

SELF-REGULATED LEARNING IN MATHEMATICS LEARNING: DESIGN OF LEARNING MODEL BASED ON BIBLIOMETRIC ANALYSIS

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Abstract

Self-Regulated Learning (SRL) has been a growing topic since 1983 in the Scopus database. The importance of SRL has been known through several studies because it is proven to be able to improve student learning outcomes, both at school and in life. By realizing the importance of SRL topics, the problem is wanting to know trends in SRL topics in the world of mathematics education so that interested researchers can develop them. The purpose of this study is to determine the trend of topics in the field, through bibliometric analysis with the help of the VOSViewer application. Findings reveal that there is still little discussion on the topic of SLR in mathematics learning. The journal that can be used as a reference is the International Journal of Science and Mathematics Education, which the latest topics related to Learning Systems and Education. The conclusion obtained is that SRL topics can still be developed in the world of mathematics education. Suggestions for further research are to make technology-based learning models using the latest theories and research results and evaluate the results achieved for improving students' learning outcomes in mathematics and in life.

Keywords: Advanced mathematics; creative thinking; critical thinking; independent learning; society 5.0.

Abstrak

Self-Regulated Learning (SRL) adalah topik yang muncul sebagai artikel di jurnal sejak tahun 1983 dalam basis data Scopus dengan topik yang semakin berkembang. Pentingnya SRL telah diketahui melalui beberapa penelitian karena terbukti mampu meningkatkan hasil belajar siswa, baik di sekolah maupun dalam kehidupannya. Dengan menyadari akan pentingnya topik SRL, maka masalah yang muncul adalah ingin diketahuinya trend pada topik SRL di dunia pendidikan matematika, agar dapat dikembangkan oleh peneliti yang berminat. Penelitian ini bertujuan untuk mengetahui tren topik pada bidang SRL, dengan metode analisis bibliometric melalui bantuan aplikasi VoSViewer. Hasil yang didapatkan adalah masih minimnya pembahasan topik SLR pada pembelajaran matematika, dan topik terbaru adalah Learning System dan Education serta jurnal yang dapat menjadi rujukan adalah International Journal of Science and Mathematics Education. Simpulan yang didapat yaitu topik SRL masih dapat dikembangkan di dunia pendidikan matematika. Saran untuk penelitian selanjutnya, pembuatan model pembelajaran berbasis teknologi dengan menggunakan teori dan hasil penelitian terbaru di bidang SRL pada dunia pendidikan matematika, agar dapat dievaluasi hasil yang dicapai bagi peningkatan hasil belajar siswa di bidang matematika maupun dalam kehidupannya.

Kata kunci: Berpikir kreatif; berpikir kritis; masyarakat 5.0; matematika tingkat lanjut; pembelajaran mandiri.



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INTRODUCTION

Many factors affect the success of students' learning, both during the

learning process, and at the time of evaluation. Self-Regulated Learning (SLR), which is an awareness in

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students to always be able to plan, assign and do assignments independently, has a strategy to monitor the results of their work, and have self-reflection on the performance of their workers, to then return to planning tasks and so on. (C. A. Brenner, 2022; Williams et al., 2018) is known as a factor that can support success during the learning process. In general, SRL has proven to be beneficial for education in the 21st century, since SRL is able to make students adaptable and able to work and study independently (C. A. Brenner, 2022; Hodiyanto & Firdaus, 2020). These abilities are needed in today's era, where readiness to face change is crucial. Several recent studies have shown that SLR can affect student learning progress (Ejubović & Puška, 2019; Yang et al., 2018) so that educators can use it in learning. In addition, research (Amalia & Puwaningsih, 2020) shows that SRL can increase the ability to understand concepts. Although it is believed that SLR is useful in learning, this can only be done if educators understand the stages of SLR and are able to bring them into their learning model. (Li & Lajoie, 2021) summarizes the SRL stages of the 6 dominant learning models. The oldest model discussed is the model of Winne and Hadwin, with an information processing theory approach. This model produces 4 stages, which are: task definition, goal setting and planning, studying tactics, and adaptations to metacognition. Then, it is followed by Pintrich, with a social cognitive theory approach, which produces 4 stages: forethought, monitoring, control, and reflection. Meanwhile, Zimmerman produces 3 stages: forethought, performance, and self-reflection. Boekaerts and Niemvirta establish 5 stages, namely an

