

# Mapping self-regulated learning research in mathematics education for quality education: A bibliometric analysis (2016–2025)

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| <b>ABSTRACT</b><br><b>Background:</b> Although Self-Regulated Learning (SRL) has been extensively studied in mathematics education, existing studies primarily report empirical findings, while the intellectual structure, thematic evolution, and emerging research directions of the field remain insufficiently synthesized. This limitation hinders a comprehensive understanding of research development and future priorities.<br><b>Aims:</b> This study aims to analyze trends in publications and citations, the most influential authors and journals, co-occurrence patterns of keywords, temporal trends in research topics, and the density of research topics related to SRL in mathematics education to support Quality Education.<br><b>Methods:</b> A quantitative bibliometric approach was employed using the Dimensions database. Publications published between 2016 and 2025 were retrieved using the keywords "Self-Regulated Learning" and "Mathematics Education." Of the 181 records identified, 91 journal articles met the predefined inclusion criteria and were analyzed using VOSviewer (version 1.6.20). Performance analysis was conducted to examine publication and citation trends, while science mapping using co-occurrence, overlay, and density visualizations identified the intellectual structure and thematic development of the field.<br><b>Result:</b> The results indicate that publications and citations related to SRL in mathematics education have increased during the 2016–2025 period. Furthermore, Tatang Herman and Dadang Juandi were the authors with the highest number of publications three each while the Journal of Physics: Conference Series was the journal with the highest number of publications, totaling six. Co-occurrence analysis identified three interconnected research clusters dominated by motivation, achievement, self-efficacy, engagement, feedback, and learning environment. Overlay visualization revealed a shift from studies emphasizing individual learner characteristics toward technology-supported learning, instructional frameworks, and learning environments. Density visualization showed that achievement, engagement, feedback, and quantitative empirical approaches remain the most intensively studied themes.<br><b>Conclusion:</b> This study advances current understanding by identifying emerging themes and research gaps in SRL within mathematics education. The findings provide evidence-based directions for future research integrating pedagogical, psychological, and technological perspectives, while informing the design of innovative mathematics learning.<br>To cite this article:<br>Fadillah, N., Nastiti, K. V., Putri, N. N., Putri, M. S., & Minadja, A. W. S. (2026). Mapping self-regulated learning research in mathematics education for quality education: A bibliometric analysis (2016–2025). <i>Interdisciplinary Journal of Pedagogy and Research in Media Technology</i> , 2(1), 45-57. | <b>ARTICLE HISTORY</b><br>Submitted: February 08, 2026<br>Accepted: April 27, 2026<br>Published: June 30, 2026<br><br><b>KEYWORD</b><br>Bibliometric Analysis;<br>Mathematics Education;<br>Quality Education;<br>Self-Regulated Learning. |
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## INTRODUCTION

Quality mathematics education remains a major challenge in many countries because mathematical competence forms the foundation for critical thinking, problem-solving, and decision-making skills (Asmaarobiyah et al., 2025). Numerous studies have reported that students continue to experience difficulties in understanding mathematical concepts, demonstrate low learning motivation, and struggle to regulate their learning processes independently (Suhartono et al., 2024). As a result, mathematics learning outcomes remain unsatisfactory, posing a significant obstacle to achieving Sustainable Development Goal (SDG) 4 on Quality Education (Fadil et al., 2023). These conditions indicate that improving mathematics education cannot rely solely on cognitive interventions but also requires strengthening students' self-regulatory capacities throughout the learning process (Ramansyah & Arif,

2025). This need highlights the importance of developing a comprehensive understanding of the knowledge structure surrounding Self-Regulated Learning (SRL) in mathematics education.

SRL is generally defined as students' ability to plan, monitor, control, and evaluate their own learning processes in order to achieve academic goals (Mahrufah & Rijanto, 2024). However, the role of SRL in mathematics education cannot be equated with its function in other disciplines because mathematics requires systematic thinking, appropriate problem-solving strategies, and continuous reflection throughout each stage of the solution process (Bangun et al., 2026). The hierarchical and procedural nature of mathematics makes self-regulation not merely a supporting factor but an integral component of mathematical thinking itself. Failure to regulate learning strategies at one stage often leads to conceptual errors in subsequent stages. Students with higher levels of SRL generally demonstrate stronger problem-solving abilities, mathematical reasoning, mathematical literacy, learning motivation, and academic achievement than those with lower levels of SRL (Juniari et al., 2021). Nevertheless, existing studies remain predominantly correlational and tend to conceptualize SRL as a generic construct rather than examining how self-regulatory processes operate across different phases of mathematical thinking. Consequently, SRL should be understood within the specific cognitive demands of mathematics instead of being adopted uniformly from other academic disciplines.

