A Bibliometric Analysis of Research on Self-Regulated Learning: From the Beginning to 2021

Öz-düzenlemeli Öğrenme Üzerine Yapılan Araştırmaların Bibliyometrik Analizi: Başlangıçtan 2021'e

Rahime ÇOBANOĞLU* [iD] **Serap BÜYÜKKIDIK**** [iD]

Gülfem D. YURTTAŞ KUMLU*** [iD]

ABSTRACT: The present study explores the self-regulated learning (SRL) research published in English or Turkish language journals included in the Web of Science database from the beginning to 2021 via bibliometric analysis. The 2197 articles that met the eligibility criteria were included in the study. The results reveal that the research on SRL has been carried out mostly by scholars from the USA and has gained increased attention since the 2000s. The three most influential scholars of self-regulated research are Chia-Wen Tsai, Philip H. Winne, and Roger Azevedo; however, the two top documents by local citations belong to Barry J. Zimmerman (2008) and Paul R. Pintrich (2004) in the study. The analyzed studies cited the Journal of Educational Psychology and Contemporary Educational Psychology most. The results reveal that motivation, metacognition, self-efficacy, and learning strategies are the keywords that most frequently occur and co-occur in the analyzed studies along with SRL. The trend topics of SRL research have been learning analytics, flipped classrooms, and MOOCs since 2018.

Keywords: Bibliometric analysis, learning, self-regulated learning, Web of Science database.

ÖZ: Bu çalışma, başlangıçtan 2021 yılına kadar Web of Science veri tabanında yer alan İngilizce veya Türkçe dergilerde yayınlanan öz-düzenlemeli öğrenme araştırmalarını bibliyometrik analiz yoluyla incelemektedir. Uygunluk kriterlerini karşılayan 2197 makale çalışmaya dahil edilmiştir. Sonuçlar, araştırmaların çoğunlukla ABD'li akademisyenler tarafından yürütüldüğünü ve öz-düzenlemeli öğrenmenin 2000'li yıllardan bu yana eğitim araştırmalarında artan bir ilgi gördüğünü ortaya koymaktadır. Öz-düzenlemeli öğrenme araştırmalarının en etkili üç akademisyeni Chia-Wen Tsai, Philip H. Winne ve Roger Azevedo olarak belirlenirken, yerel atıflara göre en etkili ilk iki doküman Barry J. Zimmerman (2008) ve Paul R. Pintrich'e (2004) aittir. İncelenen çalışmalar en çok Journal of Educational Psychology ve Contemporary Educational Psychology dergilerine atıfta bulunmuştur. Ayrıca, sonuçlar incelenen çalışmalarda öz-düzenlemeli öğrenme ile birlikte en sık geçen ve birlikte kullanılan anahtar kelimelerin motivasyon, üstbiliş, öz-yeterlik ve öğrenme stratejileri olduğunu göstermektedir. 2018'den bu yana SRL araştırmalarının trend konuları öğrenme analitiği, ters yüz edilmiş sınıflar ve MOOC'lar olmuştur.

Anahtar kelimeler: Bibliyometrik analiz, öğrenme, öz-düzenlemeli öğrenme, Web of Science veri tabanı.

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* *Corresponding Author*: Dr., Sinop University, Sinop, Türkiye, crahime@gmail.com, https://orcid.org/0000-0003-4662-8920

** Dr., Sinop University, Sinop, Türkiye, sbuyukkidik@gmail.com, https://orcid.org/0000-0003-4335-2949

*** Dr., Sinop University, Sinop, Türkiye, gdyurttas@gmail.com, https://orcid.org/0000-0003-4741-2654

Self-regulated learning (SRL) is a crucial skill for the 21st century, an era that prioritizes learning how to learn rather than the direct transmission of information (Saavedra & Opfer, 2012). Due to our need for lifelong learning, it is critical that individuals are empowered to become self-regulated learners in schools (Zimmerman, 2002). The promises of SRL for effective academic learning have paved the way for developing interventions that basically aim to provide individuals with the required information, motivation, and skills for SRL (Winne, 1995). We agree that making a shift from other-regulated learning to SRL should be an educational goal for all individuals (Paris & Newman, 1990) as SRL, explaining academic achievement differences among learners, can turn into an effective means for improving learner performance (Pintrich & De Groot, 1990; Schunk, 2005).