identification process, task-focused and self-focused, as well as primary and secondary appraisal processes. Efklides summarizes it into 3 stages, namely task representation, cognitive processing, and performances. Meanwhile, Hadwin, who was greatly influenced by Winne and Hadwin, produces 4 steps, namely task understanding, goal setting and planning, and large and small-scale adaptation. Taking into account the six models, in summary, it can be said that the stages in the SRL are (i) Planning the completion of the work, (ii) Monitoring the work results, and (iii) Reflecting on the work. All stages are carried out by students independently and are the result of the syntax of the learning model created by the teacher. Thus, students are unwittingly used to doing it in every job, both assignments at school and in their daily lives.

Mathematics is a subject that is considered important at any level of education since mathematics underlies the logical thinking skills needed to understand other fields of science (Bosque et al., 2017; Hodaňová & Nocar, 2016; Sarimsakova, 2022). Although it has been realized that the importance of mathematics subjects in other fields of science, teaching mathematics is not easy. Moreover, some cases prove that according to students, mathematics is difficult and it is proven by the mathematics scores of students in Indonesia are still lagging behind other countries (Nurqamar & Nur, 2022). In an effort to improve students' abilities in mathematics, an assumption arises as to whether SLR already has a role in teaching mathematics, both through learning models and tools. If there has been a role for SLR in mathematics learning, how new is the research in this area?

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Even though several topics have discussed SLR, it is still rare to find topics that present specifically the development of research on SLR in mathematics education. From this type of research, data on the development of SLR topics will be disclosed so that topics still trending and can be developed known, namely through Bibliometric Analysis.

The purpose of this study is to analyze the publications in the form of articles in journals recorded in the Scopus database for SLR topics in mathematics learning. Thus, the trend of topics in the field is known with the help of Bibliometric analysis using the Open Source VOSviewer Application. The objectives of this research are, (1) To analyze the authors, languages, and countries with the topic of SLR on mathematics learning, (2) To analyze the citations and titles of the two authors with the most articles published, (3) To analyze keywords on the topic of feedback literacy along with research trends and mapping visualization on the topic of SLR in mathematics learning.

METHOD

In accordance with the objectives of this research, data will be analyzed on scientific papers with the topic of SLR in mathematics, with the help of Bibliometric Analysis as a method by using the VOSviewer application and Open Refine to help refine keywords that may have the same intent, but have different writings. Data is taken from the Scopus database which access is obtained from the Ministry of Education, Culture, Research, and Technology (Kemdikbudristek) on October 3, 2022. The Scopus database is used since it is the largest database and has a reliable reputation (Deta et al.,

2021; Mishra et al., 2021). Thus, it can be used to visualize, track and analyze publications. This study uses the steps adopted from (Prahani et al., 2022) as shown in Figure 1.

