

# Research Trends in Self-Regulated Learning in the Field of Mathematics Education

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## Abstract:

In learning, the skills developed are not only cognitive but also affective, such as self-regulated learning. Research on self-regulated learning has been extensively studied by researchers. Given this background, this study aims to examine the developments in research on self-regulated learning in mathematics education. For this purpose, the researcher reviewed 55 articles from journals accredited by the Science and Technology Index (SINTA 1 and SINTA 2). This research used a Systematic Literature Review (SLR) method with a primary focus on self-regulated learning research. The findings indicate instability in the publication of self-regulated learning articles over the years up to 29 November 2023. Based on these results, the researcher recommends that other researchers increase the diversity of rarely conducted types of research, such as Research & Development (R&D), aimed at developing products that can enhance self-regulated learning and support the research trends in self-regulated learning in the field of mathematics education.

**Keywords:** Research, Self-Regulated Learning, Systematic Literature Review.

## 1. Introduction

Quality education can be supported by a robust curriculum, designed to provide a foundation for educational implementation. Within this curriculum, there are several subjects, including mathematics. In this subject, students are expected to possess a willingness to learn independently, explore new things, and think mathematically, as mathematical thinking differs from merely performing mathematical operations (Tanujaya et al., 2017). Self-learning here transcends individual study of mathematical concepts; it encompasses setting personal learning targets, managing learning strategies, and taking responsibility for achieving these targets. This concept is known as self-regulated learning. Self-regulated learning is a self-directed process where learners independently manage their metacognition, motivation, and behavior to achieve learning objectives (Zimmerman, 1990). The self-regulated learning method consists of three aspects: metacognition, motivation, and behavior. There are nine indicators of students' self-regulated learning, namely: (1) managing oneself for learning preparation, (2) choosing strategies to overcome learning failures, (3) managing emotions and self-motivation during learning, (4) believing in the ability to evaluate learning outcomes, (5) acknowledging the obligation to complete school assignments, (6) participating effectively in learning activities, (7) selecting appropriate learning strategies, (8) reviewing one's own work, and (9) developing cognitive and metacognitive strategies.

One study conducted found that self-regulated learning among junior high school students in Karawang still requires improvement, as learning objectives are not being fully met, and students are expected to succeed in learning (Febriyanti & Imami, 2021). Similar findings indicated that only a few students learn of their own volition, suggesting low levels of self-regulated learning in planning and managing learning preparations (Kurnia & Warmi, 2020). Such results occur because mathematics is considered daunting by many students, leading to learning difficulties. There are also students who perceive mathematics lessons as unenjoyable. Not only students, but society also shares this view. Therefore, it is not without reason why students show little interest or motivation, as well as a lack of independence in learning mathematics. This represents a challenge for teachers who must be creative and innovative in order to create high-quality and enjoyable learning experiences that can foster student interest in mathematics (Hapsari & Fatimah, 2021).

Research using Systematic Literature Reviews (SLR) on self-regulated learning, aimed at testing

theoretical assumptions, has yielded inconsistent results (Tamur et al., 2023). Similar studies were conducted between 2012 and 2020, analyzing 19 effect sizes from 19 research datasets obtained from primary sources such as national journals, conference proceedings, and published theses, using five aspects of analysis: study year, education level, sample size, research duration, and publication source (Yunita et al., 2020). Research on self-regulated learning has been performed using the Scopus database since 1983, demonstrating its effectiveness in enhancing student outcomes in both formal and non-formal education. Thus, realizing the importance of self-regulated learning, there arises a need to understand the trends on this topic in the field of mathematics education (Sunarto & Koentjoro, 2023).

This research aims to gather information on or to assess the trends in self-regulated learning research within the field of mathematics, specifically focusing on those published in scientific journals accredited by the Science and Technology Index (SINTA 1 and SINTA 2) up until 29 November 2023, using a Systematic Literature Review (SLR) methodology. This study was conducted to address the following research questions: What are the trends in self-regulated learning research from year to year as published in journals accredited by the Science and Technology Index (SINTA 1 and SINTA 2)? What is the diversity of research types conducted? How are the research subjects distributed? What types of treatments or learning models are used in the studies? Are there other variables associated with self-regulated learning in the research? What are the dominant or frequently used data analysis techniques? Which publication venues most commonly feature articles on self-regulated learning research?