The current study examines the intellectual structure within the broad field of SRL from its inception to 2021 (December 31) through bibliometric analysis to reveal the evolution of the construct. There exist many review studies on SRL, some of which are very recent (e.g., Anthonysamy et al., 2020; Araka et al., 2020; Blackmore et al., 2021; Dignath & Veenman, 2021; Hooshyar et al., 2020; Lim & Yeo, 2021; Min & Nasir, 2020; Theobald, 2021). To our current knowledge, Zhang et al. (2020) carried out a bibliometric study on SRL; however, its scope is limited to game-based self-regulated learning. Saepulmilah and Azhari (2022) published a bibliometric study with a focus on SRL; nonetheless, this study covers the data between 2017 and 2021. Despite years of research on SRL, the field is considered weak regarding bibliometric analysis. Such analyses are essential for capturing the academic view of the literature on a research area (Mejia & Kajikawa, 2017) and demonstrating the scientific productivity and the characteristics of scientific growth in a given field (Andres, 2009). In light of this, the current study applied a bibliometric analysis to uncover various aspects of SRL research. Specifically, this study aims to reveal (a) the productivity and citations over the years, (b) the most influential countries, collaborations, scholars, articles, and journals in SRL research, (c) the keywords that frequently occur in the SRL publications and the words in their references, and (d) the co-occurring keywords and the important themes in the SRL literature. The findings drawn from this bibliometric analysis are expected to demonstrate the trends, identify new developments in SRL research, and provide significant implications for future research in SRL.

Definition of SRL

Zimmerman (1990) defines SRL by highlighting three fundamental features including learning strategies, self-oriented feedback, and independent motivation. According to Zimmerman, self-regulated learners apply appropriate learning strategies to accomplish the desired outcome considering feedback about their learning performance. Pintrich (1995) similarly draws attention to an individual's active and goal-directed control of behavior, motivation and affect, and cognition in SRL. As Torrano Montalvo and González Torres (2004) define, SRL is a combination of an individual's skill and will to optimize his or her performance by controlling and adjusting the learning process.

The literature commonly proposes that the SRL process occurs in three phases, including the "preparatory phase," "actual performance phase," and the "appraisal phase" (Puustinen & Pulkkinen, 2001). Broadly, in the preparatory phase of SRL,

learners examine the tasks, plan, and set targets. In the phase of performance, they use strategies and monitor their activities. In the appraisal phase, learners evaluate their performance and their outcomes.

Research on SRL

SRL has been an important strand of research for years, especially in education since 1980 (Schunk & Greene, 2018). Paris and Paris (2001) noted that Educational Psychologist devoted special issues to SRL, and more than 30 articles related to SRL were published in this single journal during the period between 1990 and the year of their study. Winne (2005), using PsycINFO, found 463 hits with the phrase "self-regulated learning" searched in all text, while there were 103 publications in 1995 on SRL and only one article in 1976 (i.e., Mlott et al., 1976). According to Panadero (2017), the emergence of meta-analysis studies, new models, and a new handbook on SRL after 2001 are important hallmarks in the development of the field.

Today, a great deal of scientific publications has accumulated in the field of SRL. Boekaerts (1999) argues that the three schools of thought, namely "metacognition and regulation styles," "research on learning styles," and "theories of self and goal-directed behaviors," have greatly influenced the research on SRL. Schunk and Greene (2018) define three paradigms, which have predominantly influenced the SRL research since the 1980s, including the research on the relation of SRL to academic outcomes, intervention studies to teach SRL and their effect on student outcomes, and the more dynamic studies on the operation of SRL processes and changes in outcomes in a cyclical fashion. The studies on SRL are generally diverse regarding the approaches, methods, and subject areas. The common measurement tools of the SRL studies involve self-report inventories, think-aloud protocols, unstructured interviews, and traces of cognitive events (Winne, 2010). The development of the "Motivated Strategies for Learning Questionnaire (MSLQ)" by Pintrich et al. (1993), a valid and reliable tool that addresses individuals' motivational orientations and their use of learning strategies, has especially played a great role in the proliferation of research on SRL (Schunk, 2005).

