Mapping Research Trends on Mathematics Learning Motivation: A Bibliometric Analysis Using VOSViewer

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ABSTRACT

Mathematics learning motivation is one of the crucial factors influencing students' success in understanding concepts and improving learning outcomes. This study aims to map the development of research on mathematics learning motivation through bibliometric analysis using the VOSViewer software. The data were obtained from 100 publications downloaded from the App.Dimensions database with the keyword "mathematics learning motivation" within the 2020–2025 period. The research process involved identification, selection, validation, and data analysis based on research type, learning tools, learning models, educational levels, and class groupings. The analysis results indicate three main clusters: issues of low learning outcomes associated with the RME approach, problem-solving strategies through problem-based learning (PBL), and global trends highlighting students' motivation and engagement. Overall, research is more dominantly conducted using quantitative methods and classroom action research (CAR), with the use of teaching materials, media/applications, and student worksheets (LKPD) as the primary learning tools. Cooperative and collaborative models are the most frequently applied strategies, with the majority of studies focusing on junior and senior high school levels. In contrast, early childhood, elementary, and higher education levels are still rarely explored. These findings emphasize the importance of expanding research to early and higher education levels, as well as developing innovative learning tools and models to support the sustainable improvement of mathematics learning motivation.

ABSTRAK

Motivasi belajar matematika merupakan salah satu faktor penting yang memengaruhi keberhasilan siswa dalam memahami konsep dan meningkatkan hasil belajar. Penelitian ini bertujuan untuk memetakan perkembangan kajian tentang motivasi belajar matematika melalui analisis bibliometrika dengan bantuan

perangkat lunak VOSViewer. Data penelitian diperoleh dari 100 literatur yang diunduh dari basis data App.Dimensions dengan kata kunci "motivasi belajar matematika" pada rentang tahun 2020–2025. Proses penelitian mencakup identifikasi, seleksi, validasi, serta analisis data berdasarkan jenis penelitian, perangkat pembelajaran, model pembelajaran, jenjang pendidikan, dan pengelompokan kelas. Hasil analisis menunjukkan adanya tiga kluster utama, yaitu isu rendahnya hasil belajar yang dikaitkan dengan pendekatan RME, strategi pemecahan masalah melalui problem-based learning (PBL), serta tren global yang menyoroti aspek motivasi dan keterlibatan siswa. Secara umum, penelitian lebih dominan menggunakan metode kuantitatif, PTK, serta memanfaatkan bahan ajar, media/aplikasi, dan LKPD sebagai perangkat pembelajaran. Model kooperatif dan kolaboratif menjadi strategi yang paling sering digunakan, dengan fokus penelitian terbanyak pada jenjang SMP dan SMA/SMK. Sebaliknya, jenjang PAUD, SD, dan perguruan tinggi masih jarang diteliti. Temuan ini menegaskan pentingnya memperluas eksplorasi ke jenjang pendidikan awal dan tinggi, serta mengembangkan perangkat dan model pembelajaran inovatif untuk mendukung peningkatan motivasi belajar matematika secara berkelanjutan.

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INTRODUCTION

Mathematics learning motivation is a key factor in determining students' success in understanding concepts, solving problems, and improving academic achievement. Many studies have shown that high motivation can help students overcome learning difficulties and reduce the tendency to give up when encountering obstacles (Alam et al., 2025). In the context of mathematics learning, motivation plays an essential role, as this subject is often perceived as difficult and intimidating by most students (Heryuriani et al., 2025). Not a few students experience anxiety or even avoid mathematics because they feel less capable. Therefore, studies on mathematics learning motivation need to be conducted more deeply to identify effective strategies for improving it, so that mathematics can be perceived more positively and become more approachable for students.

Along with the development of educational science, various learning models have been applied to support the enhancement of student motivation. Cooperative and collaborative learning models, for instance, have been proven to encourage students' active engagement in the learning process, thereby increasing their intrinsic motivation (Saleh et al., 2025). Through group work, students learn to interact, help each other, and construct shared understanding, which can foster self-confidence in facing mathematical content. In addition, the problem-based learning (PBL) approach has been shown to be effective in fostering curiosity and critical

thinking skills, which ultimately has a positive impact on mathematics learning motivation (Park et al., 2022). Nevertheless, studies on the effectiveness of learning models in relation to motivation still need to be systematically mapped so that educators can choose the most suitable strategies based on students' needs and characteristics.