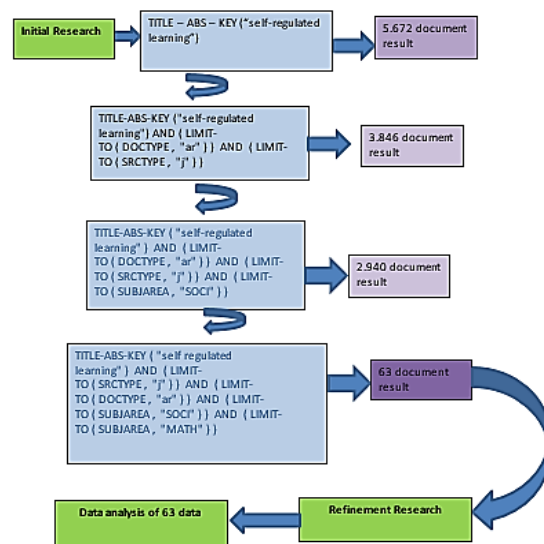


Figure 1. Steps in the Bibliometric process

The steps in the bibliometric process can be described as follows: First, define keywords. The first step is to determine the keywords of the topic that will be analyzed. In this study, the keyword 'Self-Regulated Learning' was chosen because the researcher wants to reveal the benefits of SLR in Mathematics learning. From the SLR keyword, as many as 5,672 documents are obtained. Then, in order to focus more on the novelty, the document type is limited to 'Article' and the source type is 'Journal' until 3,846 documents are obtained. The data are then filtered by limiting it to the subject area of 'Social Science' because later it would be discussed in the field of education, which then produces 2,940 documents. The last limitation is on the keyword 'Mathematics', to focus more on learning mathematics, and 63 documents are obtained. These sixty-

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three articles will be analyzed using Bibliometric analysis, with the help of the VOSviewer application in order to find out the data that supports the search for the latest topics and topics that can still be developed on SLR topics in mathematics learning.

Then, Compile the Results of Statistical Data and Data Processing. Statistical data are obtained from VOSviewer (Centre for Science and Technologies Studies, Leiden University, Netherlands), an application for building and visualizing bibliometric networks such as journals, titles, authors, authors, publications, and so on (Prahani et al., 2022). VOSviewer is used to map, visualize and analyze trends on a particular topic in a right way (Afraz et al., 2022; Donthu et al., 2021; Prahani et al., 2022) In addition, VOSviewer is also able to map various types of bibliometric analysis, to then generate the main bibliographic database, and advanced visualization with visual labeling (Hallinger & Kovačević, 2019; Hudha et al., 2020). The resulting data is then analyzed further with a .csv file and assisted with Microsoft Excel to make the data more detailed and easier to understand.

Last, we do data analysis. Data analysis is carried out descriptively by looking at the strength of the link based on the results of mapping and visualization using the VOSviewer application, and then given an analysis based on existing data, with the aim of answering research questions based on the 63 documents that have been determined in first step.

RESULT AND DISCUSSION

1. Analysis of Authors, Languages, and Countries with SLR Topics in Mathematics Learning

In order to be able to trace the trend of topics in the field of SLR in mathematics learning which is in accordance with the objectives of this study, it is necessary to explore the authors, languages and countries that have documents in this field. Obviously, these documents will be needed for the development of topics in the intended field, by studying the gaps or shortcomings. The data is taken without limiting the year so that the progress can be noticed easily. From the data taken from the Scopus database, the data obtained are shown in Table 1.

Table 1. Ten authors with the most articles on SLR topics in Mathematics learning.

Writer's name	Number of Articles	Language	Institution	Country
Chen S	4	English	National Taiwan University of Science and Technology	Taiwan
Wang, C. Y	3	English	National Chiao Tung University	Taiwan
Abedalaziz, N	2	English	University of Malaya	Malaysia
Chang, W.H.	2	English	National Taiwan Normal University	Taiwan
Hsu, Y. S	2	English	National Taiwan Normal University	Taiwan
Kramarski, B	2	English	School of Education, Bar-Ilan University	Israel
Leng, C.H.	2	English	Faculty of Education University of Malaya	Malaysia
Talbert, R	2	English	Vanderbilt University	USA
Tsai, C.C.	2	English	National Taiwan University of Science and Technology	Taiwan
Yen,M.H	2	English	National Taiwan Normal University	Taiwan

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From the data in Table 1, it appears that writers from Taiwan have dominated the writing of articles on the topic of SLR in the field of mathematics, although there are also other countries such as Malaysia, Israel, and the United States.

2. FigurAnalysis of Citation and Title of the two authors with the most articles published

According to table 1, it can be seen that the two authors with the most articles on SLR topics in mathematics education are Chen and Wang. From the data obtained through the Scopus database, it can be seen the work of Chen and Wang along with the number of citations, as shown in Table 2.