The review studies have also occupied an important place in SRL research. The recent review studies on SRL research have especially delved into different types of technology-enhanced learning environments, including online learning (e.g., Broadbent & Poon, 2015), e-learning (e.g., Garcia et al., 2018), massive open online courses (MOOCs) (e.g., Alonso-Mencía et al., 2020; Wong et al., 2019), blended learning (e.g., Anthonysamy et al., 2020), flipped learning (e.g., Rasheed et al., 2020), mobile learning (e.g., Palalas & Wark, 2020), and learning analytics dashboards (Matcha et al., 2019). Moreover, the review studies by van Houten-Schat et al. (2018) and Cho et al. (2017) explore the SRL in the context of medical education. While the meta-analytic review of Panadero et al. (2017) examines the relationship between self-assessment and SRL, Ergen and Kanadli (2017) review the link between SRL and academic achievement.

These review studies, reduced to specific aspects of SRL, are important. Yet more comprehensive reviews are required to understand the general status of the SRL research and propose future directions. The current study takes advantage of bibliometric analysis to expand the scope of the review to present an inclusive overview of this broad field of study. Presenting a holistic view of a research area is vital when

the number of publications is great, and its boundaries are complicated (Mejia & Kajikawa, 2017), as it is in SRL research.

Method

This study is a bibliometric analysis of research on SRL. In a broader sense, a bibliometric study provides a bibliographic overview of scientific productions within an identified subject area via quantitative analysis (Ellegaard & Wallin, 2015). Donthu et al. (2021) state that bibliometric studies, used especially when the dataset is too large and the review scope is broad, can greatly advance the field by showing the less developed areas in the literature and triggering novel ideas for future studies.

Search Procedure

In this study, we used the Web of Science (WOS) database that hosts a broad collection of widely known journals in social sciences to reach scientific publications on SRL. As suggested by Linnenluecke et al. (2020), an initial review exercise was undertaken by the three researchers to determine the scope and search terms. Considering previous review studies (e.g., Broadbent & Poon, 2015; Gambo & Shakir, 2021; Lee et al., 2019; Moos & Ringdal, 2012; Wong et al., 2019), the following terms were searched in the abstract: "self-regulated learning" or "SRL" or "self-regulat* learning" or "self-regulat* learn*," or "self-regulat* learning strateg*." The search, performed on January 19, 2022, involved all years except 2022 and was confined to articles as the document type.

Selection of the Publications

The search resulted in 5575 publications, while 2197 articles were included in the analysis (see Figure 1). The early access articles that did not provide a publication year and the publications for which the document type was defined as a book chapter or proceeding rather than an article were not involved in the data set. As the title and the abstract were not always helpful in making a judgment if a publication addressed SRL, the researchers needed to examine the full text of the manuscripts in the selection process. For this reason, the articles written in languages other than English or Turkish (the native language of the researchers) and to which the researchers did not have full access were not included in the study. Furthermore, the articles that have a scope out of SRL were excluded. In this regard, we found that 2466 articles were totally irrelevant to the topic because of the abbreviation, SRL, which stands for diverse things apart from self-regulated learning. In addition, some publications addressed metacognition, self-efficacy, and self-regulation. The articles with these constructs were only included if they were related to SRL.

The intercoder agreement was sought in the selection of the articles for this study. The twelve Web of Science-produced Excel documents were used for coding. Of these documents, eleven of them include data for 500 publications, and one comprises data for 75 publications. Initially, the three researchers discussed the first data set, including 500 publications considering the eligibility criteria in a meeting. The remaining sets were examined and coded independently for inclusion and exclusion. Krippendorff's alpha value was .94, showing a high rate of agreement among the three coders. The average pairwise percent agreement value was 97% among the three coders

for 15225 decisions. Moreover, any disagreement was solved in meetings through a careful discussion of the publications.