Growing recognition of the importance of SRL has led to a substantial increase in publications investigating its relationship with mathematics achievement, problem-solving, mathematical reasoning, learning motivation, and mathematical literacy (Sholiha et al., 2022). Although this expanding body of literature reflects the increasing significance of SRL in mathematics education, it has also become widely dispersed across various themes, constructs, and research contexts. Such fragmentation makes it difficult to obtain a comprehensive understanding of the overall knowledge structure within this field. Therefore, a systematic and quantitative approach is needed to identify publication patterns rather than merely synthesizing previous findings narratively (Ritmayanti et al., 2025). Bibliometric analysis provides an appropriate methodological approach because it enables researchers to identify publication trends, collaboration networks, and emerging as well as established research themes based on objective publication data (Yekti & Patmaningrum, 2026). Compared with conventional literature reviews, bibliometric analysis offers a more comprehensive overview of the development and intellectual structure of SRL research in mathematics education (Agustina et al., 2025).

Despite the growing number of bibliometric studies on SRL, the existing literature has not adequately addressed the specific context of mathematics education. Judijanto (2025), for example, examined SRL from a global educational perspective without distinguishing the unique cognitive characteristics of individual disciplines. Consequently, themes closely associated with mathematical reasoning and problem-solving become embedded within broader educational discussions rather than being examined independently. Likewise, Lintangesukmanjaya et al. (2025) and Nuryadin et al. (2024) investigated SRL within physics and STEM education. However, the interdisciplinary nature of STEM tends to obscure the distinctive conceptual relationships that characterize mathematics, whose procedural and hierarchical structures differ substantially from those of physics and other STEM disciplines. Therefore, the absence of a dedicated bibliometric mapping of SRL in mathematics education represents not merely a topical gap but also limits a clear understanding of the field's intellectual structure.

Another important limitation concerns the databases used in previous bibliometric studies. Most existing investigations rely exclusively on the Scopus database because of its established reputation and high indexing standards. However, this study employs the Dimensions database because it offers broader document coverage, including regional educational journals, open-access publications, and other scholarly sources that frequently publish research on SRL in mathematics education, particularly from Southeast Asia. Consequently, Dimensions provides a more comprehensive representation of current research developments and captures a substantial proportion of mathematics education studies that may

not yet be comprehensively indexed in Scopus. This broader coverage makes Dimensions particularly suitable for mapping the contemporary development of SRL research in mathematics education.

Based on these identified gaps, this study aims to map and analyze the development of SRL research in mathematics education using the Dimensions database. Specifically, the study addresses five research questions: (1) How have publications and citations related to SRL in mathematics education evolved over time? (2) Which authors and journals have contributed most significantly to this field? (3) What keyword co-occurrence patterns emerge from network visualization? (4) What research trends can be identified through overlay visualization? and (5) How are research topics distributed based on density visualization? By answering these questions, this study seeks to provide a comprehensive bibliometric mapping of SRL research in mathematics education while expanding the evidence base beyond the Scopus database. The findings are expected to contribute to the development of the field by offering a systematic overview of its intellectual structure and serving as a valuable reference for researchers, educators, and policymakers in designing strategies to strengthen students' self-regulated learning as part of efforts to improve the quality of mathematics education.

METHOD

This study employs a bibliometric analysis method with a quantitative approach to map the development of research on SRL in mathematics education as an effort to support improvements in educational quality. This approach was chosen because it provides a comprehensive overview of publication trends, patterns of author collaboration, and the dynamics of research topic development based on published scientific literature. Furthermore, bibliometric analysis allows for the identification of research trends, dominant themes, and potential research opportunities for future development (Hidayatullah et al., 2024). The research data were obtained from the Dimensions database on June 12, 2026. The search terms used were: “Self-Regulated Learning” AND “Mathematics Education.” The search was conducted in the title and abstract fields to enhance the relevance of the results. The initial search yielded 181 publications related to the research topic. Subsequently, a screening process was conducted based on the publication year range, specifically 2016–2025, to ensure the data’s currency in line with the latest developments in the research field. After this stage, the number of publications was reduced to 147 documents. Subsequently, filtering was performed based on the Sustainable Development Goals (SDGs) classification available in the Dimensions database, specifically SDG 4: Quality Education. This filtering process yielded 112 publications that met the initial criteria. The final step was to select publications based on type, including only journal articles. Following this process, 91 articles were selected as the final dataset used in the bibliometric analysis. For more details on the data selection process presented in Figure 1.