Table 2. Number of citations and article titles from the two authors with the most articles published

Author	Article Title	Journal Name	Publication Year	Number of citations
Chen S	Assessing Metacognitive Components in Self-Regulated Reading of Science Texts in E-Based Environments	International Journal of Science and Mathematics Education	2018	11
	The Intellectual Structure of Metacognitive Scaffolding in Science Education: A Co-citation Network Analysis	International Journal of Science and Mathematics Education	2016	14
	Content Analysis Of 1998–2012 Empirical Studies in Science Reading Using a Self-Regulated Learning Lens	International Journal of Science and Mathematics Education	2016	12
	The Effect of Metacognitive Scaffolds on Low Achievers' Laboratory Learning	International Journal of Science and Mathematics Education	2016	16
Wang, C.Y	Assessing Metacognitive Components in Self-Regulated Reading of Science Texts in E-Based Environments	International Journal of Science and Mathematics Education	2018	11
	The Intellectual Structure of Metacognitive Scaffolding in Science Education: A Co-citation Network Analysis	International Journal of Science and Mathematics Education	2016	14
	Content Analysis Of 1998–2012 Empirical Studies in Science Reading Using a Self-Regulated Learning Lens	International Journal of Science and Mathematics Education	2016	12

From the two authors, it can be seen that they have the same three writings, and one different writing. This shows that the two authors have collaborated on their papers. Furthermore, by using VOSviewer, it is

possible to analyze the frequency of collaboration between authors. The results are presented in Figure 2.

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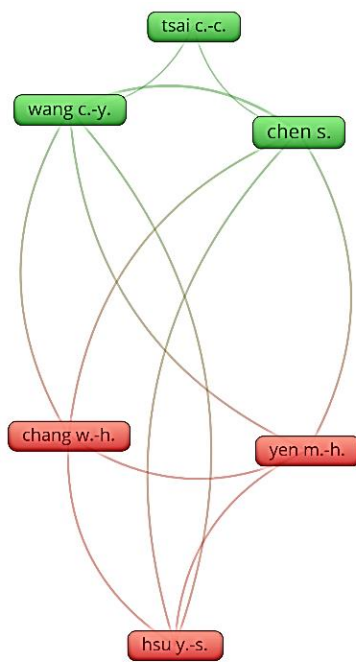


Figure 2. Writer’s Cluster

Based on Figure 2, it can be seen that there are 2 clusters of authors with 6 items. Cluster 1 in red is occupied by 3 authors, namely Chang, Hsu, and Yen. Cluster 2 in green is occupied by 3 other authors, namely Chen, Tsai, and Wang. The authors who are in the same cluster, show that they often write together,

although it is also possible that between clusters also collaborate, the frequency is not as frequent as if in the same cluster.

Next, the findings and recommendations from 1 article with the latest year, and 1 article with the most citations will be discussed, so that they can become recommendations for further research.

From the data, it can be seen that the latest year the SRL topic was discussed by researchers who had the most articles was in 2018 with the topics raised still more focused on the relationship between SRL and metacognition. After that year, there were still several researchers during the Covid Pandemic, for example regarding the use of Massive Open Online Courses (MOOCs) which required basic SRL skills (Vilkova, 2022) as well as the efforts of a school in Kenya to create online math textbooks that could guide students to develop SRL capabilities. (Munahefi et al., 2022; Otieno & Povey, 2022) discusses the importance of SRL in forming Critical Thinking Skills.

Table 3. Finding and Recommendation 2 articles on the topic of SLR in Mathematics Learning

Writer	Article’s Title	Finding
(Yen et al., 2018)	Assessing Meta-cognitive Components in Self-Regulated Reading of Science Texts in E-Based Environments	This study uses 47 articles as a literature study to explore the effects of metacognition with SRL on electronic science reading. There are 3 forms of metacognitive that are considered from the results of this study, namely metacognitive knowledge, skills, and experiences. It also results in ways to provide an assessment of reading with paper texts and using electronic media along with the implementation and interpretation of data in reading. In addition, there are also methods that appear when capturing dynamic behavior when reading electronic readings.