Figure 1

The Flow Diagram of the Study, Adapted from the PRISMA of Page et al. (2021)
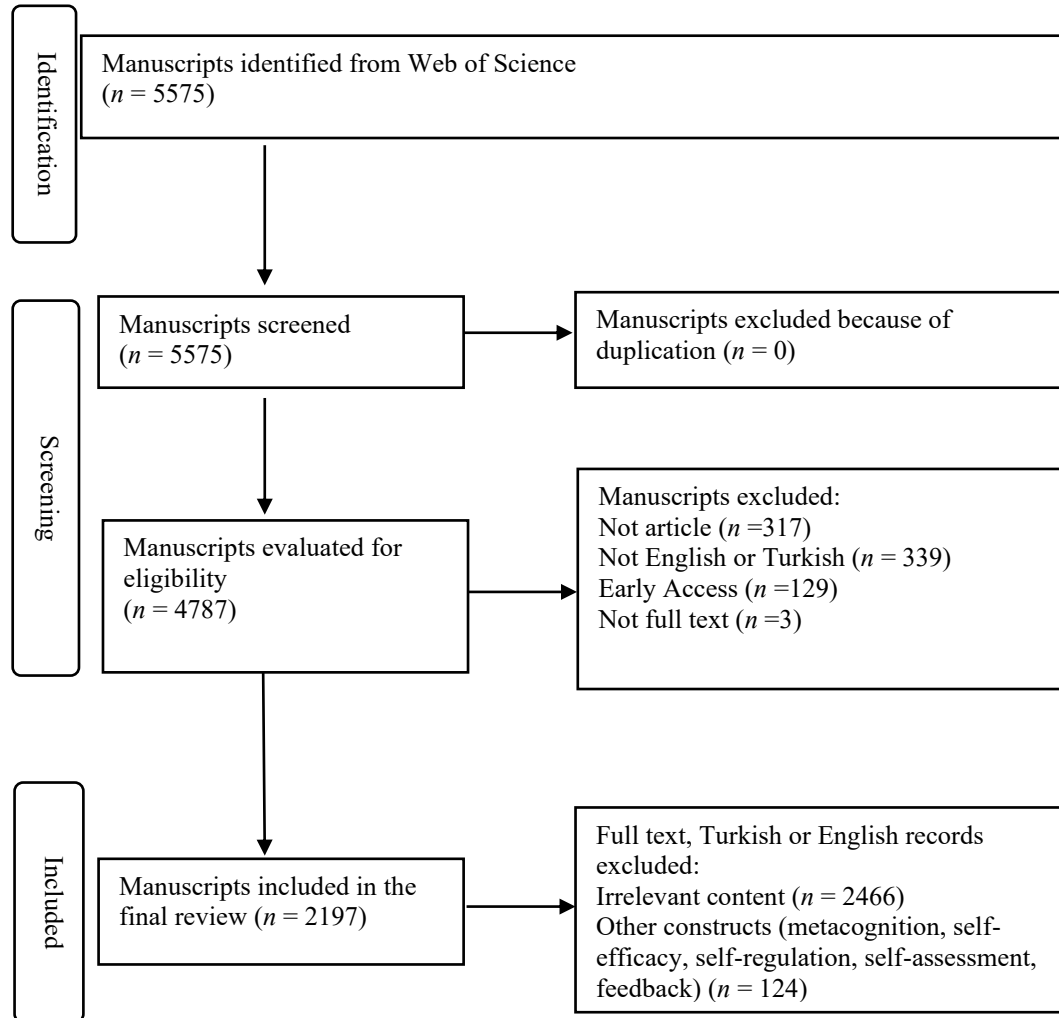
Included Publications

Table 1 presents general statistics related to the included publications in the dataset. Specifically, this study involved a total of 2197 articles on SRL. The studies are published by 4724 authors between 1990 and 2021 in 647 different journals.

Table 1

Main Information about the Data from WOS with a Timespan 1990:2021

Description	Number
Documents (Articles)	2197
Authors	4724
Authors of multi-authored documents	4407
Single-authored documents	401
Sources (Journals)	647
Author's Keywords	3973
Keywords Plus	1984

The studies are mostly multi-authored papers (f = 4407). The articles overall included 3973 author keywords. The number of keywords plus, derived from the titles of the references of the included articles, is 1984.