## **2. Research Methods**

### **2.1 Eligibility Criteria**

The method used in this study is a Systematic Literature Review (SLR) with a primary focus on self-regulated learning articles published in accredited mathematical education journals by the Science and Technology Index (SINTA 1 and SINTA 2). Additionally, this research used a mathematical review and PRISMA meta-analysis. The study involved several stages: (1) collecting and categorizing mathematical education research journals accredited by the Science and Technology Index (SINTA 1 and SINTA 2), (2) searching for articles relevant to the topic in each journal using the keyword 'self-regulated learning', (3) filtering articles relevant to the topic, (4) assessing the eligibility of articles, and (5) reviewing the overall articles.

### **2.2 Information Sources**

Data were collected based on content analysis of all self-regulated learning articles gathered from scientific journals accredited by the Science and Technology Index (SINTA 1 and SINTA 2) as of 29 November 2023. The articles reviewed in this study were those published by journals before 29 November 2023.

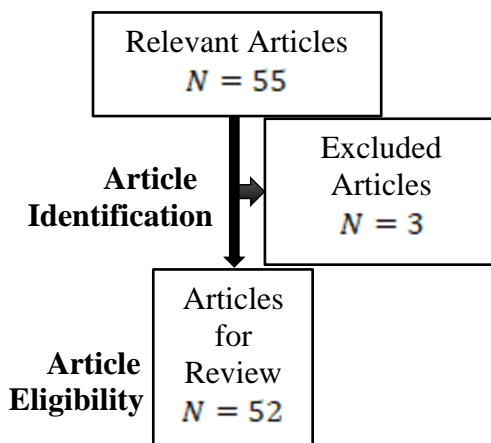
### **2.3 Search Strategy**

The search for scientific journal articles covering the topic of self-regulated learning in this study followed several steps: (1) searching for mathematical education scientific journals accredited in the Science and Technology Index (SINTA 1 and SINTA 2) by visiting the SINTA platform, (2) clicking on each journal website on the SINTA platform using the keyword 'self-regulated learning' to find articles relevant to the topic, (3) in journals where publications on self-regulated learning were found, the articles were displayed in full, and (4) subsequently, all selected articles were downloaded.

### **2.4 Selection Process**

From the search process, a total of 55 articles relevant to self-regulated learning were identified through keyword searches. These 55 selected articles underwent the following filtration steps: (1) all selected articles were downloaded, (2) all chosen articles were uploaded to a reference management software, (3) titles and abstracts relevant to the topic of self-regulated learning were sorted and recorded in Microsoft Excel, (4) articles that matched the research topic of self-regulated learning were selected for further review, and (5) a comprehensive review of all the collected articles was conducted using seven key aspects: (a) number of research publications per year, (b) type of research, (c) research subjects, (d) treatments or learning models used in the studies, (e) the linkage of self-regulated learning variables with other variables, (f) data analysis techniques used in the research, and (g) publication venues. During the selection process, 3

articles were excluded from further stages as they did not meet the eligibility criteria for deeper review. Consequently, 52 articles met the eligibility criteria for the literature study related to the topic of self-regulated learning. Figure 1 illustrates the extraction stages of the self-regulated learning articles:



**Figure 1:** Stages of Self-Regulated Learning Article Extraction

### 2.5 Data Collection Process

This stage involved downloading all accredited mathematical education articles from the Science and Technology Index (SINTA 1 and SINTA 2) using the keyword 'self-regulated learning.' This was followed by the selection process based on seven predetermined aspects. From the extraction stage, 52 articles were identified to be thoroughly reviewed and categorized into seven aspects. The process of grouping articles by each aspect involved recording the findings in Microsoft Excel.

### 2.6 Data Items

The data from the articles, reviewed and categorized based on the seven research aspects contained in Microsoft Excel, include data on the number of research publications per year, type of research, research subject aspects, treatment or learning model aspects in the research, aspects of the linkage of self-regulated learning variables with other variables in the research, data analysis technique aspects, and publication venue aspects. The next step involves presenting the findings of all articles in each aspect in bar charts and tables to facilitate the interpretation of the results obtained.