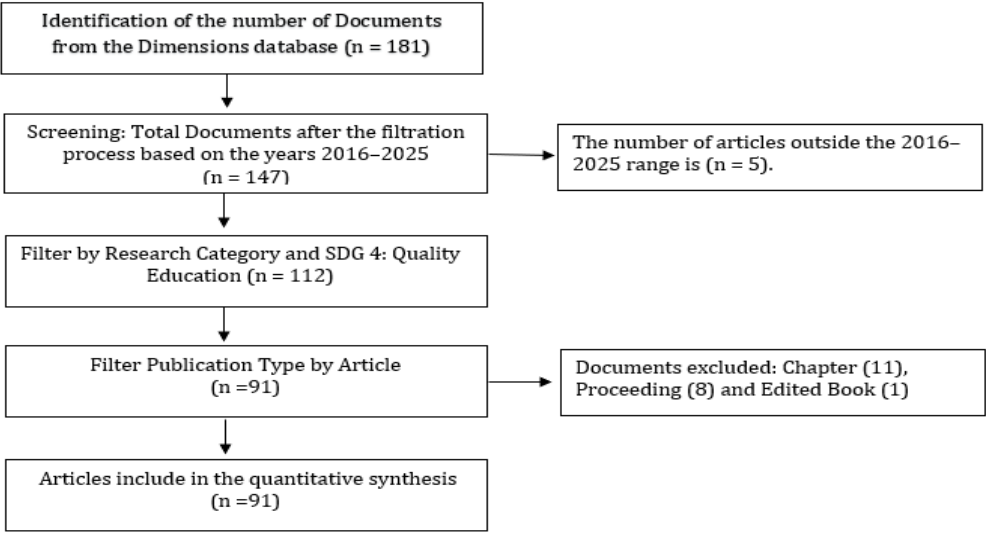


Figure 1. Flowchart Data search process

Before the analysis was conducted, the data first underwent a data cleaning process, which included removing duplicate documents, normalizing author names and keywords (for example, merging the terms “SRL” and “Self-Regulated Learning”), and checking the consistency of metadata to improve the accuracy of the analysis results. The selected data was then saved in RIS format and analyzed using VOSviewer software. VOSviewer is capable of evaluating documents based on bibliographic pairs of institutions, journals, and authors, as well as the co-occurrence of author keywords through network visualization (Fitriyah & Dasari, 2023). The analysis conducted included co-authorship analysis to identify patterns of author collaboration, as well as co-occurrence analysis to examine relationships between keywords. In this process, a minimum threshold of 5 occurrences was set for keywords to ensure that only significant terms were analyzed. The resulting visualizations included network visualizations to show relationships between elements, overlay visualizations to track the temporal development of research, and density visualizations to identify the density of research themes.

RESULTS AND DISCUSSION

A search for publications related to “Self-Regulated Learning,” “Mathematics Education,” and “Quality Education” in mathematics education conducted between 2016 and 2025, using the Dimensions database, yielded 91 publications that met the criteria for further analysis using the VOSViewer application. The following are the results of the bibliometric analysis of this study based on the research questions presented earlier.

Trends in Publications and Citations

Information regarding publications and citations of SRL articles in mathematics education for quality education during the 2016–2025 period is presented in Figure 2.

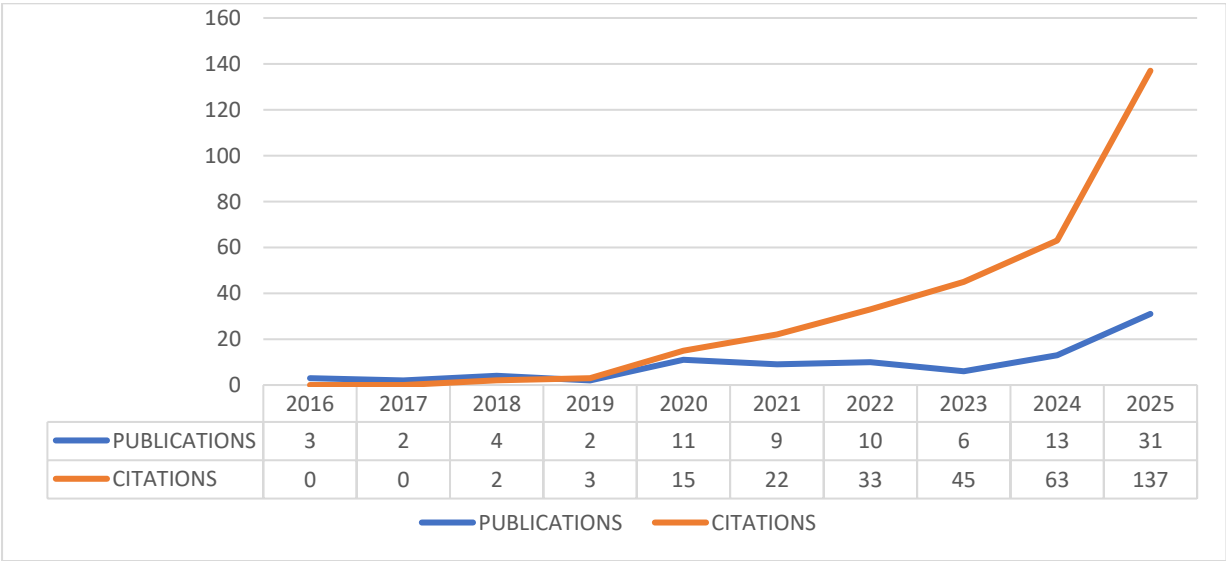


Figure 2. Graph of the Development of Publications and Citations for the 2016–2025 Period