Data Analysis

We analyzed the bibliographic metadata from the WOS database via the bibliometrix package (Aria & Cuccurullo, 2017) in the R programming language (R Core Team, 2021). The data were analyzed at six levels, including years, countries, authors, documents, sources, and keywords. The citation, collaboration, and co-occurrence network analyses were performed to explore the SRL publications included in the study. The analyses with the keywords were conducted after data cleaning for plurals, abbreviations, and conjugations, leading to a decrease in the number of the author's keywords from 3973 to 3940 and from 1984 to 1952 for keywords plus. Table 2 displays the data analysis outputs for the present study.

Table 2

Main Information about Data Analysis

Level of analysis	Analysis output
Years	Annual scientific production, Annual citation per year
Countries	Corresponding author's country, Most cited countries, Collaboration network based on countries
Authors	Most relevant authors, Authors' production over time, Author h-index
Documents	Most locally cited articles, Most globally cited articles
Sources	Most relevant journals, Most locally cited journals
Author Keywords	Most relevant keywords, Trend topics, Thematic map
Keywords Plus	Most relevant keywords

Results

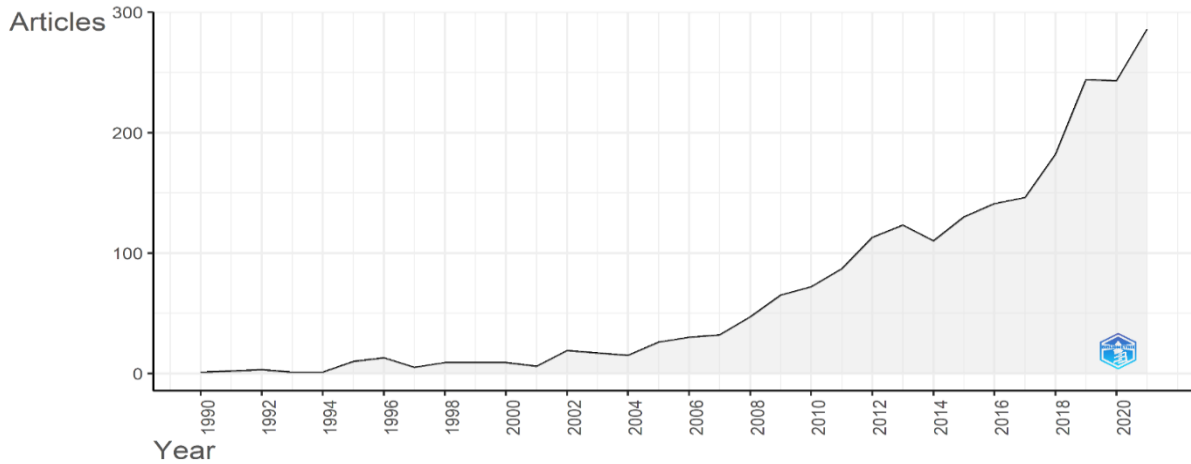### Productivity and Citations over the Years

The present study offers results regarding the rate of annual production and average citations per year for the manuscripts retrieved from WOS on SRL. Of the 2197 analyzed papers, the first paper dates to 1990 (see Figure 2).

Figure 2

Annual Scientific Production

Except for a few minor declines, the production generally shows a trend of increase, especially from 2001 and onwards. The annual growth rate is 20% for annual scientific production. The production exceeds 100 papers by 2012 and reaches 286 manuscripts by 2021.

Countries and Collaboration

While the single-country publications dominate the literature on SRL, Figure 3 displays the results for the collaboration network based on countries. As the thickness of the lines in Figure 3 reflects, the SRL researchers from the USA collaborated mostly with researchers from Canada, followed by China and Korea. It appears that European countries are more likely to collaborate with each other, especially the collaborations between the United Kingdom and the Netherlands and between the Netherlands and Germany are remarkable. Australia has the most collaborations with the United Kingdom and the Netherlands as a country outside Europe.