In addition to learning models, instructional tools also play an important role in building students' motivation. Technology-based learning media, student worksheets (LKPD), and interactive teaching materials have been shown to increase learning interest and make students more enthusiastic in learning mathematics (Sadiyah et al., 2025). The presence of innovative instructional tools allows students to understand abstract concepts in a more concrete and engaging way. Furthermore, innovations such as comics and educational games are increasingly being used to reduce the rigid impression of mathematics learning and make it more enjoyable (Masjudin et al., 2024). However, research distribution that discusses various instructional tools remains uneven across educational levels. Therefore, bibliometric mapping is required to identify how far this topic has developed and to determine which areas still lack research attention.

From the perspective of educational levels, studies on mathematics learning motivation have tended to focus more on junior and senior high schools, while early childhood education, elementary schools, and higher education remain underexplored (Astiwi et al., 2024). In fact, learning motivation at an early age is crucial in shaping students' initial attitudes toward mathematics, while at the higher education level, motivation plays a vital role in guiding students to develop creativity and critical thinking (Harahap et al., 2025; Rochmat et al., 2025). The scarcity of research in these levels may hinder a comprehensive understanding of how motivation develops throughout the educational process (Siswanto et al., 2023). If this aspect is neglected, there may be gaps in motivational strategies across educational stages. This indicates the existence of a research gap that needs to be addressed to generate more comprehensive and continuous studies.

The bibliometric method has emerged as a relevant approach to map the development of research on mathematics learning motivation. Through bibliometric analysis, researchers can identify publication trends, thematic clusters, and research distribution based on learning models, instructional tools, and educational levels (Niza et al., 2023). With the assistance of software such as VOSViewer, such mapping can be visualized, providing a clearer picture of the direction and density of research within a given period (Perez et al., 2023). This type of analysis can also reveal relationships between research topics, identify saturated areas, and open new opportunities for underexplored research fields. Thus, bibliometrics is not only descriptive but also strategic in guiding the development of future studies.

METHOD

This study employed a bibliometric approach using VOSViewer software to map the development of research on mathematics learning motivation. The research data were obtained from 100 publications sourced from the App.Dimensions database using the keyword "mathematics learning motivation". The research procedure included the stages of identification, selection, and analysis of publications based on research type, instructional tools, learning models, educational levels, and class groupings. Visualization analysis consisted of

three forms: network visualization to examine the relationships among topics, overlay visualization to identify the development of research trends, and density visualization to observe the concentration of research themes. Quantitative data were processed to obtain the frequency distribution of each category, while qualitative analysis was conducted to interpret the relationships among clusters and research trends.

The stages of data analysis techniques were as follows: (1) mapping RIS data files from Mendeley Desktop chronologically based on year, author, and publisher; (2) mapping bibliometric network visualizations and scientific publication trends using VOSViewer (Visualization of Similarities) based on the number of clusters and items; and (3) mapping research topics through literature review studies. A total of 100 publications were retrieved from App.Dimensions, supported by Google Scholar, from 2020–2025 by searching for the title word "mathematics" and the keyword "learning motivation", with a maximum of 100 journals selected. Data validation was conducted by checking titles and abstracts. Furthermore, URLs of each publication were verified, and bibliographic data were re-examined using Mendeley. To map the relationship between publication themes and authors, data analysis was conducted using VOSViewer software, which assists users in effectively and efficiently visualizing and analyzing publication data (Naufal et al., 2025). The 100 selected journals were then grouped into five categories: research type, instructional tools, learning models, educational levels, and class levels.

