Emerging Trends of Self-regulated Learning: A Comprehensive Bibliometric Analysis

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Abstract

Barry J Zimmerman considered that self-regulated learning is an active learning process including strategy use, metacognition, and motivation. Self-regulation failure is the core problem of academic procrastination, which seriously threatens academic success. The present research aims to provide a complete outline of SRL and catch the trends and current hotspots. VOSviewer and Bibliometric software was used to analyze the data from the Web of Science core collection database. The results showed that there are a considerable number of publications of articles on self-regulated learning every year; the USA is the most influential country, and Maastricht University is the most productive institution; it is clear that most authors do not like to cooperate with others, which leads to major groups of writers like Azevedo Roger and Gasevic Dragan. The Frontiers in Psychology is an influential journal that received much more articles and citations. The main hotspots of self-regulated learning were: (a) self-regulated learning; (b) self-regulation; (c) metacognition; (d) motivation; (e) learning analytics. In a word, this study is useful for practitioners and scholars to comprehensively understand the trend of self-regulated learning research.

Keywords: self-regulated learning, the trend, Bibliometric analysis, VOSviewer, Bibliometric tool

1. Introduction

Self-regulated learning refers to self-generation, strategic participation, and reflection in completing learning tasks (Lichtinger & Kaplan, 2011; Barry J Zimmerman, 2000). Self-regulated learning was usually divided into pre-action, action, and post-action phases, which was also the widely used notation. The SRL model described students' learning behavior under given tasks. The pre-action phase means a person regulates his behavior by setting goals related to pieces of work (Schmitz & Wiese, 2006; Schunk & Ertmer, 2000). In the action phase, under the framework of social cognition theory, there are 14 self-regulating learning strategies, which can be divided into four domains: (a) resource management (Anthonysamy, Koo, & Hew, 2020b; Barry J Zimmerman & Pons, 1986), (b) metacognitive knowledge, (c) motivational belief (Anthonysamy et al., 2020b; Pintrich, 1999), and (d) cognitive engagement. In general, the main learning purpose is to reach the expected outcomes of learning. Learning results occur in the stage of action and belong to the post-action stage (Bandura, 1986; Schmitz & Wiese, 2006; Barry J Zimmerman, 2000).

Cyclical models of SRL (Valenzuela, Codina, Castillo, & Pestana, 2020; Barry J Zimmerman, 1998) believe that disorders like the low ability to make decisions or perseverance lacking can contribute to academic procrastination. Self-regulation failure is the core problem of academic procrastination, which seriously threatens the subjective well-being and academic achievement of students (Piers Steel & Klingsieck, 2016; Valenzuela et al., 2020). It was shown that procrastination relates to academic success negatively (Cosnefroy, Fenouillet, Mazé, & Bonnefoy, 2018).

Self-regulated learning has attracted increasing attention for its importance in predicting academic success (Pintrich & De Groot, 1990; J. Wang, King, & Rao, 2019). In recent decades, the self-regulated learning conception has attracted more and more attention in educational practice and educational research (Bolhuis, 2003; De Smul, Heirweg, Van Keer, Devos, & Vandevelde, 2018) as it is recognized as a component of academic success (De Smul et al., 2018; Philip H Winne, 1997).

It is necessary to comprehensively review the research progress, new trends, and hot spots of SRL strategies. The present research aims to find the answer to the following five research questions:

1) What are the trends and subject categories of self-regulated learning?

2) Which authors, countries, or institutions actively participate in the self-regulated learning strategies research?

3) What are the most cited journals in the SRL strategies research field?

4) What references are highly cited in self-regulated learning strategies?

5) What are the new trends and hot spots in self-regulated learning strategies?

2. Methodology

2.1 Data Collection

In this study, data was collected from the WoS database because of its high standard, wider coverage, and ease of refining and filtering queries (Elaish, Shuib, Ghani, Mujtaba, & Ebrahim, 2019). A total of 2254 articles were analyzed. The query method is as follows (see Figure 1):

Topic	• ("self-regulat* learning" OR "self-regulat* strategies" OR SRL)
Timespan	• Last five years
Languages	• English
Document types	• All document types
Indexes	• SCI-EXPANDED, A&HCI, SSCI, CPCI-SSH, CPCI-S, BKCI-S, ESCI, BKCI-SSH

Figure 1. Data queries

2.2 Data Analysis

This part uses Bibliometrix tools and R language to provide a comprehensive and clear analysis of selected publications in the field of SRL. For instance, the quality paper, the hot research topics, the best author, the sources, research categories, and the most cited keywords from the year 2018 to 2022.

Excel was used to export all data for the following analysis. For bibliometric analysis, VOSviewer, visualization, and construction software, were applied for conducting the analysis (Contreras & Abid, 2022). The keyword units' coexistence network, bibliographic coupling network of sources, authors, organizations, countries, co-cited authors, and references were analyzed in detail.

3. Results

3.1 Publication Output

The trends of annual publication help to understand the development stages of self-regulated learning strategies (Gao, 2022). Figure 2 showed that, on the whole, the annual publications mainly showed an upward trend over the past five years. The total number of articles published each year is more than 504, and the total number of articles published in 2018 is 515. In 2019, the number of articles continued to rise to 526, the highest in five years. In 2020, 504 articles were published. In 2021, 516 articles were published. Fewer articles were published in 2022 because the data was collected as of January 2022. Scholars or researchers attach importance to self-regulated learning strategies.
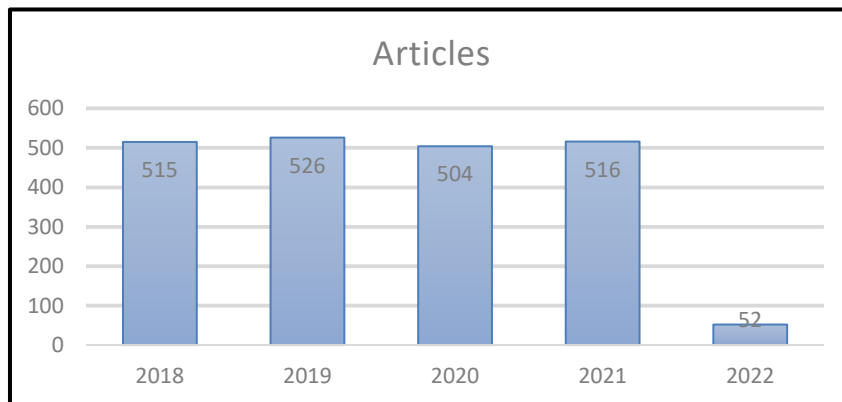

Figure 2. The annual publication of the SRL area

3.2 Categories

In Web of Science classification, a literature review of self-regulated learning can reflect the level of a particular discipline's development of research at a certain time and shows more objects of study over time (Hamidi & Ramavandi, 2020). SRL is included in approximately 25 domain categories in the database of the Web of Science. Table 1 showed the first five subjects, which include education research (701articles, taking a percentage of 31.10%), psychology educational (217 articles, taking a percentage of 9.63%), education scientific disciplines (190 articles, taking a percentage of 8.43%), psychology multidisciplinary (148 articles, take the percentage of 6.57%), computer science interdisciplinary applications (143 articles, take the percentage of 6.34%). In terms of the distribution of discipline categories, the focus of these disciplines has a higher priority in research. Different categories of publication numbers show the trend of self-regulated learning research in different subjects.