Figure 3

Collaboration Network Based on Countries
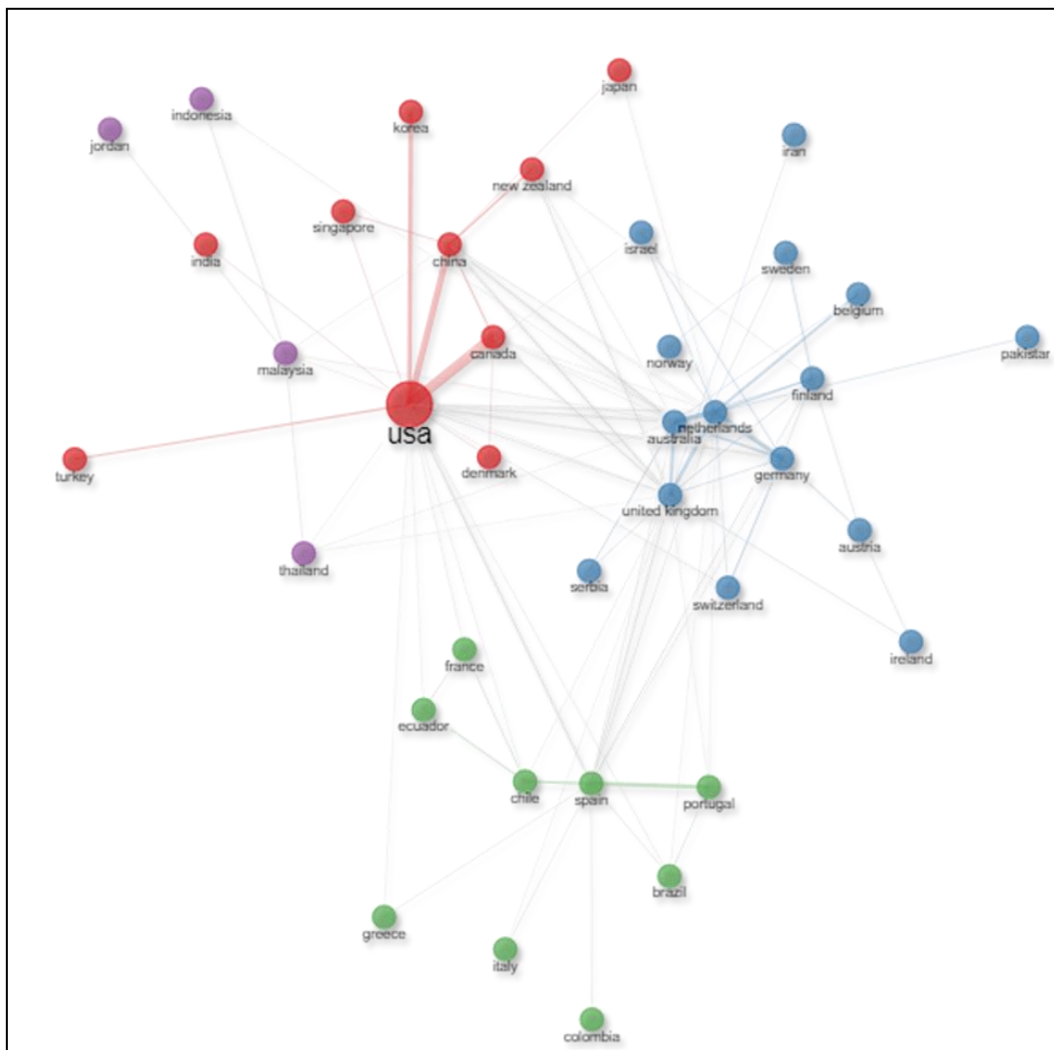
In addition, the analyzed collection of the publications in the study represents 72 different countries. The results show that most of the publications ($f = 564$, 26%) were produced by the corresponding authors from the USA, followed by the publications of the corresponding authors from China ($f =241$, 11%) and Canada ($f =143$, 7%). The publications with the corresponding authors from the European region are mostly from Germany ($f = 131$, 6%), followed by the Netherlands ($f = 121$, 6%), and the United Kingdom ($f = 88$, 4%). Additionally, the three countries cited most in SRL research respectively involve the USA ($f = 24610$) with an average citation value of 43.63 per document, Canada ($f = 5282$) with an average citation value of 36.94 per document, and the Netherlands ($f = 4375$) with an average citation value of 36.16 per document. China, the second country concerning the number of corresponding authors, ranked sixth among the most cited countries with an average citation value of 12.60 per document. Table 3 presents the distribution of the SRL publications by the corresponding author's country and the most cited countries.