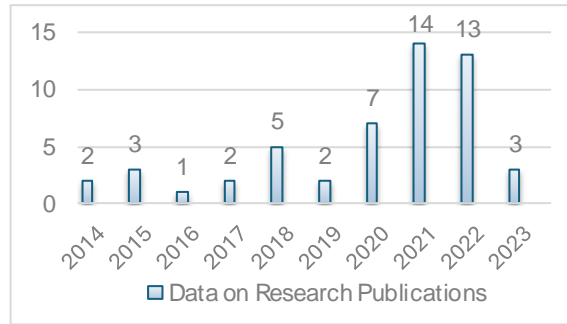
## 3. Result and Discussion

After gathering 55 scientific articles relevant to the keyword 'self-regulated learning,' the next step involved a selection process for these articles, which proceeded as follows: (1) all selected articles were downloaded, (2) all chosen articles were then uploaded to a reference management software, (3) titles and abstracts relevant to the research topic of self-regulated learning were sorted and recorded in Microsoft Excel, (4) articles that matched the research topic were determined and collected, and (5) a comprehensive review of all collected articles was conducted. During the selection process, 3 articles were excluded as they did not meet the eligibility criteria for further detailed study. Thus, 52 articles were selected and met the eligibility criteria for the literature study on the topic of self-regulated learning.

From the article extraction phase, 52 articles were reviewed in their entirety and categorized by recording findings in Microsoft Excel based on the seven aspects identified in the research objectives. Subsequently, the data compiled from the reviews of all articles across these aspects were presented in the form of bar charts and tables for interpretation. The following presents the data from the analysis of self-regulated learning research in the field of mathematics education.

### 3.1 Annual Research Publication Counts

Research on self-regulated learning began in 2014 and has continued to the present day, 29 November 2023, exhibiting highly variable trends each year. This variability indicates an instability in publication rates from year to year. Figure 2 presents the data on the number of self-regulated learning research publications from 2014 – 2023:

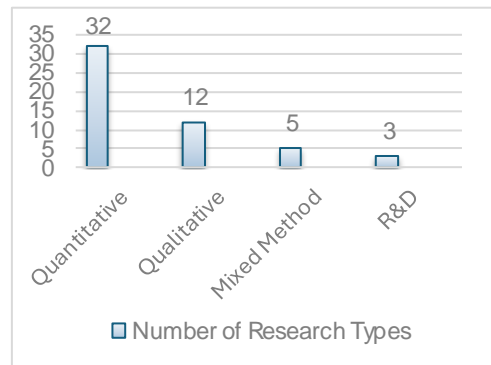


**Figure 2:** Number of Self-Regulated Learning Research Publications from 2014 – 2023

According to Figure 2, there was an increase of one publication from 2014 to 2015, followed by a decrease of 2 publications from 2015 to 2016. However, the years 2016 to 2017 and 2017 to 2018 each saw increases in publications, by 1 and 3 publications, respectively. Subsequently, there was a decrease of 3 publications from 2018 to 2019, but an increase of 5 publications from 2019 to 2020, and also an increase from 2020 to 2021 by 7 publications. However, from 2021 to 2022 there was a decrease of 1 publication. Furthermore, from 2022 to 2023 it cannot yet be determined whether there will be an increase or decrease in publications, as this data was collected on 29 November 2023, but preliminary data shows a decrease of 10 publications. Therefore, given this instability, it is recommended that researchers intensify their efforts in studying self-regulated learning as it can positively impact the development of mathematics education, especially given the currently low levels of self-regulated learning among students.

### 3.2 Research Types

Based on the 52 journal articles reviewed, there are four types of research identified: quantitative, qualitative, mixed methods (Quantitative Qualitative), and Research & Development (R&D). Figure 3 presents the data on the number of self-regulated learning research studies according to the type of research:

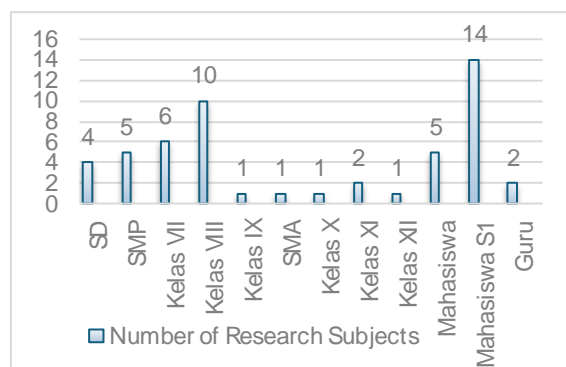


**Figure 3:** Data on the Number of Self-Regulated Learning Research Studies by Type of Research

According to the Figure 3 it can be interpreted that quantitative research is the most frequently conducted design by researchers studying self-regulated learning compared to other types of research, totaling 32 out of the 52 studies. Studies of this type predominantly utilize quasi-experimental methods. Following quantitative research, the next most common type is qualitative research, accounting for 12 studies. Studies of this type most often use survey methods. The third most common type of research is mixed methods, with 5 studies. The least common type is Research & Development (R&D), which includes only 3 studies, focusing on the development of learning tools to enhance self-regulated learning.

### 3.3 Research Subjects

Based on the 52 journal articles reviewed in this study, there are five categories of research subjects, namely elementary school students, junior high school students, senior high school students, as well as university students and teachers. Figure 4 presents the data on the number of self-regulated learning studies according to the distribution of research subjects:



**Figure 4:** Number of Self-Regulated Learning Research Studies by Distribution of Research Subjects

According to Figure 4 the most frequent research subjects in self-regulated learning studies are undergraduate students, with 14 out of the 52 studies, indicating that researchers are particularly interested in or focused on undergraduates, a group that represents a transitional phase from being students. This is followed by Class VIII students with 10 studies, and Class VII students with 6 studies. Next, the research subjects include junior high school students in general and university students in general, each with 5 studies.

Elementary school students are the subjects of 4 studies. This is followed by Class XI students and teachers, each with 2 studies. The least studied subjects, with only 1 study each, are Class IX students, high school students in general, Class X students, and Class XII students. In the conducted research, there has yet to be specific research involving master's and doctoral students. It is presumed that these students are already focused on advancing their studies, hence the predominant use of undergraduate students as research subjects.

### 3.4 Treatments or Learning Models in Research

Based on the 52 journal articles reviewed, there are numerous types of treatments or learning models used in the research. Table 1 presents the data on the number of self-regulated learning studies according to the treatment or learning model used in the research:

**Table 1:** Number of Self-Regulated Learning Research Studies Based on Treatment or Learning Model

No.	Treatment	Number
1	Problem-Based Learning (PBL)	3
2	YouTube-Assisted PBL	1
3	PBL with Cooperative Setting Types NHT and TPS	1
4	Hybrid Based on Self-Regulated Learning Strategies	1
5	Digital Module Based on Self-Regulated Learning	1
6	RPP (Blended Learning with Rotated Flipped Classroom and Schology Materials)	1
7	VBA Microsoft Word Based Teaching Materials	1
8	Use of Mathematica-Assisted Computational Mathematics Teaching Materials	1
9	Online Training for Continuous Professional Development (Geogebra)	1
10	Geogebra Online Based on Scaffolding	1
11	Project-Based with Geogebra Assistance	1
12	Flipped Learning Approach	1
13	Constructivism-Based Learning	1
14	Cooperative Type Group Investigation	1
15	Cooperative Type Jigsaw	1
16	Contextual Teaching and Learning (CTL)	1
17	Advocacy Approach (Open-Ended)	1
18	Thiagarajan and Semmel Development Model	1
19	STEM Approach Assisted by Wolfram Alpha	1
20	Partial Least Square from Structural Equation Modeling (PLS-SEM)	1

21	Situation Based Learning (SBL) Model	1
22	E-Learning Type Web Course Assisted by Google Classroom and WhatsApp Group	1
23	Learning Worksheet Assisted by Maple	1
24	Quick on the Draw Learning Strategy	1
25	Online Learning	4
26	Blended Learning	2
27	Blended Learning with Macromedia Flash	1
28	Blended Learning Based on RME	1
29	Realistic Mathematics Approach	1
30	RME Learning Approach with Scientific Method	1
31	Scientific Approach	1
32	New Normal Learning Period	1
33	Others	6
34	None	8

According to Table 1, a diverse range of treatments or learning models is used in self-regulated learning research. However, 8 out of the 52 studies did not use any treatment or learning model. This indicates that not all self-regulated learning research is conducted using specific treatments or learning models.