Table 1. The first five subjects

Subject category	2018-2022	%/ of 2254
Education research	701	31.10%
Psychology educational	217	9.63%
Education scientific disciplines	190	8.43%
Psychology multidisciplinary	148	6.57%
Computer science interdisciplinary applications	143	6.34%

3.3 Countries and Institutions

The national distribution analysis can be helpful to understand the spatial and geographical distribution of research articles. In the study of self-regulated learning,

Figure 3a showed the cooperation between countries. The major countries' visualization is drawn by the VOSviewer tool. Node size represents the published article numbers. Larger nodes indicate more articles published. Cooperation should be strengthened among international countries and institutions.
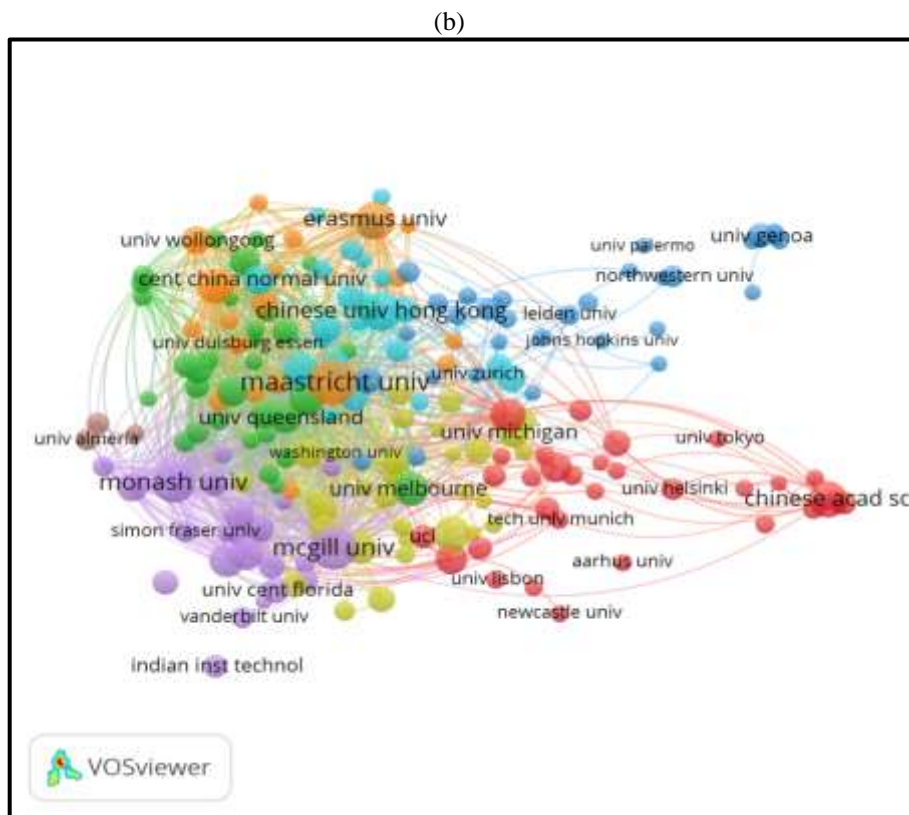
(a)

(b)
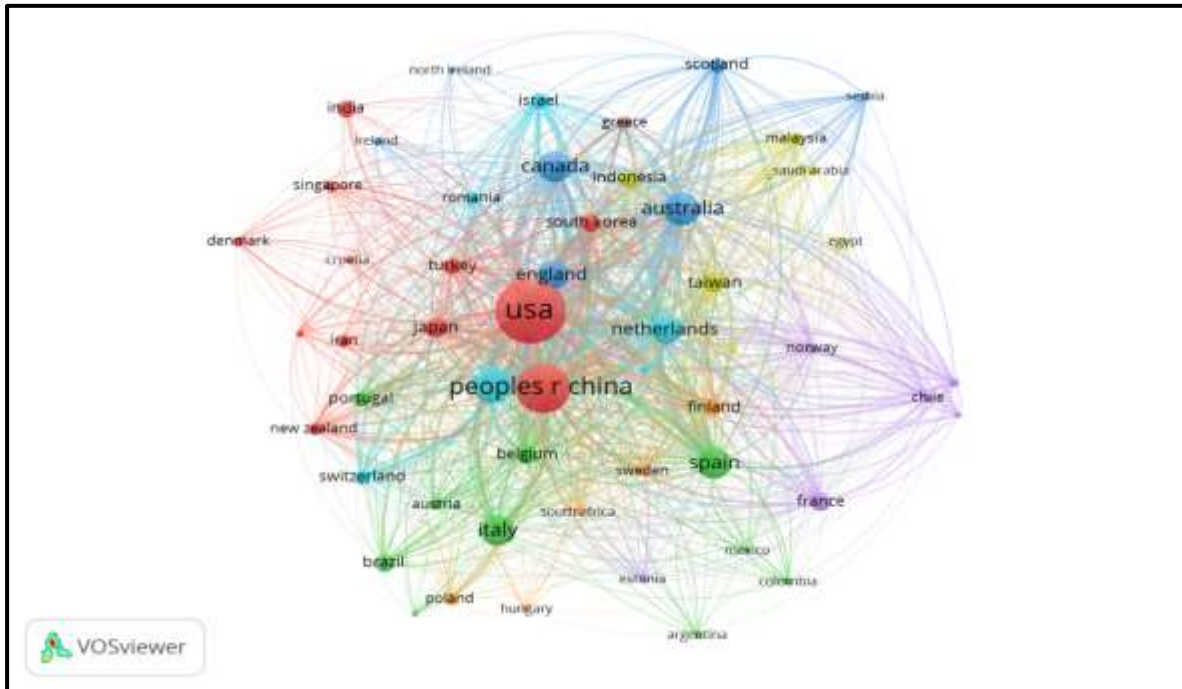
Figure 3. The map of visualization in self-regulated learning research: (a) Major countries' mapping; (b) Organizations' mapping