RESULTS AND DISCUSSION

The visualization results generated by VOSViewer software on the research development map revealed several clusters and topic items in the mapping, as follows.
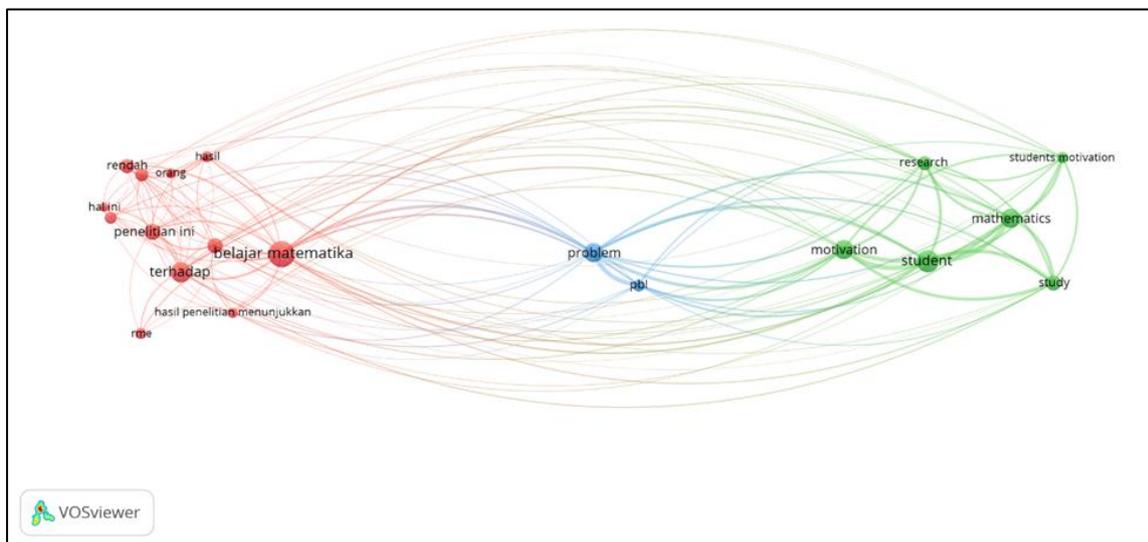

Figure 1. Network Visualization Map of Mathematics Learning Motivation

Based on the visualization results from VOSViewer, it can be concluded that research on mathematics learning motivation is divided into three main interconnected clusters. The red cluster focuses on the topic of "learning mathematics", which is closely related to issues of low learning outcomes, research findings, and the RME approach. The blue cluster highlights the themes of "problem" and "PBL", which serve as a bridge between learning challenges and

problem-solving strategies. Meanwhile, the green cluster emphasizes global themes such as "motivation", "students", "study", and "mathematics", reflecting the latest research trends. The inter-cluster relationships indicate that the issue of mathematics learning motivation is considered essential in linking learning problems with efforts to improve outcomes through innovative models and strategies.

Figure 2 illustrates the Frames Overlay Visualization Study on mathematics learning motivation, providing a clearer picture of thematic trends in journal articles retrieved from the App.Dimensions database.
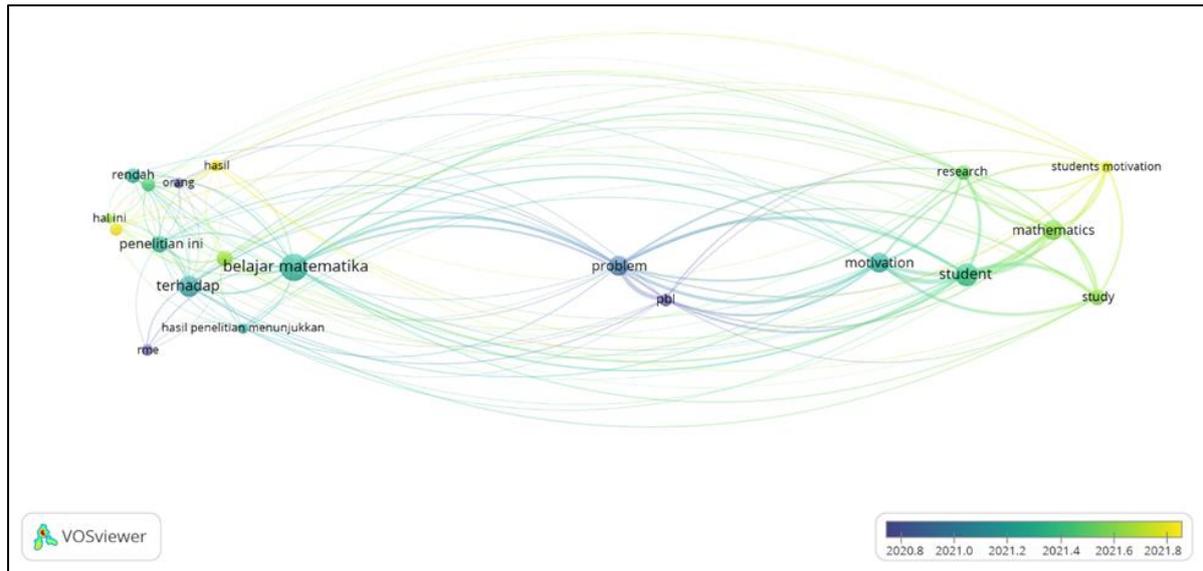