Based on Table 2, the development of research publications related to Self-Regulated Learning (SRL) in mathematics education shows an upward trend during the 2016–2025 period. The number of publications at the beginning of the period was still relatively low 3 publications in 2016 and 2 in 2017 and then gradually increased, reaching 11 publications in 2020. Although there were fluctuations from 2021 to 2024, the number of publications rose significantly again in 2025, peaking at 31 publications. Meanwhile, the number of citations showed more consistent growth compared to the number of publications. Citations, which were not recorded in 2016 and 2017, began to rise in 2018 with 2 citations and continued to increase, reaching 137 citations in 2025. This increase in the number of publications and citations indicates that research on SRL in mathematics education is growing and gaining greater

attention from the academic community, thereby demonstrating its relevance and significant contribution to the advancement of research in the field of mathematics education.

**Journals by Number of Publications and Citations**

Research publications related to the development of SRL publications and citations in mathematics education are spread across various journals. The fifteen journals with the highest number of publications are shown in Table 1.

**Table 1.** Journals with the highest number of documents related to the development of publications and citations

| Journal                                                        | Publications | Citations | Citations (Mean) |
|----------------------------------------------------------------|--------------|-----------|------------------|
| Journal of Physics Conference Series                           | 6            | 27        | 4.50             |
| Infinity Journal                                               | 4            | 23        | 5.75             |
| AKSIOMA Jurnal Program Studi Pendidikan Matematika             | 4            | 13        | 3.25             |
| Mosharafa Jurnal Pendidikan Matematika                         | 4            | 21        | 5.25             |
| Jurnal Absis Jurnal Pendidikan Matematika dan Matematika       | 3            | 0         | 0                |
| Jurnal Elemen                                                  | 3            | 36        | 12.00            |
| Jurnal Derivat Jurnal Matematika dan Pendidikan Matematika     | 3            | 5         | 1.67             |
| Frontiers in Psychology                                        | 2            | 22        | 11.00            |
| JIPM (Jurnal Ilmiah Pendidikan Matematika)                     | 2            | 17        | 8.50             |
| AL-ISHLAH Jurnal Pendidikan                                    | 2            | 1         | 0.50             |
| JPMI (Jurnal Pembelajaran Matematika Inovatif)                 | 2            | 4         | 2.00             |
| (JIML) JOURNAL OF INNOVATIVE MATHEMATIS LEARNING               | 2            | 1         | 0.50             |
| Teachers College Record the Voice of Scholarship in Educations | 1            | 28        | 28.00            |
| Sustainability                                                 | 1            | 14        | 14.00            |
| BMC Psychology                                                 | 1            | 1         | 1.00             |

Based on Table 1, research publications related to SRL in mathematics education are distributed across various national and international journals. The Journal of Physics: Conference Series is the journal with the highest number of publications, namely 6 articles and 27 citations. Meanwhile, Teachers College Record: The Voice of Scholarship in Education has the highest average citation count, at (28.00) citations per publication, followed by Sustainability (14.00) and Jurnal Elemen (12.00). These findings indicate that research on Self-Regulated Learning in mathematics education is not only widely published but also has diverse academic impacts, as reflected in the number of citations received.

In terms of scientific impact, Teachers College Record: The Voice of Scholarship in Education has the highest average citation, followed by Sustainability and Jurnal Elemen. The high average citation counts for these journals indicate that, although the number of published articles is relatively small, their publications carry significant academic influence. This situation indicates that a journal's impact is determined not only by the number of publications but also by the quality of the articles, the journal's reputation, its international readership, and the relevance of research topics to emerging educational issues. Conversely, some journals with a higher number of publications do not necessarily have a high average citation count because most of their articles are still relatively new and have not yet had sufficient time to accumulate citations.

Overall, these findings suggest that the development of SRL research in mathematics education is supported by a combination of reputable international journals that generate high citation impacts and mathematics education journals that consistently serve as the primary platforms for disseminating research in this field. This trend reflects that SRL research is not only evolving within the field of mathematics education but is also becoming increasingly integrated with broader studies in education, psychology, and learning, thereby opening opportunities for interdisciplinary collaboration to enrich the development of both theory and practice in mathematics education.



### ***Author by Number of Publications and Citations***

The trends in publications and citations by author, based on works published in both national and international journals, are presented in Table 2, which lists the 15 authors with the highest number of publications and citations.