Table 2. The first ten countries for publications

Rank	Country	Publication	%/of papers	TC	TC/P
1	The USA	1120	49.69%	2296	5.08
2	China	853	37.84%	2108	5.68
3	Italy	338	15.00%	586	4.80
4	Germany	336	14.91%	813	6.11
5	Australia	306	13.58%	850	8.25
6	Canada	301	13.35%	556	5.51
7	UK	279	12.38%	546	6.66
8	Spain	270	11.98%	528	5.33
9	Netherlands	238	10.56%	921	10.84
10	Brazil	154	6.83%	105	2.92

Note. TC: the total number of citations a country has received; TC/P: the average number of citations per paper in a country

As

Table 2 showed, the USA published the most articles about 578 articles accounting for *25.64%*, followed by China, which published 351 articles accounting for *15.57%*, and Italy published 184 articles accounting for *8.16%*. The top 10 countries published 1980 articles, accounting for 87.84% of the total 2254 self-regulated learning research papers, while other countries only accounted for only 12.16% of self-regulated learning research papers.

Another important measure of a country's scientific influence in the area of self-regulated learning is the total number of citations. It is worth noting that the total citation number in The USA is higher than in other countries (2296 citations). The theory, the application, the strategies, the assessment, and the settings of self-regulated learning are actively analyzed in the United States. For TC/P and TC values, the USA, the PRC, the Netherlands, Australia, Germany, and Italy have made significant contributions to the overall effort. The Netherlands' TC/P is as high as 10.84, while Brazil's TC and TC/P are relatively low.

In

Figure 3b, a visual map of the major organization was drawn using VOSviewer software. In Table 3, the institutions that are most productive in terms of publication were listed. The most influential institutions are Maastricht University (54 articles), Mcgill University (42 articles), Monash University (39 articles), University of Toronto (39 articles), and Chinese University of Hong Kong (31 articles). Of these institutions, six came from China and Canada, and the remaining four were from Australia and the Netherlands, which shows that China and Canada have made outstanding contributions to the area of self-regulated learning.

Table 3. The first ten institutions for publications

Rank	Institution	Publication	Country
1	Maastricht Univ	54	Netherlands
2	Mcgill Univ	42	Canada
3	Monash Univ	39	Australia
4	Univ Toronto	39	Canada
5	Chinese Univ Hong Kong	31	China
6	Univ Melbourne	30	Australia
7	Erasmus Univ	27	Netherlands
8	Educ Univ Hong Kong	26	China
9	Univ British Columbia	26	Canada
10	Cent China Normal Univ	24	China

3.4 Author Collaboration and Co-citation Network

The study of the author plays an important role in indicating study capability and evaluating progress in the academic field. In Figure 4a, the collaboration between authors in a self-regulated learning area is vividly mapped, a visual map of the principal authors was created by VOSviewer software. Most authors do not prefer to work with other collaborators, resulting in few connections among the main authors. Table 4 lists the most productive authors and their associations for 2018 to 2022. In terms of published articles, Azevedo Roger from the United States (20 articles) and Gasevic Dragan from Australia (20 articles) dominated the main positions of published articles. Other notable authors include Baars Martine (14 articles), Cleary Timothy J. (14 articles), and Li Shan (14 articles). These authors' unremitting efforts have contributed to the promotion of self-regulated learning research. For example, Azevedo Roger, an author from America, is interested in using multi-modal and multichannel SRL data analysis to improve learning techniques and meet students' self-regulation needs (Azevedo & Gasevic, 2019). Gasevic Dragan with interdisciplinary team members concentrated on using educational data-mining and statistical techniques to measure, infer social processes, infer metacognition, infer cognition, and detect which are related to self-regulation (Azevedo & Gasevic, 2019). A systematic literature review from Baars Martine analyzed learning analytics dashboards and assessed their effects on teaching and learning through empirical findings (Matcha, Uzir, Gasevic, & Pardo, 2020). Cleary Timothy J. investigated the sequential-stage relationship between performance, forethought, and self-reflective processes (Callan & Cleary, 2019). In a computing environment, Li Shan studied the relationships among task values, self-regulated learning, and self-efficacy, and discovered that self-efficacy significantly predicted SRL and the intrinsic value of students; utility value and intrinsic value predict students' self-regulated learning significantly (Li & Zheng, 2018).

In Figure 4b, to analyze the co-authorship, VOSviewer drew the graph of the citation relationship between authors, which was described by default, tags, and circles. Higher weight co-cited authors expressed by items' larger tags and circles. The cluster of items determines its color. The lines between the items constitute their connections. The top ten authors are cited most are listed in

Table 5. The most frequently cited author is *Baars Martine (frequency 92), who has conducted a systematic literature review of how SRL strategies support can be used in online settings and how to deal with human factors (Wong et al., 2019). The second came* Paas Fred (*frequency 79*), who cooperated with *Baars Martine to conduct the systematic literature review*. The third was Cleary Timothy J. (*frequency 71*) examined the predictive validity and the convergent validity of self-regulated learning, the results suggested the approach of multidimensional assessment should be in consideration by psychologists at school (Callan & Cleary, 2018). The fourth author is Gasevic Dragan (*frequency 67*), who studied the harm of procrastination, the form of self-regulated failures, and the impact of procrastination on academic life satisfaction and emotional well-being (Balkis & Duru, 2016). The fifth was Maldonado-Mahauad J (*frequency 61*), who used computational methods to theoretically establish self-regulated learning processes (Maldonado-Mahauad, Perez-Sanagustin, Kizilcec, Morales, & Munoz-Gama, 2018).