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Writer	Article's Title	Finding
(Chen et al., 2016)	The Effect of Meta-cognitive Scaffolds on Low Achievers' Laboratory Learning	SRL is applied to students with low-level academic abilities. The SRL used is the SRL model from Winne and Hadwins and has involved technology to improve learning, namely the Microcomputer Based Laboratory (MBL). The results obtained in this study are differences in results between male and female students, where male students are more successful because they have more mature planning than female students.

3. Keyword Analysis on the Feedback Literacy Topic

Analyzing the relationship between keywords is also important if the researcher wants to know the novelty of a topic, so that the

relationship between the topic and other topics can be known. With the help of the VOSviewer application, it can be seen the relationship between SLR topics and other topics, as shown in Figure 3.

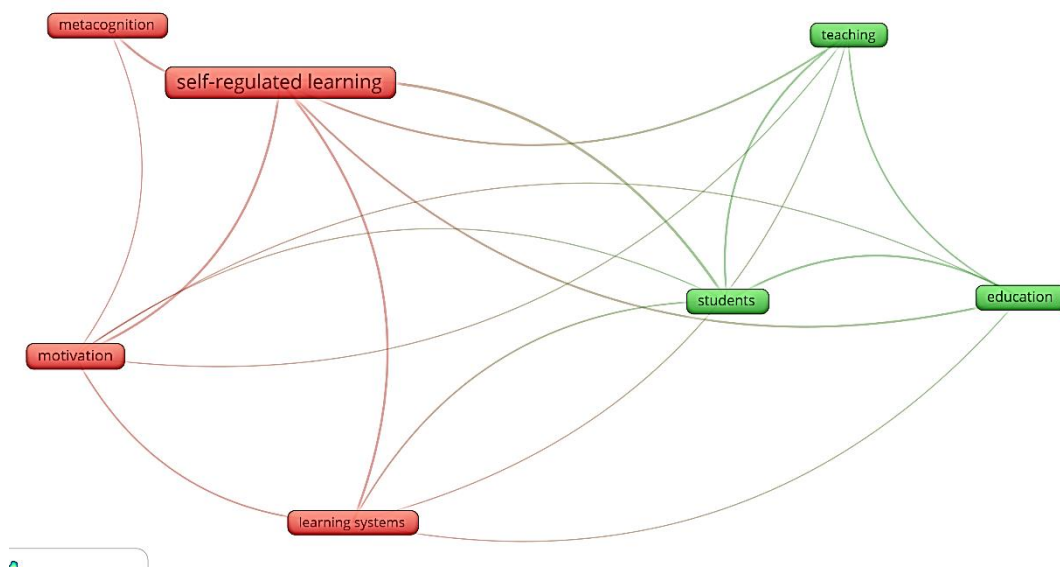


Figure 3. Keyword Cluster

There are 2 clusters in the keywords in the SLR topic: the first cluster and the second cluster. The first cluster, red, consists of SRL, metacognition, motivation, and learning systems. The second cluster, green, consists of students, education, and teaching. From the first cluster, it can be seen that articles containing SLR will be discussed with metacognition, this is in accordance with (Ader, 2019) which

states that SRL is superordinate or as part of metacognition. While Motivation is also often discussed with SLR, because students must have motivation in order to have SLR skills (Ng et al., 2016), as well as learning systems, because in this technological era, a systematic learning platform will help students to develop themselves more independently (Li & Lajoie, 2021).

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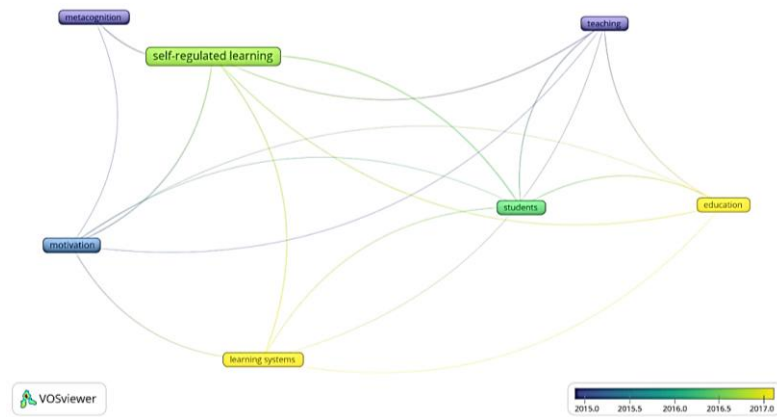