**Table 2.** List of Authors by Number of Publications and Citations

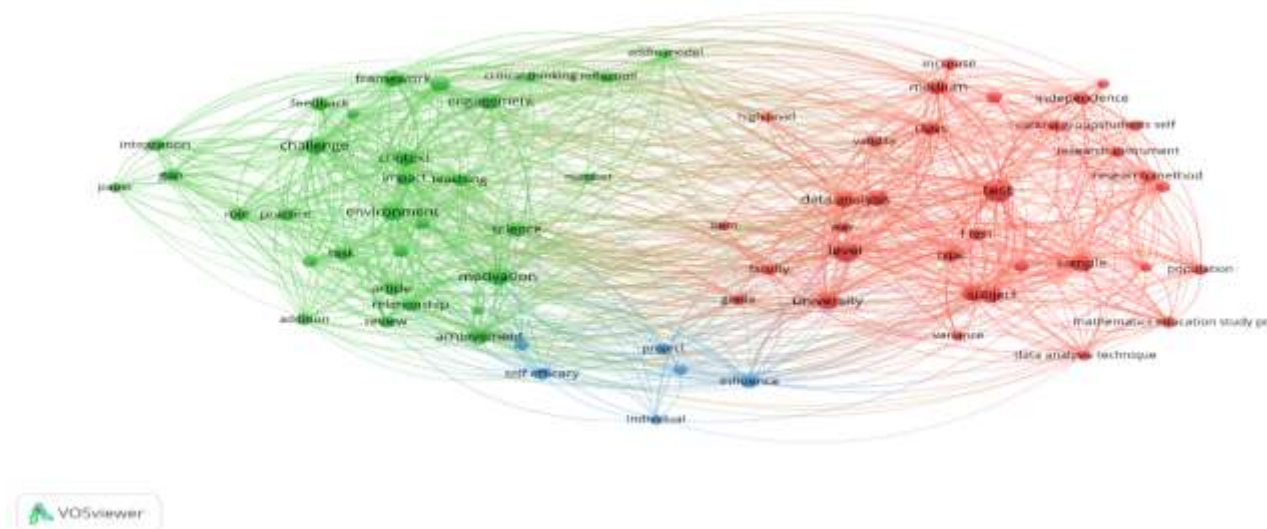
| Authors                         | Publications | Citations | Citations (Mean) |
|---------------------------------|--------------|-----------|------------------|
| Tatang Herman                   | 3            | 11        | 3.14             |
| Dadang Juandi                   | 3            | 2         | 3.13             |
| Ulises Salinas-Hernandez        | 2            | 49        | 3.12             |
| Sri Rahmawati Fitriatien        | 2            | 1         | 3.11             |
| Abdul Mujib                     | 2            | 4         | 3.10             |
| Sufyani Prabawanto              | 2            | 4         | 3.09             |
| Ninik Mutianingsih              | 2            | 1         | 3.08             |
| Didi Suryadi                    | 2            | 4         | 3.07             |
| Sofri Rizka Amalia              | 2            | 9         | 3.06             |
| Heni Pujiastuti                 | 2            | 1         | 3.05             |
| Hepsi Nindiasari                | 2            | 1         | 3.04             |
| Yaya Sukjaya Kusumah            | 2            | 0         | 3.03             |
| Maxmudova Dilnoza Xaytmirzaevna | 2            | 0         | 3.02             |
| Iik Nurhikmayati                | 2            | 20        | 3.01             |
| Isnarto                         | 2            | 6         | 3.00             |

Based on Table 2, the productivity and scientific impact of authors in research on SRL in mathematics education show different patterns. Tatang Herman and Dadang Juandi are the authors with the highest number of publications three articles each which demonstrates their contribution to sustaining research in this field. However, high publication productivity does not always correspond to high scientific impact. Ulises Salinas-Hernandez, for example, has only two publications but has received the highest number of citations 49 followed by Iik Nurhikmayati (20 citations) and Tatang Herman (11 citations). This pattern suggests that an author's influence is determined more by the relevance and quality of their scientific contributions than by the mere number of articles published.

These findings suggest that the development of SRL research in mathematics education is supported by two types of authors: those who are prolific in producing publications and those who produce work with high academic impact. This distinction reflects the fact that citations are influenced by various factors, such as the novelty of the topic, the quality of the research, the visibility of the journal, and the extent to which the research findings are utilized by the scientific community. Thus, mapping authors' productivity and impact not only identifies the key actors in the field of SRL but also provides information on the sources that contribute to the advancement of knowledge and the direction of research in the field of mathematics education

### ***Network Visualization Base on Keywords***

To identify the intellectual structure and dominant themes in SRL research in mathematics education, a co-occurrence analysis of keywords was conducted using VOSviewer. The visualization results in Figure 1 show the relationships among keywords organized into several clusters, which represent the focus and direction of research development in this field.



**Figure 2.** *Network Visualization Base on Keywords*

Based on the results of network visualization using VOSviewer, research on SRL in mathematics education forms three interconnected main clusters, indicating that the development of this field is built upon three complementary dimensions of research. The first cluster (green) connects keywords such as motivation, engagement, achievement, feedback, environment, and critical thinking. The interconnectedness of these keywords suggests that SRL research largely views self-regulation as a process influenced by pedagogical and psychological factors. From this perspective, motivation and engagement in learning are not viewed as standalone variables but interact with the learning environment, learning strategies, and reflection to shape students' ability to independently manage their mathematics learning process.