Table 4. First ten prolific authors

Rank	Publications	Author	Institution	Country
1	20	Azevedo, Roger	University of Central Florida	The USA
2	20	Gasevic, Dragan	Monash University	Australia
3	14	Baars, Martine	Erasmus University Rotterdam	Netherlands
4	14	Cleary, Timothy J.	Rutgers State University-New Brunswick	The USA

5	14	Li, Shan	McGill University	Canada
6	13	Lajoie, Susanne P.	McGill University	Canada
7	13	Zheng, Juan	McGill University	Canada
8	12	Paas, Fred	Erasmus University Rotterdam	Netherlands
9	12	Rosario, Pedro	Universidade do Minho	Portugal
10	11	Bai, Barry	Chinese University of Hong Kong	China

Table 5. Top ten cited authors and articles

Rank	Frequency	Year	Author	Highly-Cited References
1	92	2019	Baars, Martine	Supporting self-regulated learning in online learning Environments and MOOCs: a systematic review
2	79	2019	Paas, Fred	Supporting self-regulated learning in online learning Environments and MOOCs: a systematic review
3	71	2018	Cleary, Timothy J.	Multidimensional Assessment of Self-regulated Learning with Middle School Math Students
4	67	2020	Gasevic, Dragan	A systematic review of empirical studies on learning analytics dashboards: a self-regulated learning perspective
5	61	2018	Maldonado-Mahauad J	Mining theory-based patterns from big data: identifying self-regulated learning strategies in massive open online courses
6	61	2018	Perez-Sanagustin, Mar	Mining theory-based patterns from big data: identifying self-regulated learning strategies in massive open online courses
7	54	2020	Azevedo, Roger	A systematic review of empirical studies on learning analytics dashboards: a self-regulated learning perspective
8	54	2020	Pardo, Abelardo	A systematic review of empirical studies on learning analytics dashboards: a self-regulated learning perspective
9	53	2020	Kester, Liesbeth	Supporting learners' self-regulated learning in massive open online courses
10	49	2020	Janssen, Jeroen	Supporting learners' self-regulated learning in massive open online courses

(a)
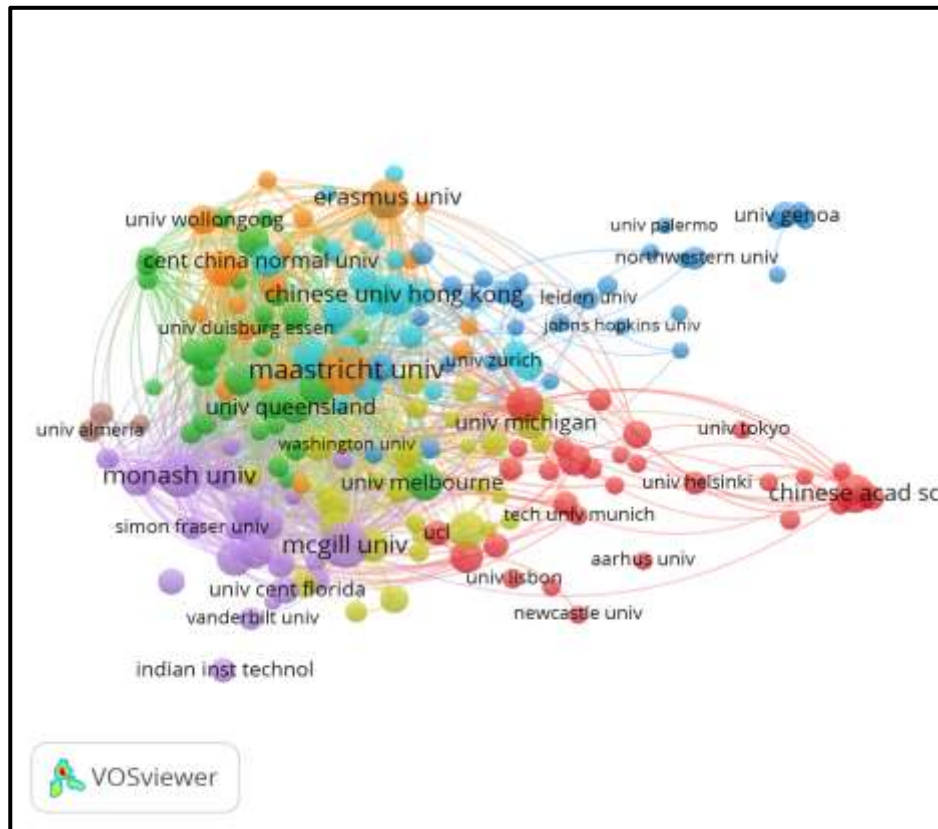
(b)

Figure 4. The visualization map: (a) Main authors; (b) Co-cited authors

3.5 Co-cited Journals

To understand the core journals in a certain field, one should first focus on the number and frequency of citations. Table 6 showed Frontiers in Psychology published the most, followed by Computers & Education. Notably, Computers in Human were cited the most (554 times of

citations). The results suggested that Frontiers in Psychology and the Computers in Human play an important role in the study of self-regulated learning. The influence of journals can be assessed using the H-index. The result shows that Computers & Education's H-index is the highest, which reaches up to 15, and has the biggest impact on self-regulated learning. According to the classification of the top five journals by subject, education, psychology, and multidisciplinary journals receive more attention than other journals. The journals' high citation and publication levels indicate the journals are the most popular in this field.

The analysis of the co-cited journals revealed that the highly cited journals have an obvious distribution in the field of self-regulated learning. Figure 5 shows the time zone view of the network of co-cited journals.

Table 6. The first five high-producing journals in self-regulated learning: 2018-2022

Rank	Journal	P_a	%/of papers	TC_b	TC/P_c	H-index	IF	Subject
1	Frontiers In Psychology	74	3.28%	231	3.12	9	3.618	Psychology, Multidisciplinary
2	Computers & Education	33	1.46%	477	14.45	15	9.269	Computer Science, Interdisciplinary Applications, Education & Educational Research
3	Computers In Human Behavior	33	1.46%	554	16.79	13	8.302	Psychology, Experimental, Multidisciplinary
4	Metacognition And Learning	29	1.29%	199	6.86	7	5.264	Education & Educational Research, Psychology, Educational
5	Sustainability	29	1.29%	109	4.24	3.76	5	Environmental Sciences; Environmental Studies

Note. P_a: the total publications; TC_b: the total number of citations; TC/P_c: the average number of citations; IF: a 5-year impact factor

Figure 5. The time zone view of the network of co-cited journals

3.6 Cited References

Table 7 lists the first ten cited papers. Analyzing the cited references helps investigators understand the inner relationships among authors, countries, and organizations. One of the most cited references in the field of self-regulated learning is Zimmerman Barry J., "Attaining self-regulation: a social cognitive perspective" (Barry J Zimmerman, 2000). The second was still Zimmerman Barry J., "The Nature of Procrastination: A Meta-Analytic and Theoretical Review of Quintessential Self-Regulatory Failure" (P. Steel, 2007). The third was Zimmerman Barry J., "Investigating self-regulation and motivation: Historical background, methodological developments, and prospects" (B. J. Zimmerman, 2008). The fourth was Panadero, "A review of self-regulated learning: six models and four directions for research" (Panadero, 2017). The fifth was Winne P.H., "Computing technologies as sites for developing self-regulated learning" (Philip H Winne & Stockley, 1998). Their research is considered fundamental to the region because of its high co-citation and huge influence. In the geographical distribution aspect, seven articles from two authors *Zimmerman* Barry J. and Pintrich Paul R., who came from the USA, showed that the USA lead the research of self-regulated learning.

