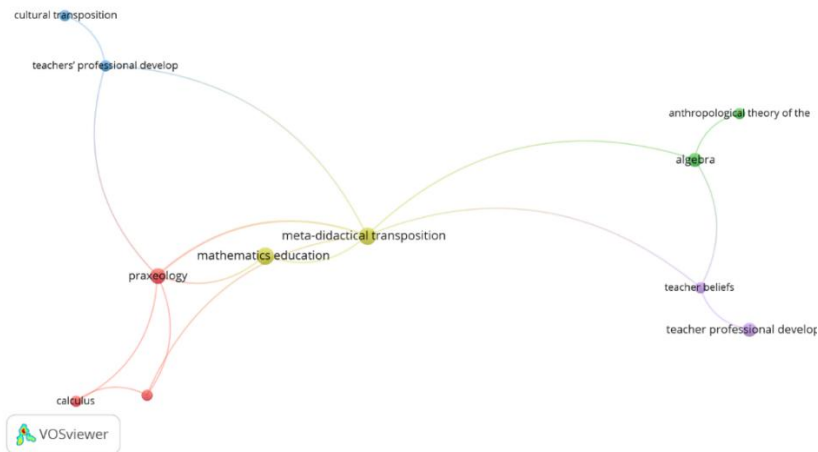


Figure 6. Co-occurrence of Author Keywords (Network Visualization)

The results of the Circles Network Visualization software VOSviewer in the Figure show that there are 5 clusters consisting of 11 themes related to didactic transposition in mathematics education, namely: (1) Cluster 1 (red) consists of 3 themes, namely: praxiology, calculus, mathematics teacher education; (2) Cluster 2 (green) consists of 2 themes, namely: algebra, anthropology of theory didactic; (3) Cluster 3 (blue) consists of 2 themes, namely: teacher professional develop, cultural transposition; (4) Cluster 4 (yellow) consists of 2 themes, namely meta didactic transposition, mathematics education and (5) Cluster 5 (purple) consists of 2 themes, namely teacher belief, teacher professional develop.

The existence of five clusters in the analysis shows that cluster 1 and cluster 2

have the largest number of items, indicating that the themes in these clusters have received great attention from researchers. In Figure 6, the lines connecting the terms indicate the relationship between concepts, where each node (circle or circle) represents a keyword, while the edges (connecting lines) describe the relationship between pairs of nodes. The circles are distinguished by unique labels, colors, and sizes that reflect the level of relationship and frequency of occurrence of terms in research titles and abstracts. This network visualization provides a clearer understanding of the relationships between concepts, but also reveals that there are a number of relationships that are still minimally explored, opening up great opportunities for further research in this field.

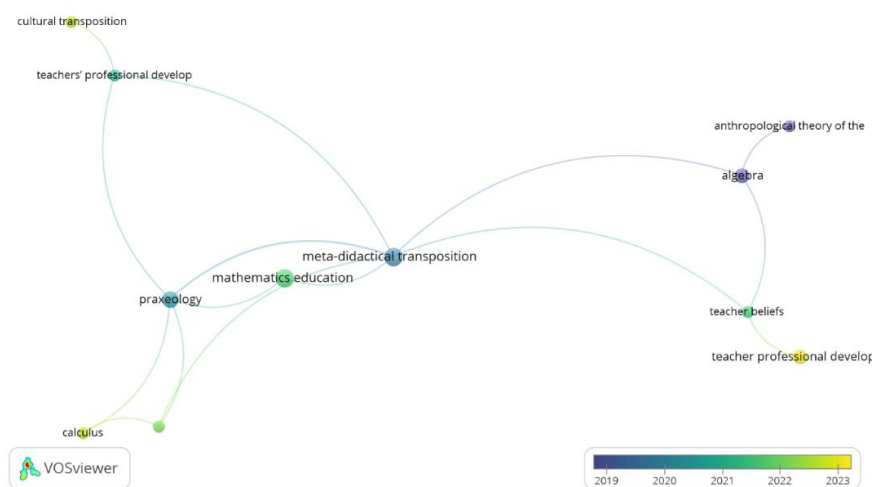


Figure 7. Frames Overlay Visualization software

The results of Frames Overlay Visualization of VOSviewer software in Figure 7 show the trend of article writing themes in Scopus indexed journals based on the year. The trend of article writing themes related to mathematical literacy in mathematics education from the oldest to the newest year is marked by the themes in purple, blue, turquoise, dark green, light

green and yellow. This means that the themes of "teacher belief", "teachers professional develop", "praxeology", "calculus" in light green and "teachers professional develop" in yellow are the latest themes related to didactic transposition in mathematics education. These themes can be a reference for further research.