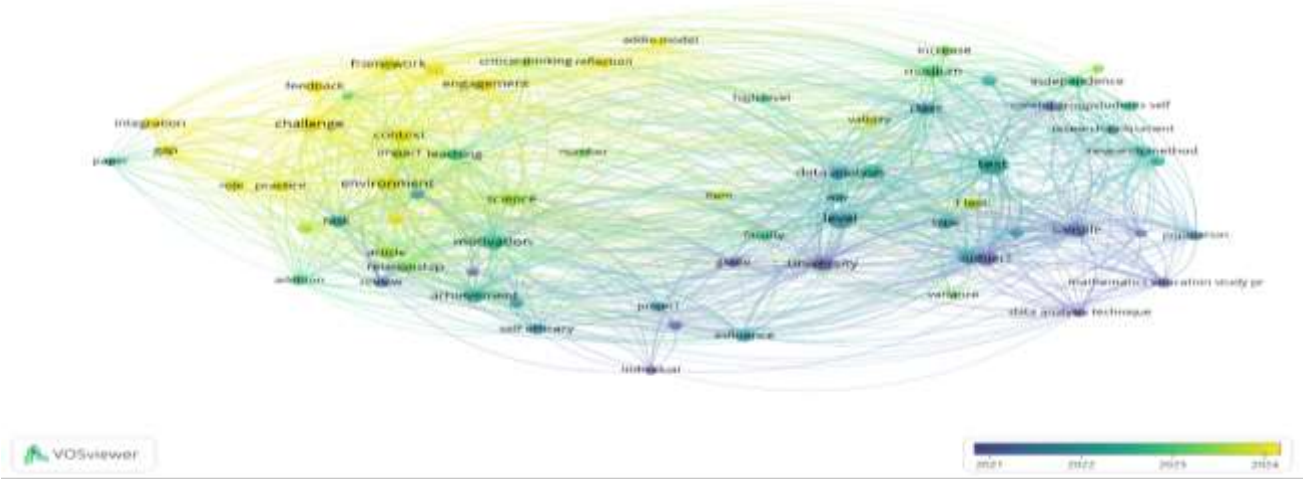
The second cluster (red) is dominated by the keywords "test," "sample," "subject," "class," "research method," and "data analysis," which represent the methodological dimension of SRL research. The proximity of these keywords indicates that most studies are still focused on testing the relationships or effectiveness of SRL through a quantitative empirical approach. Meanwhile, the third cluster (blue) connects "self-efficacy," "individual," "project," and "influence," illustrating that individual characteristics are positioned as internal mechanisms that influence students' success in applying SRL. The strong relationships among the three clusters suggest that SRL research in mathematics education is evolving through the integration of pedagogical factors, students' psychological characteristics, and methodological approaches. This network structure indicates that future research needs to integrate these three dimensions to produce a learning model that not only measures the effectiveness of SRL but also explains the mechanisms by which the learning environment, motivation, and individual characteristics interact to improve the quality of mathematics learning.

These findings are consistent with the theory of SRL proposed by Zimmerman (2000), which states that SRL is an active process involving learners' cognitive, motivational, and behavioral aspects in planning, monitoring, and evaluating the learning process. The dominance of the keywords "motivation," "achievement," and "self-efficacy" also supports the social cognitive theory proposed by Priyambudi (2024), which asserts that an individual's belief in their own ability (self-efficacy) influences motivation, learning behavior, and academic achievement. This indicates that research on SRL in mathematics education continues to focus on understanding how students' motivational factors and self-beliefs influence their success in learning mathematics. Furthermore, the relationship between SRL and Quality Education suggests that developing self-regulation skills can serve as a strategy for achieving the Sustainable Development Goals (SDGs), particularly SDG 4, which emphasizes the importance of quality, inclusive, and sustainable education (Apriyanto et al., 2025a). The conceptual relationships depicted in this bibliometric map indicate that SRL research in mathematics education continues to evolve toward a

more integrative approach, linking personal factors, the learning environment, and academic achievement in an effort to improve the quality of education in a sustainable manner.

**Overlay Visualization Base on Keywords**

To identify trends in the development of research topics, an overlay visualization analysis was conducted using VOSviewer. The results shown in Figure 3 illustrate the temporal distribution of keywords, thereby enabling the identification of themes that have long been studied as well as new topics that are beginning to gain attention in SRL research in mathematics education.



**Figure 3.** Overlay Visualization Base on Keywords

Based on the results of the overlay visualization using VOSviewer, research on SRL in mathematics education shows a shift in focus from individual aspects toward more contextual and technology-based aspects. The colors on the overlay map indicate the temporal development of research topics, where shades of blue to green represent earlier topics such as self-efficacy, achievement, individual, sample, and population which focus on students’ personal factors and empirical research. Meanwhile, yellow indicates topics that have emerged in the most recent period, such as engagement, feedback, framework, goal, reflection, and tool, which suggest a growing emphasis on the development of learning strategies, the use of technology, and student interactions to support self-regulation skills. Initially, SRL research primarily examined the relationship between self-regulation, self-efficacy, and students’ mathematics learning outcomes. However, in recent years, researchers’ focus has shifted toward the development of learning frameworks, the use of technology, student engagement, and the provision of feedback to support the process of self-regulation in mathematics learning. The predominance of topics such as feedback, engagement, environment, and tools indicates that SRL research is increasingly emphasizing the importance of learning environment support, instructional design, and the use of digital technology to enhance students’ self-regulation skills (Fauzan et al., 2026). These findings demonstrate that SRL research continues to evolve and adapt to the learning needs of the 21st century.