Figure 4. Relationships between keywords by year

In addition to seeing the relationship between keywords, the novelty of keywords can also be seen, as shown in Figure 4. Figure 4 shows a lighter color meaning that it has a newer topic. From the picture, it can be seen that the topic of learning systems is the newest topic in cluster 1, while the topic of education is the newest topic in cluster 2. The topic of learning systems is the newest topic, especially during the Covid-19 pandemic and technology has become very important in the world of education. learning can be made as a system supported by technology, as discussed by (D. G. Brenner et al., 2017; Van Horne et al., 2018). While the topic of education is discussed by

always involving technology that can facilitate the learning process (Andersen et al., 2020). From this analysis, it can be seen that although it seems that SLR with metacognition and motivation is a fairly close topic, in fact, it is not a new topic anymore, and has begun to be abandoned by researchers.

In addition to keywords, from the Scopus database, there are 21 journals that discuss SLR topics in the field of Mathematics learning. Among the twenty-one journals, there are 5 journals that publish the most on the topic, as shown in Figure 4. This data is useful for researchers to develop their research topics, which can focus more on reading the articles contained in these journals.

Number of Articles in Journals

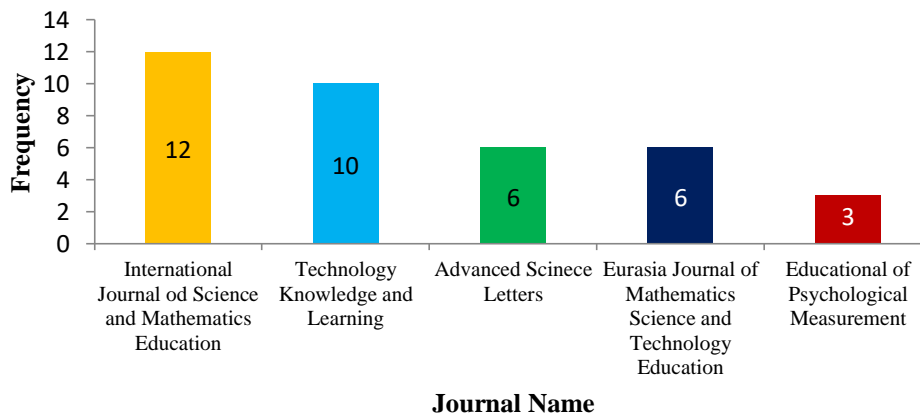


Figure 5. Five journals with the highest number of articles

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In brief, the findings of this study are:

- (1) Writers from Taiwan dominate the writing of articles on SLR topics in Mathematics Education.
- (2) Chen and Wang are the authors of the most SLRs and citations.
- (3) SLR topics are often discussed with metacognition and MOOCs.

The results of these findings contribute to researchers who are interested in the SLR field to discover topics that can be developed further, especially in mathematics education.

CONCLUSION AND SUGGESTION

Based on our research, there are 3 conclusions and 1 recommendation. The first conclusion refers to the data. From 5,672 documents regarding SLR, if filtered based on the type of writing in the form of articles and published in journals, and selected in the fields of Social Science and Mathematics, it turns out that only 63 articles are found. This means that research in the field of SLR in mathematics learning, has not been widely studied.

Second, the journal that can be used as a reference (because it contains the most articles in the fields discussed this time) is the International Journal of Science and Mathematics Education with Springer Netherlands as its publisher. Moreover, it occupies Quartile 1 both in Mathematics and Education with SJR 2021 is 1.15. Third, the latest topics related to SLR are Learning Systems and Education, whereas the topics of Metacognition and Motivation have begun to be abandoned. The topic of learning systems discusses the use of technology to facilitate and manage every step of the SLR more closely.

Suggestions for further research is to create a learning model related to SLR in the field of mathematics, which uses the Learning System so that it can be used online and all stages are monitored by the system from the application that is built.

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