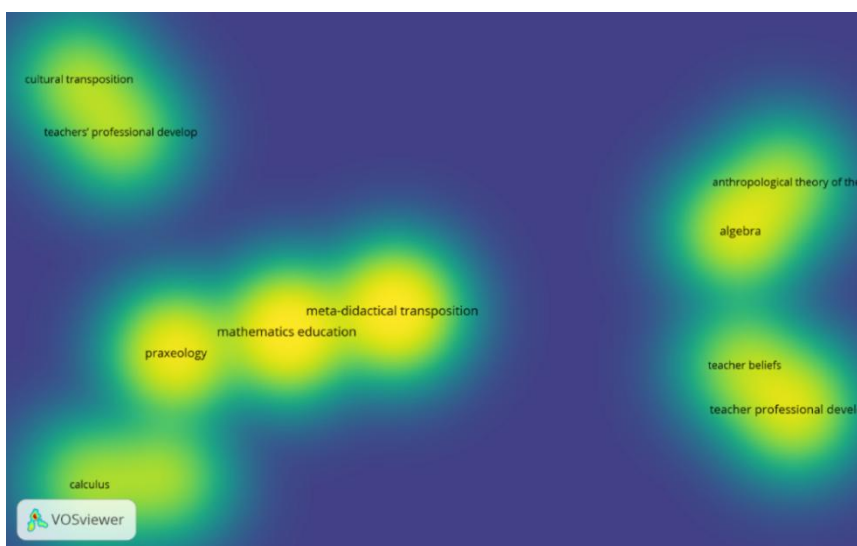


Figure 8. Source Bibliography Coupling (Density Visualization)

The results of Density Visualization of VOSviewer software in Figure 8 show density. The density of the research theme is shown in bright yellow. The brighter the color of a theme, the more research has been done. The dimmer the color, the less

researched the theme. Dimly colored themes such as "Anthropology of theory didactic", "algebra", "culture transposition" and "calculus" are themes that can be used as references for further research because the research is still small or few.

The bibliometric analysis using VOSviewer software provides a comprehensive overview of the research landscape on didactic transposition in mathematics education. The analysis identifies five distinct clusters, each representing key themes in the field. Notably, praxeology, calculus, and mathematics teacher education, as well as algebra and the anthropology of theory didactic, emerge as the most prominent themes, indicating significant academic interest in these areas (Abou-Hayt, 2024). The relationships between these terms highlight the interconnectedness of concepts within didactic transposition, reinforcing established research areas while also revealing gaps that present opportunities for further exploration (Bosch et al, 2020). The analysis of thematic trends over time further indicates a shift in focus toward teacher belief and professional development as more recent areas of interest. This evolution suggests a growing emphasis on the role of educators in adapting and implementing didactic transposition within mathematics instruction (Chevallard & Bosch, 2020). Such a trend aligns with contemporary educational reforms that prioritize teacher agency in curriculum development and instructional design (Pak et al, 2020; Choppin & Borys, 2017). In terms of research density, some topics have been extensively explored, while others remain underrepresented. Highly researched themes contrast with less-examined topics such as the anthropology of theory didactic, algebra, cultural transposition, and calculus, which appear to offer promising directions for future studies. The identification of these underexplored areas highlights the evolving nature of research in didactic transposition and underscores the need for continued investigation to bridge theoretical and practical gaps in mathematics education.

Although some themes such as praxeology and teacher professional development show high research density, other themes such as cultural transposition and gaps still appear dim in the density visualization. The lack of exploration on these themes may be due to limited local perspectives or the lack of integration of

contextual approaches in international research. In developing countries such as Indonesia, cultural and educational issues play a significant role in the process of didactic transposition, but have not been widely explored in global literature. Therefore, it is important for researchers in Indonesia to start raising these issues so that the results of didactic transposition are more relevant and applicable in the local educational context.

CONCLUSION

This study analyzed 76 Scopus-indexed articles published between 2014 and 2024 using the keywords "didactic transposition" and "mathematics", utilizing VOSviewer and RStudio for bibliometric mapping. The results show a significant increase in publications over the past decade, with China emerging as the most productive country and journals such as *Discrete Applied Mathematics*, *ZDM – Mathematics Education*, and the *International Journal of Mathematics Education* playing key roles in disseminating research. The keyword co-occurrence analysis reveals several dominant themes, including *praxeology* and *teacher professional development*. However, themes such as *cultural transposition*, *algebra*, and *calculus* remain underexplored. This underrepresentation may stem from the complexity of integrating sociocultural dimensions into didactic frameworks or the lack of localized research perspectives. In contexts like Indonesia, where cultural and systemic diversity significantly shapes the teaching and learning process, these less-researched themes are highly relevant. Thus, future studies should not only aim to bridge theoretical gaps but also address practical implications for local educational systems, highlighting the need for more context-sensitive applications of didactic transposition in mathematics education.

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AUTHOR CONTRIBUTIONS

Author one: Conceptualization, writing - original draft, editing, and visualization;

Author two: Writing - review & editing, formal analysis, and methodology;

Author three: Editing, Validation and supervision.

Author four: Editing, Validation and supervision.

Author five: Validation and supervision.

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