Table 7. Top ten cited references

Citation	Year	Author(s)	Title	Source	Country
335	2000	Zimmerman Barry J.	Attaining self-regulation: a social cognitive perspective	A Handbook of Self-regulation	The USA
222	2002	Zimmerman Barry J.	Becoming a self-regulated learner: an overview	Theory into Practice	The USA
188	2008	Zimmerman	Investigating self-regulation and	American Educational	The USA

		Barry J.	motivation: Historical background, methodological developments, and prospects	Research Journal	
169	2017	Panadero	A review of self-regulated learning: six models and four directions for research	Frontiers in Psychology	Spain
167	1998	Winne, P.H.	Computing technologies as sites for developing self-regulated learning	Self-regulated learning: From teaching to self-reflective practice	Canada
164	1990	Pintrich, Paul R.	Motivational and self-regulated learning components of classroom academic performance	Journal of Educational Psychology	The USA
160	2000	Pintrich, Paul R.	The role of goal orientation in self-regulated learning	Handbook of self-regulation	The USA
159	2004	Pintrich, Paul R.	A conceptual framework for assessing motivation and self-regulated learning in college students	Educational Psychology Review	The USA
141	1990	Zimmerman Barry J.	Self-regulated learning and academic achievement: an overview	Educational Psychologist	The USA
126	1989	Zimmerman Barry J.	A social cognitive view of self-regulated academic learning	Journal of Educational Psychology	The USA

4. Research Hotspots and Trends

By frequency of keywords analysis of the specific discipline and research field, one can get a general understanding of the *self-regulated learning* field. In Figure 6, VOSviewer software drew the keyword co-occurrence network.

Cluster 1 (Blue): The largest node is self-regulation. This cluster was focused on self-control, strategies, and skills, such as reflection, self-determination theory, structure equation modeling, learning analytics, metacognition, and education.

Cluster 2 (Yellow): The largest node was self-regulated learning, which concentrated on the learning strategies, learning assessment, learning outcomes, learning environments, and regulation, such as learning environment, strategies of learning, academic self-efficacy, language learning strategies, assessment for learning, interactive learning environment, emotion regulation, academic achievement, strategy instruction, academic success, and classroom assessment.

Self-regulated learning means the learning process led by behaviors, metacognitive activities, and motivational beliefs to achieve personal goals (Z. R. Sun, Xie, & Anderman, 2018). Self-regulated learning is also a process involving behavioral and psychological changes (Dogan, 2022) that can help students better regulate their learning to achieve academic success (Wong et al., 2019).

Cluster 3 (Orange): The largest node is metacognition, which is related to the following keywords: game-based learning, science, testing effect, retrieval practice, monitoring accuracy, transfer, judgments of learning, task selection, and problem-solving. This cluster focused more on the cognitive processes controlling including two components of knowledge and regulation in the area of self-regulated learning.

Cluster 4 (Purple): The largest node is learning analytics, which is mainly related to keywords like e-learning, reinforcement learning, deep learning, EFLwriting, literature review, task analysis, massive open online courses, and MOOC. This branch focused on various procrastination and the crucial factors associated with it.

Table 8 shows the most concerned topic is self-regulated learning, which strikes the highest frequency keywords (701), the next one is self-regulation (122), motivation (93), metacognition (91), and learning analytics (65), which showed the hotspots of the research area. VOSviewer co-occurrence analysis was used to analyze the top five keywords, which were 1301, 526, 520, 194, and 85 papers, respectively. In the overlay visualization, the circle's size indicates the keyword's weight and the different color indicates the keyword's average citation score.
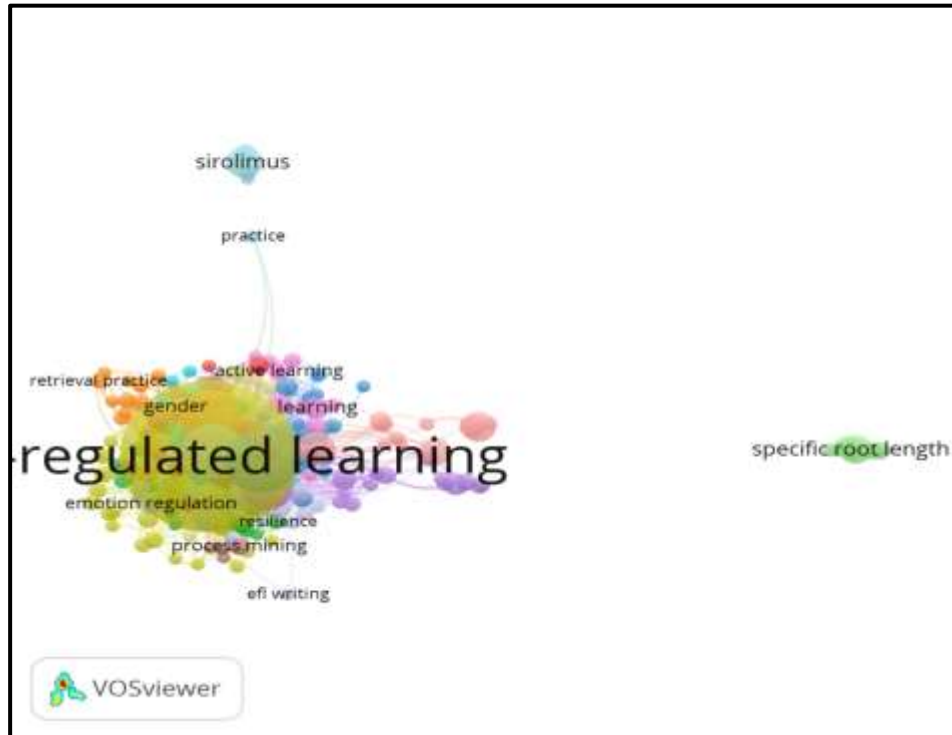
Figure 6. Overlay visualization map of Article-weights