Figure 2. Frames Overlay Visualization Study on Mathematics Learning Motivation

Based on the overlay visualization from VOSViewer, it can be concluded that research trends on mathematics learning motivation have undergone significant development from 2020 to 2021. Initially, studies were more focused on themes such as "learning mathematics", "this research", and "problem". However, over time, the focus shifted toward more recent themes such as "students motivation", "study", "student" and "mathematics," which are indicated by yellow-green colors. This shift reflects a change in research orientation from merely describing learning problems toward studies that place greater emphasis on student motivation and global perspectives. Consequently, this opens opportunities to further explore motivation within the broader and more innovative context of mathematics learning. The most frequently studied themes are illustrated in Figure 3.
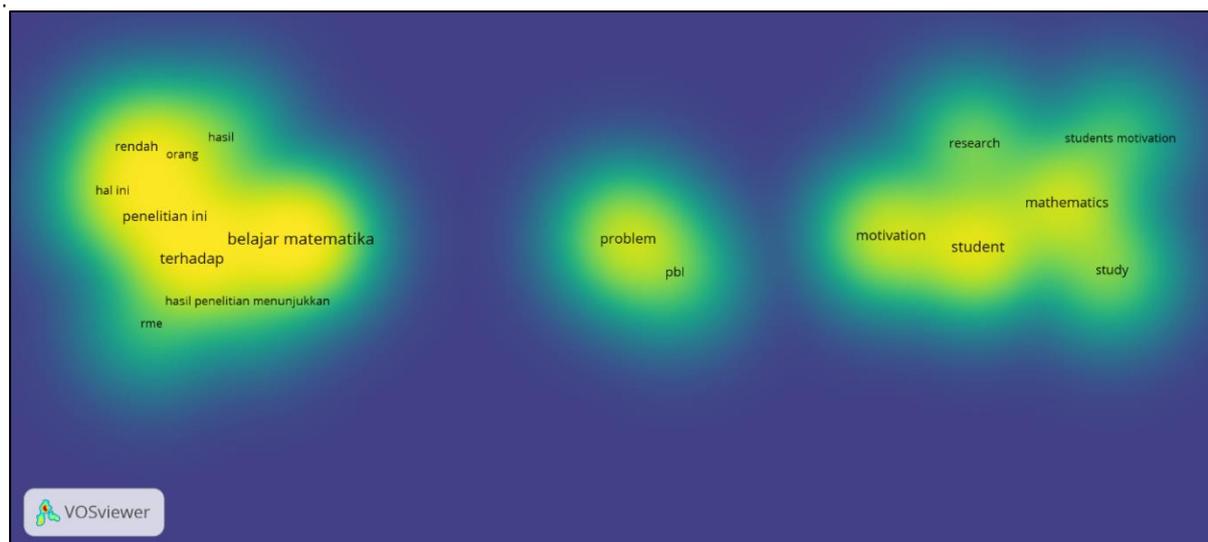
Figure 3. Density Visualization of Mathematics Learning Motivation with Other Topics

Based on Figure 3, the density visualization illustrates the intensity or concentration of the themes studied. Bright yellow indicates high-density themes, where a greater brightness represents a larger number of studies conducted on that particular theme. Conversely, dimmer colors signify that the theme has been less frequently explored. It can be observed that "motivation", "learning mathematics", and "problem" are themes that may serve as references for future research.

In this bibliometric analysis, a total of 100 research articles on mathematics learning motivation were obtained. The number of articles was derived from searches focusing on studies related to mathematics learning motivation, which were subsequently mapped based on research type, learning tools, instructional models, educational levels, and class distribution. The distribution of literature mapped according to the types of research on mathematics learning motivation is presented in table 1.