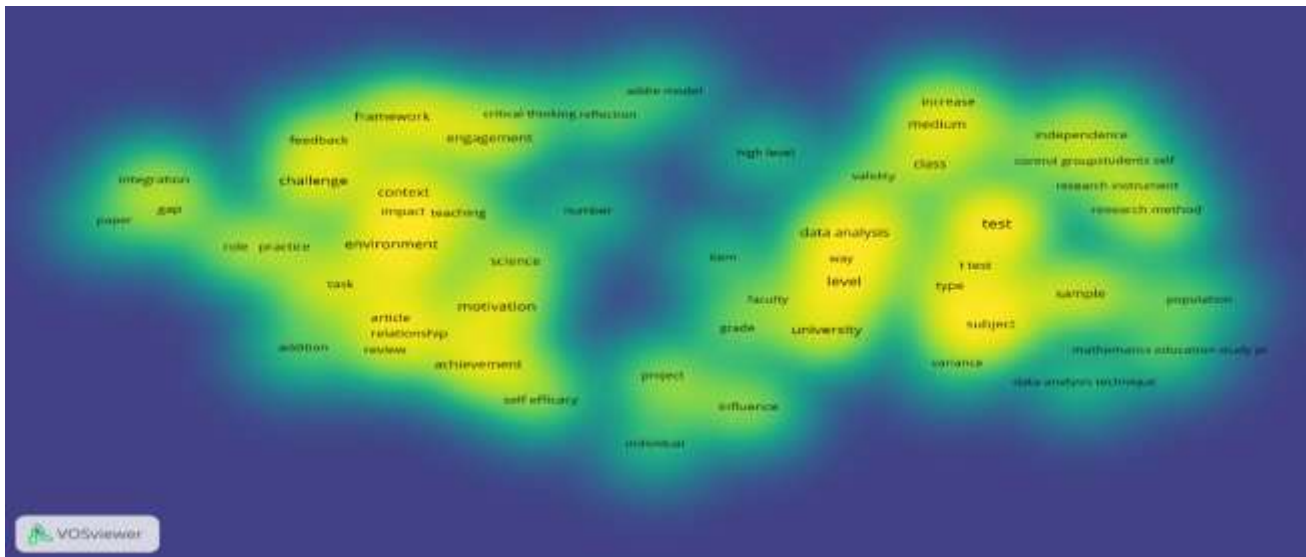
The emergence of engagement, feedback, and reflection as current themes indicates that SRL research is increasingly emphasizing the importance of an ongoing self-regulation process through interactions between learners and their environment. Research by Samadi et al., (2023) states that high-quality interactions and a supportive learning environment play a crucial role in developing students’ self-regulation skills. On the other hand, the growing attention to the topics of tools, frameworks, and environments indicates that SRL research in mathematics education is beginning to adapt to advancements in technology and digital learning. The emergence of topics such as tools, frameworks, and environments suggests that SRL research no longer views self-regulation solely as an individual ability but also as one influenced by technological support, instructional design, and digital learning environments. This is supported by Judijanto, (2025) research, which states that integrating SRL into digital platforms can enhance students’ academic achievement and learning performance. Thus, the



trends in topics depicted in the Overlay Visualization indicate that SRL research in mathematics education is moving toward a more comprehensive and innovative approach to support the achievement of Quality Education through the strengthening of self-regulation skills, the utilization of technology, and the creation of effective and adaptive learning environments.

### ***Density Visualization Base on Keywords***

To determine the level of dominance and intensity of research on each theme, a density visualization analysis was conducted using VOSviewer. The results shown in Figure 4 highlight areas of high and low density based on keyword frequency and connectivity, thereby providing an overview of the main focus of SRL research in mathematics education.



**Figure 4.** Density Visualization Base on Keywords

Based on the results of keyword density visualization, the distribution of keyword density indicates that research on SRL in mathematics education is concentrated on several main themes with the highest frequency of occurrence and interconnectivity. The areas with the highest density (highlighted in yellow) are dominated by keywords such as test, sample, subject, data analysis, level, environment, engagement, feedback, motivation, and achievement. The dominance of these keywords suggests that SRL research to date has been primarily directed toward evaluating the effectiveness of learning through an empirical approach by examining the relationship between self-regulation, motivation, learning engagement, and students' academic achievement. The high density of the keywords "test," "sample," and "data analysis" also indicates that quantitative approaches remain the dominant method in SRL research in mathematics education.