Table 8. The first thirty keywords in frequency

Rank	Frequency	Keyword	Rank	Frequency	Keyword
1	701	self-regulated learning	16	27	feedback
2	122	self-regulation	17	27	specific root length
3	93	motivation	18	26	formative assessment
4	91	metacognition	19	24	e-learning
5	65	learning analytics	20	24	SRL
6	60	self-efficacy	21	23	flipped classroom
7	57	higher education	22	21	education
8	53	learning strategies	23	19	collaborative learning
9	38	online learning	24	18	academic performance
10	33	covid-19	25	18	monitoring
11	31	sirolimus	26	18	MOOCs
12	30	SRL	27	18	self-assessment
13	29	acromegaly	28	17	achievement
14	28	blended learning	29	17	self-directed learning
15	27	academic achievement	30	17	somatostatin receptor ligands

4.1 Self-regulated Learning

Self-regulated learning is a learning process dominated by behaviors, metacognitive activities, and motivational beliefs to achieve learning goals (Schunk & Zimmerman, 2012; Z. R. Sun et al., 2018). Figure 7 presents that the keywords scored above ten are learning strategies, metacognition, co-regulation, learning analytics, SRL, problem-solving, cognitive load, mental effort, the judgment of learning, self-control, monitoring, engagement, and assessment for learning. It is equally important to analyze the influence of self-regulated learning on other factors, especially its relationship to learning outcomes and learning assessment. The study studies the relationship between academic achievement and self-regulated learning in flipped courses, and the results show that learning strategies and self-efficacy are associated with academic performance positively (Z. R. Sun et al., 2018). Strategies of motivational regulation are an important part of self-regulated learning; a study investigated its effects on English writing learning (Teng & Zhang, 2018). Another research presented the relationship between self-regulated learning and formative assessment (Panadero, Andrade, & Brookhart, 2018).
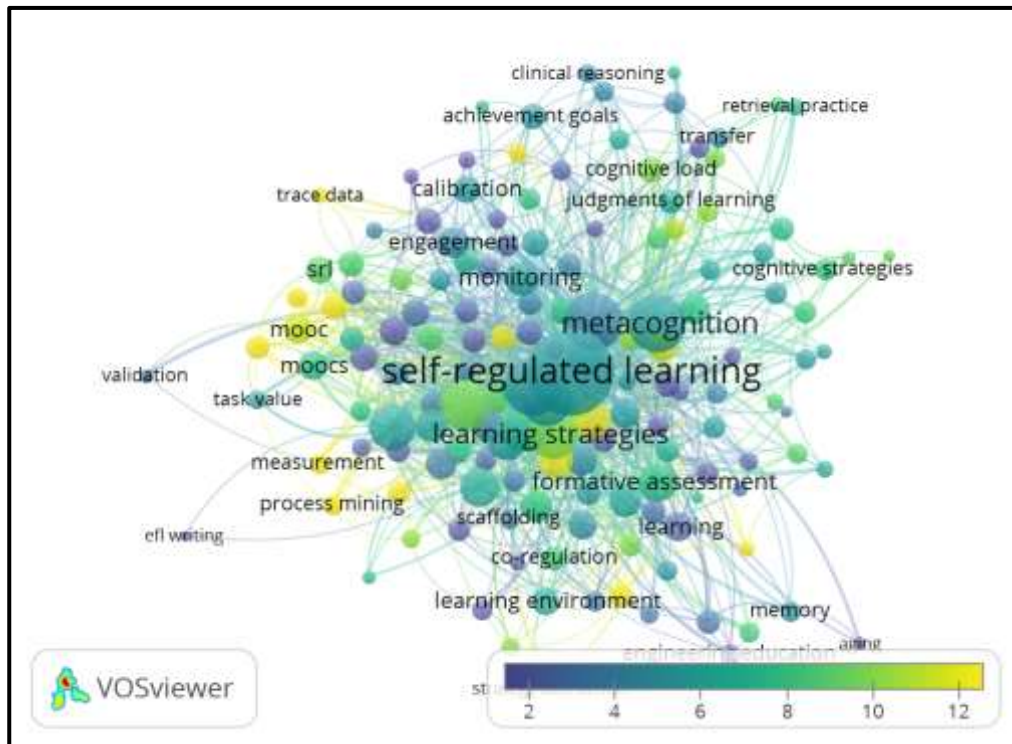
Figure 7. Overlay visualization of citation scores and link-weights

4.2 Self-regulation

A preliminary screening of 2254 papers, including 526 papers related to self-discipline, accounting for 23.3%. Self-regulation is key to performance and learning. It has been noted that self-regulation includes the component processes of self-evaluation, self-observation, and self-reaction (Shyr & Chen, 2018). Figure 8 shows that the keywords that appear more than 8 times are: learning strategies, flipped classroom, self-regulated learning strategies, self-directed learning, online learning, learning analytics, e-learning, metacognition, formative assessment, university, students, and self-control. From the perspective of self-regulation, a study analyzed related literature and proposed a model to explain how to transfer acute job strain into severe job burnout (Bakker & de Vries, 2021).