Table 1. Types of Research in the Literature Distribution

Research	Lots of Literature
Quantitative	37
Qualitative	26
CAR	24
Digital camera development	5
Mixed	5
Research	3

Based on Table 1, it can be observed that 37 studies employed a quantitative research design, 26 studies utilized qualitative research, 24 studies applied classroom action research (CAR), 5 studies adopted development research, 5 studies implemented systematic literature review (SLR), and 3 studies used a mixed-methods approach. The distribution of the collected literature based on the learning tools employed in mathematics learning motivation is presented as follows.

Table 2. Distribution of Literature with a Focus on Learning Tools

Learning tools									
	Module	Worksheets	Media/App	Comic	Video	Teaching Materials	Game	Posters/Pictures	Not Mentioned
Motivation to Learn Mathematics	-	17	21	-	3	22	6	1	30

Based on Table 2, it can be observed that none of the studies employed modules, 17 studies utilized student worksheets, 21 studies made use of media or applications, none applied comics, 3 studies employed videos, 22 studies used teaching materials, 6 studies adopted games, 1 study incorporated posters or images, and 30 studies did not specify the learning tools used. The distribution of literature according to the learning models employed in studies on mathematics learning motivation is presented as follows.

Table 3. Distribution of Literature with a Focus on Learning Models

Learning Models	Lots of Literature
PBL	3
Contextual	7
RME	7
R&D	5
Discovery Learning	4
Quantum	2
Scientific	-
Collaborative	11
Cooperative	15
Not Stated	43
Structural Equation Modeling	1
Hypnoteaching	2

Based on Table 3, it is evident that cooperative learning models (15 studies) and collaborative learning models (11 studies) are the most frequently employed, indicating that strategies grounded in cooperation and social interaction are considered effective in enhancing students' motivation. Other models, such as contextual learning and Realistic Mathematics Education (RME), were each applied in 7 studies, while Discovery Learning, Problem-Based Learning (PBL), and Research and Development (R&D) appeared in more limited numbers. Interestingly, 43 studies did not specify the learning model applied, suggesting a lack of clarity or exploration of models in a considerable portion of the literature. This highlights the need for further research that explicitly examines the effectiveness of specific learning models in improving mathematics learning motivation. The distribution of literature based on educational levels in studies on mathematics learning motivation is presented as follows.

Table 4. Distribution of Literature with a Focus on Educational Levels

Educational level						
PAUD	SD	SMP	SMA/SMK	PT	SLB	Not

							Mentioned
Motivation to Learn Mathematics	1	29	30	25	2	-	13

Based on Table 4, it can be observed that 1 study examined learning motivation at the early childhood education (PAUD) level, 29 studies focused on elementary school (SD), 30 studies on junior high school (SMP), 25 studies on senior high school/vocational school (SMA/SMK), and 2 studies on higher education. No studies were found that addressed learning motivation in special education (SLB), while 13 studies did not specify the educational level under investigation. Learning motivation plays a crucial role in driving students' learning processes and achieving quality education. Furthermore, the grouping of studies based on class level was carried out, and the results are presented in the following table.

Table 6. Distribution of Literature with a Focus on Class Grouping

Class Grouping																
	1	2	3	4	5	6	7	8	9	7-9	10	11	12	10-12	PT	Not Mentioned
Motivation to Learn Mathematics	-	2	5	9	8	1	8	13	5	2	11	7	4	2	2	21

Based on the distribution of research on mathematics learning motivation across different grade levels, it can be observed that most studies were conducted at unspecified levels (21 studies), followed by Grade 8 (13 studies) and Grade 11 (11 studies), while Grade 4 and Grade 7 also received considerable attention. In contrast, early grades such as Grade 1 had no related studies, and Grade 6 as well as higher education (HE) were represented by only 1 and 2 studies, respectively. These findings indicate that research on mathematics learning motivation tends to focus more on middle-level education, particularly junior and senior high schools, while early education and higher education remain relatively underexplored. This gap highlights the need for further research at underrepresented educational levels. All the reviewed literature specifically examined issues related to mathematics.