On the other hand, several keywords such as self-efficacy, individual, project, influence, research method, and independence are located in areas with lower density. This indicates that these themes have a relatively lower frequency of occurrence and a lower level of interconnectedness compared to the main themes. Overall, this density pattern shows that the structure of SRL research in mathematics education is still dominated by studies focused on measuring learning outcomes and factors supporting the learning process, while concepts related to individual characteristics and specific learning approaches have not yet become the center of attention in the research network. This distribution illustrates varying levels of maturity among themes in the development of SRL research in mathematics education, where some themes have evolved into primary focuses, while others remain in a more peripheral position within the scientific framework.

## IMPLICATIONS

The findings of this bibliometric study have several important implications for research and practice in mathematics education. First, the identified shift from individual learner characteristics toward engagement, feedback, instructional frameworks, and technology-supported learning indicates that future mathematics instruction should integrate pedagogical, psychological, and technological dimensions to strengthen students' Self-Regulated Learning (SRL). Second, the dominance of quantitative studies and outcome-oriented research suggests opportunities for educators and researchers to design more comprehensive SRL interventions that emphasize learning processes rather than merely measuring academic achievement. Finally, the bibliometric mapping presented in this study provides an evidence-based reference for researchers, curriculum developers, and policymakers to identify emerging research priorities, establish interdisciplinary collaborations, and develop mathematics learning environments that contribute to achieving Sustainable Development Goal 4 (Quality Education).

## LIMITATIONS

This study has several limitations that should be acknowledged. First, the analysis was limited to publications indexed in the Dimensions database, which, although broader than many other databases, may not capture all relevant publications available in databases such as Scopus, Web of Science, or ERIC. Second, only journal articles published between 2016 and 2025 were included, excluding conference proceedings, book chapters, and other publication types that may also contribute to the development of SRL research. Third, the bibliometric analysis relied primarily on publication metadata, including authors, journals, citations, and keywords, without examining the methodological quality or empirical findings of individual studies. Consequently, the results provide a comprehensive overview of research trends and intellectual structures rather than evaluating the effectiveness or quality of SRL interventions in mathematics education.

## SUGGESTIONS

Future research should expand bibliometric investigations by integrating multiple databases, such as Scopus, Web of Science, and Dimensions, to obtain broader global coverage and improve the robustness of intellectual mapping. Researchers are also encouraged to employ advanced bibliometric techniques, including co-citation, bibliographic coupling, and thematic evolution analyses, to reveal the conceptual development of SRL research more comprehensively. In addition, empirical studies should move beyond predominantly quantitative correlational designs by adopting mixed-methods, longitudinal, and experimental approaches to explain how self-regulation develops within different mathematical learning contexts. Greater attention should also be directed toward emerging themes identified in this study, including technology-supported learning, digital learning environments, feedback, engagement, artificial intelligence, and adaptive instructional frameworks, as these areas are expected to shape the future direction of SRL research in mathematics education and strengthen its contribution to Quality Education.

## CONCLUSION

Research on Self-Regulated Learning (SRL) in mathematics education has expanded considerably over the past decade, reflecting its growing importance in supporting Quality Education. The findings reveal that the intellectual landscape of this field is structured around three interconnected dimensions: pedagogical and psychological factors, methodological approaches, and individual learner characteristics. Moreover, the thematic evolution indicates a shift from emphasizing self-efficacy and academic achievement toward engagement, feedback, reflection, instructional frameworks, and technology-supported learning environments. This trend suggests that SRL research is increasingly adopting a more integrative perspective that combines learner characteristics, instructional design, and digital technologies to enhance mathematics learning. This study advances the current understanding of

SRL research in mathematics education by providing an updated and comprehensive intellectual mapping that extends beyond publication and citation trends to reveal the thematic evolution and emerging research directions in the field. Unlike previous bibliometric studies, which generally examined SRL across broader educational contexts, this study specifically highlights the development of SRL within mathematics education and identifies emerging topics such as engagement, feedback, learning frameworks, and digital learning tools. These findings provide a clearer roadmap for future research by encouraging the integration of pedagogical, psychological, and technological perspectives to develop innovative SRL-based mathematics learning that supports the achievement of Sustainable Development Goal 4 (Quality Education).

## AUTHOR CONTRIBUTIONS STATEMENT

NF contributed to the conceptualization of the study, the formulation of the research question, the development of the methodology, data analysis, interpretation of the results, and the drafting of the main manuscript. KVN was involved in data collection from the Dimensions database, data filtering and cleaning, and validation of the research data. NNP contributed to the bibliometric analysis using VOSviewer, data visualization, and the interpretation of network, overlay, and density visualization results. MSP was responsible for the literature review, the development of the theoretical framework, and the critical review of the manuscript's content. AWM served as the research supervisor, providing conceptual guidance, validating the analysis results, revising the manuscript substantively, and ensuring the article's academic quality through the final stage.

## CONFLICT OF INTEREST

The author declares no conflict of interest regarding the publication of this article.

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