An experimental study found that flipped language learning systems promoted academic performance in the flipped classroom (Shyr & Chen, 2018). Self-regulated learning is an influential and important study in educational studies in the last ten years. A paper analyzed the germane load, intrinsic load, and extraneous load phases of self-regulated learning (Seufert, 2018). A review on self-regulated learning strategies' promotion discussed its benefits to teachers, students, educators, curriculum designers, researchers, and school leaders (Lawson, Vosniadou, Van Deur, Wyra, & Jeffries, 2019). A review showed that self-reports have an insight into the self-regulation of students (Rovers, Clarebout, Savelberg, de Bruin, & van Merrienboer, 2019). A paper discussed deep versus and surface knowledge, and recapitulate described the information processing of self-regulated learning (P. H. Winne, 2018). A study revealed that self-regulated learning and self-efficacy strategies significantly promoted the writing proficiency of EFL students in the EFL context (T. Sun & Wang, 2020).
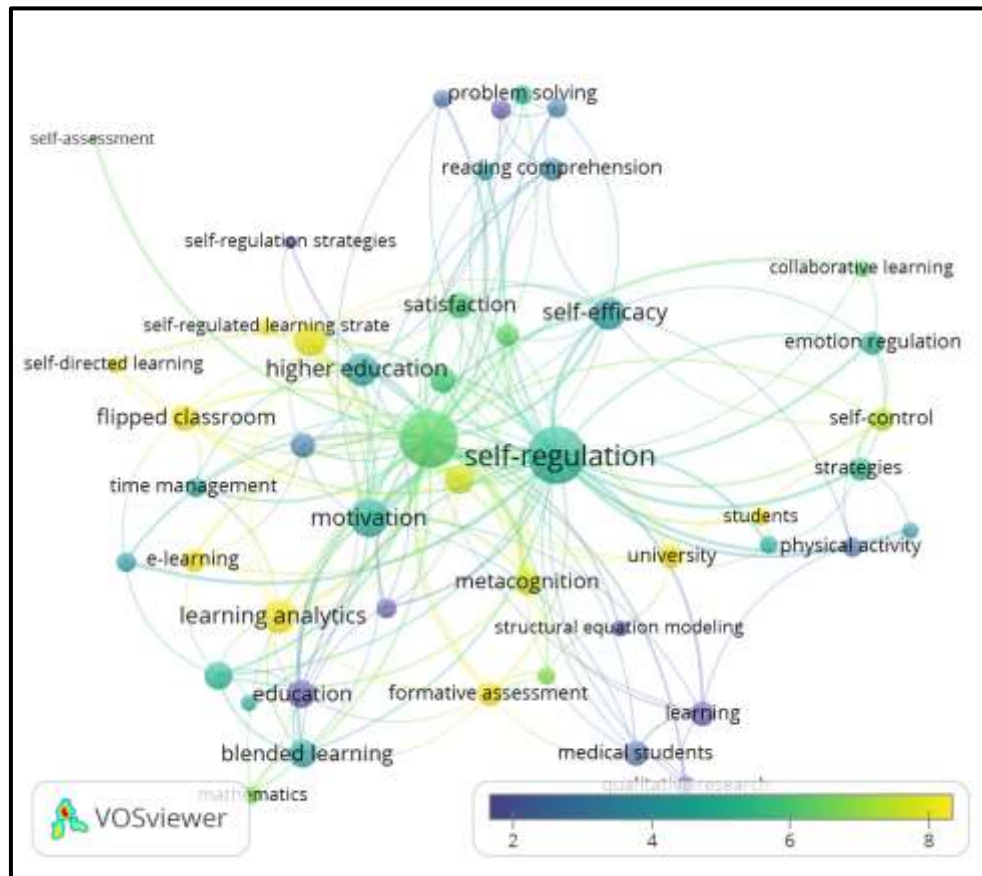
Figure 8. Overlay visualization of citation scores and link-weights

4.3 Motivation

Some researchers considered that motivation is a part of self-regulated learning and a precursor to its success (Jansen, van Leeuwen, Janssen, Jak, & Kester, 2019). Other researchers also agreed that self-regulated learning mainly contains motivation, behavior, context, and cognition. Motivation includes the regulation of self-efficacy, intrinsic goal orientation, control belief, text anxiety, and extrinsic goal orientation (Lee, Watson, & Watson, 2019; Pintrich, 1991). In the online learning environment, SRL studies pay more attention to task value and self-efficacy components of motivation (Artino, 2007; Lee et al., 2019).

Figure 9 illustrated the rising keywords and academic connections vividly. In overlapping visual maps, the keywords learning strategies, assessment, online learning, intervention, satisfaction, MOOC, massive open online courses, online learning, learning analytics, and feedback arise above ten times.

In terms of the basketball game, a study showed that self-efficacy for achievement and self-regulated learning relate to motivation positively (Yang, 2020). A study on the relationship between academic performance and learning motivation found that cognitive strategies were the mediator between self-regulated learning and motivation (Wu & Chang, 2021). The research that studied the influence of mindsets on learning motivation showed that it is necessary to reinforce and strengthen motivation and interventions (Von Suchodoletz, Rahn, Nadyukova, Barza, & Achtziger, 2020). The researchers concluded the literature on the concept of motivational regulation in terms of self-efficacy, which implied that self-efficacy for motivation can strengthen the success of self-regulation (Trautner & Schwinger, 2020).
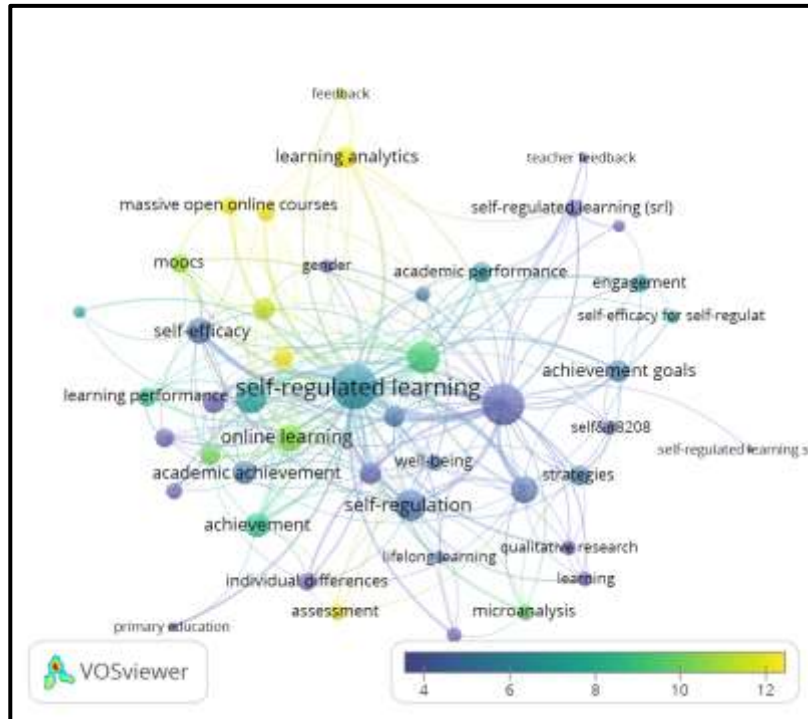
Figure 9. Overlay visualization based on motivation link weights and citation scores

4.4 Metacognition

As shown in Figure 10, there existed a significant correlation between metacognition and self-regulated learning. In overlapping visual maps, the keywords' microanalysis, self-regulated learning, and meta-cognition arise above ten times.