Discussion

The bibliometric analysis of mathematics learning motivation revealed three interconnected main clusters. The red cluster emphasizes mathematics learning issues related to low achievement, which previous studies have also identified as a major challenge in improving student performance (Janse & Rauscher, 2022). The blue cluster highlights the role of problem-based learning (PBL) as a relevant problem-solving strategy, aligning with the findings of Efendi et al. (2025) and Yurt (2025), who confirmed that PBL enhances both students' motivation and critical thinking skills. Meanwhile, the green cluster underscores global issues such as "motivation", "students", and "mathematics", reflecting the current trajectory of research. This is consistent with Kintoko et al. (2025) and Wibowo et al. (2025),

who noted a shift in research focus toward the development of motivation and student engagement in mathematics learning.

The overlay visualization further strengthens these findings, showing a shift in research focus from merely describing the issue of low learning motivation (2020–2021) toward more comprehensive examinations of student motivation. This trend is consistent with Cevikbas & Kaiser (2022) and Fitriana et al. (2025), who found that recent studies place greater emphasis on strengthening students' intrinsic motivation in mathematics. This shift illustrates an academic awareness of the need not only to diagnose problems but also to develop strategies that provide practical solutions. Thus, future research should focus more on innovative teaching practices that can sustainably enhance motivation.

The density visualization indicates that "motivation", "learning mathematics", and "problem" are relatively dense topics in research. Previous studies, such as Hairuddin et al. (2016) and Khotami et al. (2023), affirmed that learning motivation is a key factor influencing mathematics achievement, while low academic outcomes are often linked to weak motivation. Hence, further research on the interplay between motivation and learning challenges remains highly relevant. Moving forward, exploration could be directed toward strengthening motivational factors through innovative learning models tailored to students' contexts.

The analysis of research methods reveals a dominance of quantitative (37 studies) and qualitative (26 studies) approaches, with classroom action research (CAR) also widely employed (24 studies). These findings are consistent with Amalia et al. (2025) and Muthmainnah et al. (2022), who observed that studies on mathematics learning motivation are often conducted using quantitative designs to measure variable relationships and CAR to improve classroom practices. However, research on development (R&D) and systematic literature review (SLR) remains relatively limited, suggesting opportunities to strengthen theoretical foundations and diversify innovations in instructional tools.

In terms of learning tools, the majority of studies employed teaching materials (22 studies), media/applications (21 studies), and student worksheets (LKPD) (17 studies). This aligns with Restianingrum & Isnawati (2023) and Welerubun et al. (2022), who found that interactive teaching materials and contextual LKPD effectively enhanced student motivation. Nevertheless, the use of tools such as modules, comics, or visual media remains scarce, despite Putri et al. (2025) and Siswanto & Peni (2023) demonstrating that comic-based media can significantly increase interest in learning mathematics. Therefore, opportunities remain for exploring more creative and varied instructional tools to foster motivation.

The distribution of learning models highlights cooperative (15 studies) and collaborative (11 studies) models as dominant choices, reaffirming the importance of teamwork in enhancing mathematics learning motivation. This is consistent with Septiany et al. (2024), who confirmed that collaboration-based models promote students' intrinsic motivation through active social interaction. Furthermore, research distribution by educational level shows that junior high school (30 studies) and senior high/vocational school (25 studies) dominate, while early childhood, elementary, and higher education levels are rarely studied. In line with Groenewald et al. (2023) and Saputra et al. (2025), this indicates the need for more research at PAUD, SD, and higher education levels to gain a comprehensive understanding of mathematics learning

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motivation across the educational spectrum. Future studies are therefore expected to enrich perspectives and strategies for strengthening motivation in broader contexts.

CONCLUSION

Based on the bibliometric analysis, it can be concluded that research on mathematics learning motivation has experienced significant development, marked by three main clusters: low learning achievement, problem-based learning (PBL) strategies, and global trends in student motivation. The analysis also highlights the dominance of quantitative methods and classroom action research, as well as the frequent use of teaching materials, media/applications, and LKPD as learning tools. Cooperative and collaborative models are the most widely adopted strategies. However, research at early childhood, elementary, and higher education levels remains limited, and innovative tools such as comics, modules, or visual media are rarely explored. Therefore, future studies should broaden their focus to underrepresented educational levels and develop more creative and contextual learning tools and models, ensuring that mathematics learning motivation can be sustainably and comprehensively enhanced.

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