### 3.5 Linkage of Self-Regulated Learning Variables with Other Variables in Research

Based on the 52 journal articles reviewed, there are two domains of other variables linked with self-regulated learning research: the cognitive and affective domains. Table 2 presents the data on the number of self-regulated learning studies based on their linkage with other variables:

**Table 2:** Number of Self-Regulated Learning Research Studies Based on the Linkage of Self-Regulated Learning Variables with Other Variables in Research

No.	Other Variables	Number
1	Higher-Order Mathematical Thinking Skills (MHOTS)	3
2	Mathematical Literacy	4
3	Student Mathematical Achievement	3
4	Mathematical Communication	2
5	Mathematical Critical Thinking	5
6	Mathematical Creative Thinking	2
7	Mathematical Reasoning	2
8	Mathematical Concept Understanding	3
9	Mathematical Problem Solving	3
10	Anxiety and Self-Concept	1
11	Attitudes Towards Mathematics	1
12	Cooperation	1
13	Problem Solving and Mathematical Digital Literacy	1
14	Calculus Learning Mastery	1
15	Mathematics Learning Achievement and Reflective Thinking Ability	1
16	Learning Motivation	1
17	Learning Motivation and Achievement	1
18	Metacognitive Skills	1
19	Mathematical Connection Abilities	1
20	Mathematics Anxiety, Academic Achievement, and Self-Concept	1
21	Oral and Written Mathematical Communication and Learning Motivation	1
22	Learning Styles (Visual, Auditory, and Kinesthetic)	1
23	Mathematics Anxiety, Mathematical Stress Issues, Mathematics Learning Outcomes	1
24	Students Reflective Thinking Ability	1
25	Teacher Competence	4
26	Others	9

According to Table 2, there is a wide variety of other variables linked with self-regulated learning. In this research, other variables fall into two domains: cognitive and affective. Research on self-regulated learning is more frequently associated with other variables in the cognitive domain, such as MHOTS, mathematical communication, mathematical reasoning, mathematical concept understanding, mathematical critical thinking, mathematical creative thinking, and others. However, there are also studies linking to other variables in the affective domain, although these are still less common, including mathematics learning motivation, mathematics anxiety, self-concept, attitudes towards mathematics, and others.

### 3.6 Data Analysis Techniques in Research

Based on the 52 journal articles reviewed, a variety of data analysis techniques are used in the research. This is because several studies use more than one data analysis technique to ascertain the alignment and impact of self-regulated learning on learning outcomes. Table 3 presents the data on the number of self-regulated learning studies based on the data analysis techniques used in the research:

**Table 3:** Number of Self-Regulated Learning Research Studies Based on Data Analysis Techniques

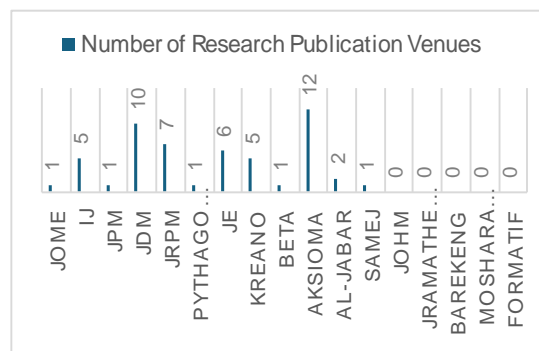
No.	Data Analysis Techniques	Number
1	Normalized Gain Score (N-Gain)	8
2	Cohen's D Effect Size	1
3	Descriptive Statistics	10
4	One-Way ANOVA	1
5	Two-Way ANOVA	6
6	Z Test	1
7	Proportion Test	1
8	Mean Difference Test	3
9	Mean Deviation Difference Test	1
10	Data Collection	1
11	Data Reduction	6
12	Data Presentation	7
13	Conclusion Drawing	7
14	Conclusion Verification	2
15	Multivariate Analysis	2
16	Multivariate Analysis of Variance (MANOVA)	3
17	T-test	11
18	Path Analysis	1
19	Correlation Analysis	4
20	Regression Analysis	9
21	Observation Sheet Review	1
22	Mann-Whitney Test	3
23	Tukey Test	1
24	Structural Equation Modeling (SEM)	1
25	Confirmatory Factor Analysis (CFA)	1
26	Validation Questionnaire Analysis (Valid, Practical, and Effective)	4
27	Inferential Testing	5
28	Normality Test	7
29	Linearity Test	2
30	Multicollinearity Test	1
31	Heteroscedasticity Test	1
32	Adjusted Rank Transform Test	1
33	Rasch Modeling and Assisted with Winsteps Version 4.4.2	1
34	Validity Analysis of Data (Rasch Model with Winstep Assistance)	1
35	Effect Size	1
36	Analyzing Unmeasurable Variables (Constructs or Latent Variables)	1