Metacognition means the understanding of processes, knowledge, affective states, and cognitive states, and the ability to regulate and monitor them consciously. Metacognition consists of the components of procedural knowledge and declarative knowledge (Marra, Hacker, & Plumb, 2022). An article aimed to integrate the ideas of related articles and analyze support from teachers for self-regulated learning and metacognition, to form a model which can be helpful for the professional development and performance of students (Greene, 2021). Since the world suffered from COVID-19 in the spring of 2020, most students had to learn at home, which needs more self-regulated learning than before, research showed the difficulties related to SRL that teachers and students experienced (Dignath & Mevarech, 2021). A structural model tested the direct effect of self-control on academic performance mediated by metacognitive regulation (Dzinovic, Devic, & Deric, 2019).
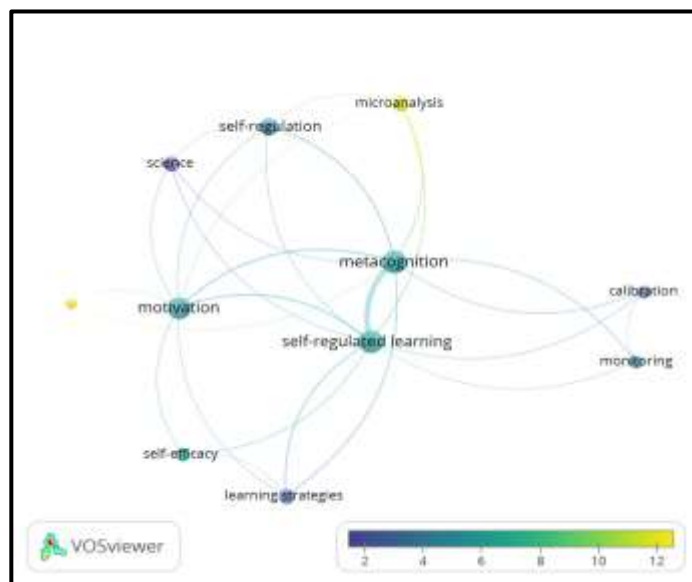

Figure 10. Overlay visualization of citation scores and link-weights

4.5 Learning Analytics

Learning analytics means the collection, measurement, reporting of data, and analysis of learners and the settings, which aims to understand learning and learning environments (Baek & Doleck). Similar to educational data mining, learning analysis is a new learning and teaching support method (Zheng et al., 2021). In the learning context, learning analytics dashboards are used to exchange insights into student performance and learning (Aguilar, Karabenick, Teasley, & Baek, 2021; Ahn, Campos, Hays, & DiGiacomo, 2019; Aljohani, Davis, & Ally, 2016; Bodily et al., 2018; Kim, Jo, & Park, 2016; Park & Jo, 2015).

Figure 11 presents keywords that appear above ten times: feedback, learning strategies, self-regulated learning, learning analytics, and blended learning.

Previous research on learning analytics showed that two types of navigating learning analytics dashboards demonstrated by instructors relied on the conversation explorer feature heavily (Zheng et al., 2021). A study learns the indirect relationship between information provided by Lads and students' academic motivation and academic achievement, which emphasized the importance of EWS-provided information on SRL and motivation (Aguilar et al., 2021).

A scoping review revealed that social constructivism and self-regulated learning guided most learning analytics studies; it is necessary to integrate theory into learning analytics to explain the data analysis better (Q. Wang, Mousavi, & Lu). A systematic literature review examines whether and how the goal outcomes of learner-oriented Learning Analytics Dashboard are consistent with the domain measures used to assess its implementations (Valle, Antonenko, Dawson, & Huggins-Manley, 2021) A quasi-experimental study indicated that performance-enabled prompts are of little use in declarative knowledge and migration testing (Schumacher & Ifenthaler, 2021). A review of empirical studies examined the differences and similarities between Learning Analytics and Educational Data Mining (Baek & Doleck).
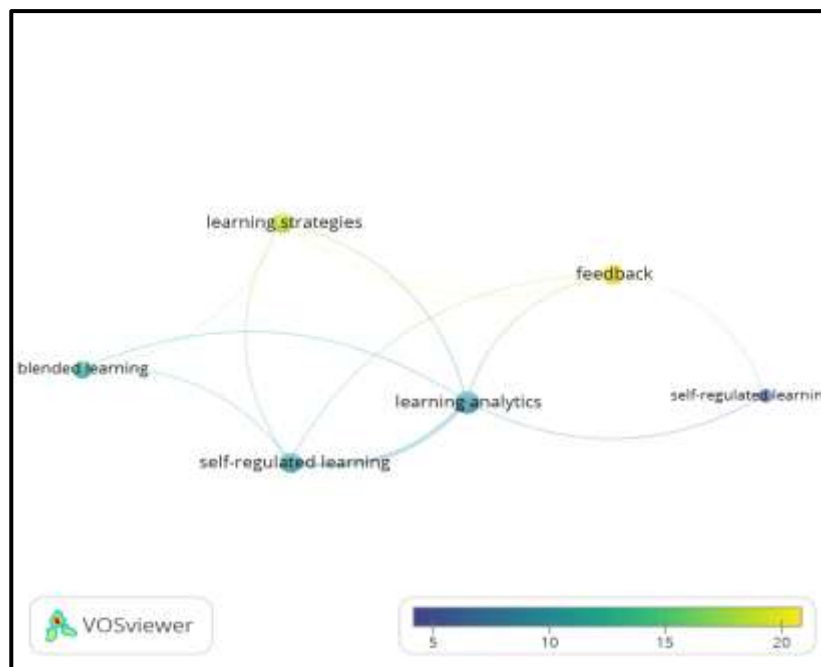

Figure 11. Overlay visualization based on learning analytics link-weights and citation scores

5. Conclusion

To conclude, this bibliometric paper offered a visual and comprehensive view of the self-regulated learning topic. This study analyzed 2254 valid articles on self-regulated learning from the WoS core collection from 2018 to 2022. Annual publications in the last five years have mainly shown an upward trend. Self-regulated learning has a wide range of research fields, involving education scientific disciplines, psychology multidiscipline, education educational research, psychology educational, and computer science interdisciplinary applications.

With the cooperation between institutions and countries, America is ahead of other countries, while the PRC, Italy, Germany, and Australia have also achieved fruitful results and made important contributions. Of the first ten institutions, six of the ten institutions are from China and Canada. The fact shows that China and Canada are more focused on this area than other countries. In this field, Maastricht University is the most productive institution. In addition, exchanges and cooperation between international countries and institutions can be strengthened.

For author analysis, the most frequently cited author is Baars Martine, whose research analyzes learning strategies support in MOOCs. Most authors generally do not prefer to work much with others, which leads to a major group of authors like Azevedo Roger and Gasevic Dragan.

Based on a network of co-cited journals, Frontiers in Psychology is an influential and prolific journal in terms of the citation numbers it received. Over the last several years, Personality and Individual Differences have also gained a lot of attention in recent years, which has led to the publication process of self-regulated learning. Many journals concentrated on the multidisciplinary area, of psychology, and

education, attracting a growing number of scholars and researchers from around the world.

VOSviewer found the hotspots of self-regulated learning, which are mainly distributed as follows: (a) self-regulated learning; (b) self-regulation; (c) motivation; (d) metacognition; (e) learning analytics.

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Abbreviations

SRL: Self-regulated learning; EFL: English AS a Foreign Language.

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