37	Homogeneity Testing	4
38	Time Triangulation	1
39	Post Hoc Tests	1
40	Field Note Data Analysis	1
41	Questionnaire Analysis	1

According to Table 3, there are 41 data analysis techniques are used in self-regulated learning research, with the T-test being the most frequently used.

### 3.7 Research Publication Venues

Based on the 52 journal articles reviewed in this study on the topic of self-regulated learning, there are 12 research publication venues, specifically accredited mathematical education journals within the Science and Technology Index (SINTA 1 and SINTA 2). Figure 5 presents the data on the number of self-regulated learning studies based on the research publication venues:



**Figure 5:** Number of Self-Regulated Learning Research Studies Based on Research Publication Venues

According to Figure 5, the publication venue that has published the most research articles on self-regulated learning over the past 10 years is the Aksioma Journal of the Mathematics Education Study Program, with 12 out of the 52 studies. This is followed by the Didaktik Matematika Journal, which has published 10 studies, the Riset Pendidikan Matematika Journal with 7 studies, and the Elemen Journal with 6 studies. Next, the Infinity Journal and Kreano: Journal of Creative-Innovative Mathematics, each published 5 studies, followed by Al-Jabar: Journal of Mathematics Education, which published 2 studies.

Research publication venues that have each published 1 study include the Journal of Mathematics Education, Jurnal Pendidikan Matematika, Pythagoras: Journal of Mathematics and Mathematics Education, Beta: Journal of Mathematics Education, and the Southeast Asian Mathematics Education Journal. There are five journals accredited by the Science and Technology Index (SINTA 1 and SINTA 2) that have not featured research articles on the topic of self-regulated learning in the last 10 years, namely the Journal of Honai Math, JRAMathEdu (Journal of Research and Advances in Mathematics Education), Berekang Journal of Mathematics and Applied Sciences, Mosharafa Journal of Mathematics Education, and Formatif Journal of Scientific Education in MIPA.

### 4. Conclusion

Since 2014, the number of self-regulated learning publications has demonstrated a yearly fluctuation in research activity through 29 November 2023, and also indicated an instability in publication rates from year to year. Quantitative research was the most prevalent during this period, predominantly using quasi-experimental methods. The majority of self-regulated learning studies focused on undergraduate students as research subjects. Among the articles reviewed, 8 out of 52 studies did not use any specific treatment or learning model, indicating that not all self-regulated learning research utilizes such frameworks. Most self-regulated learning research associated with other variables pertains to the cognitive domain, including higher-order mathematical thinking skills (MHOTS), mathematical communication, mathematical reasoning, mathematical concept understanding, mathematical critical thinking, mathematical creative



thinking, among others. The data analysis technique most commonly used in self-regulated learning research was the T-test. Furthermore, the most prolific research publication venue over the last ten years has been the Aksioma Journal of the Mathematics Education Study Program, with 12 out of 52 studies.

Based on the findings of this literature review, several recommendations for future self-regulated learning research are proposed: there is a need for more research on self-regulated learning to help stabilize publications in the coming years. There is also a call to increase the frequency of R&D research types, which are currently rare, and to diversify the types of research conducted. Research subjects should focus more on students. This literature review study has limitations as it only discusses seven aspects as presented in the results and discussion section. Therefore, further research on self-regulated learning that covers a variety of other aspects is necessary to expand the knowledge base.

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## Author Profile



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