Table 3

Top Ten Countries by Corresponding Author's Country and Citations

R	Country by Corresponding Author	TP	%	R	Country by Citations	TC	AC_d
1	USA	564	26	1	USA	24610	43.63
2	China	241	11	2	Canada	5282	36.94
3	Canada	143	7	3	Netherlands	4375	36.16
4	Germany	131	6	4	United Kingdom	4155	47.22
5	Netherlands	121	6	5	Germany	3672	28.03
6	Australia	89	4	6	China	3037	12.60
7	United Kingdom	88	4	7	Australia	2274	25.55
8	Spain	76	4	8	Belgium	1435	34.17
9	Turkey	70	3	9	Spain	1169	15.38
10	Israel	51	2	10	Finland	1155	26.86

Note. R= "Ranking", TP = "Total Publications", TC= "Total Citations", AC_d = "Average Citations per Document"

Influential Authors

As shown in Figure 4, the two most relevant authors of SRL are Chia-Wen Tsai and Philip H. Winne, with their contributions to 25 publications closely followed by Roger Azevedo ($f = 23$).

The results also show that Winne has actively produced publications since 1993, while the remaining nine relevant authors have been active after 2001 (see Figure 5). When the most relevant ten authors' publications are examined between 2021 and 2022, the two authors with the highest number of publications recently are Dragan Gašević ($f = 4$) and Roger Azevedo ($f = 3$).
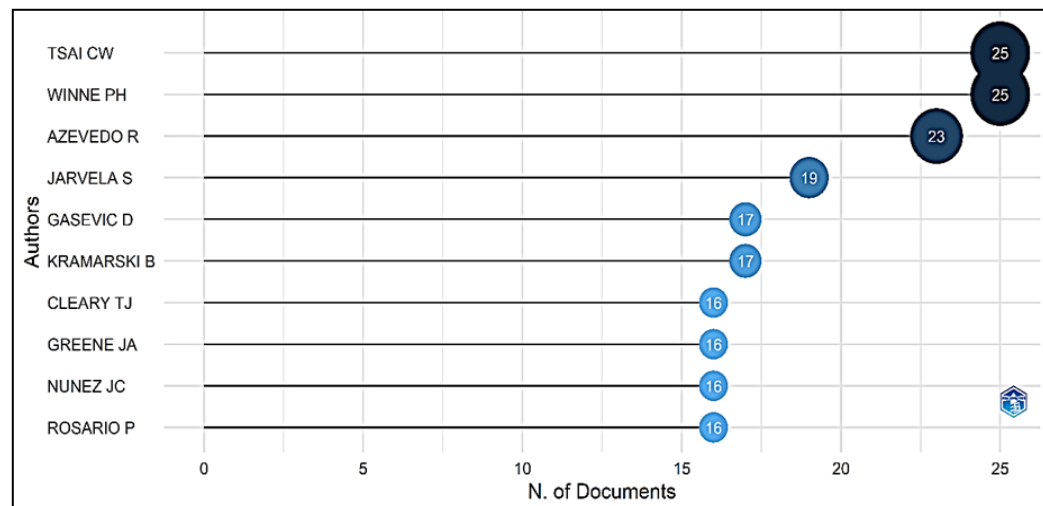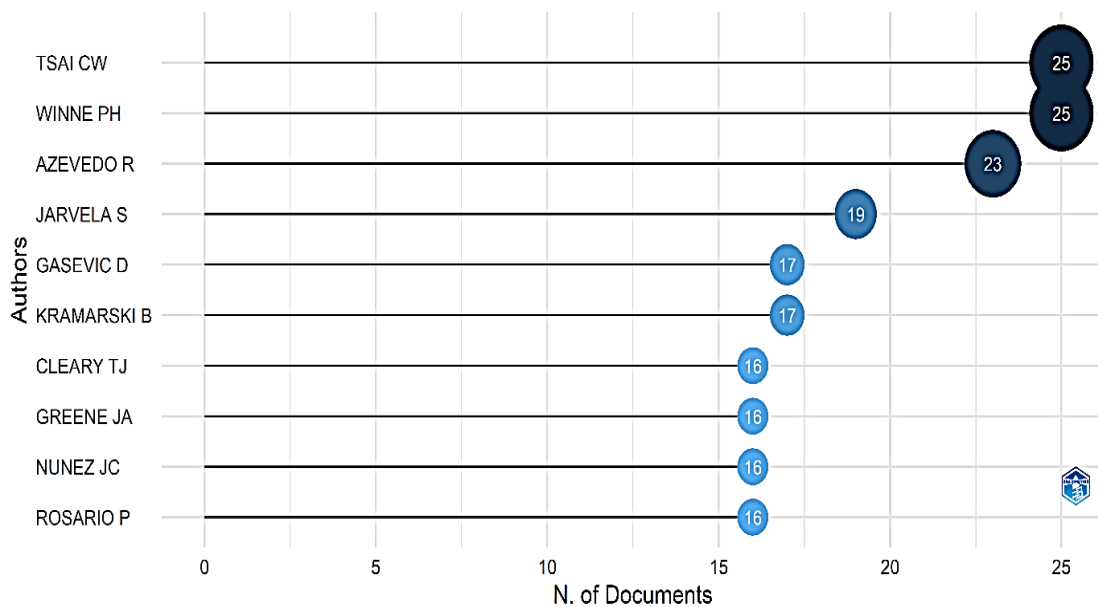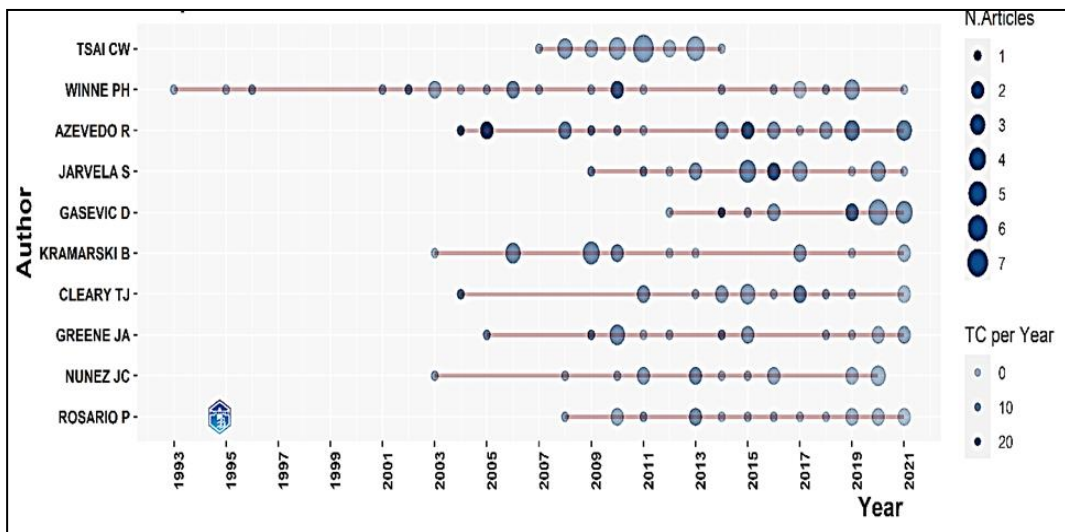
Figure 4

Most Relevant Authors

Figure 5

Top-Authors' Production Over Time

As a measure of author impact, Table 4 illustrates the authors with the top h-index in the analyzed collection of SRL papers. The results reveal that Roger Azevedo and Philip H. Winne are the most influential authors in SRL research, considering their h-index. Both Azevedo and Winne have 18 publications on SRL, each receiving at least 18 citations. Amongst the ten authors with the highest h-index, Azevedo and Winne also have the highest number of total citations (TC), each exceeding 1500.

Table 4

Author Impact

Author	h_index	TC	NP	PYs
Azevedo R.	18	1882	23	2004
Winne P. H.	18	1501	23	1993
Tsai C. W.	14	441	25	2007
Artino A. R.	13	853	15	2008
Cleary T. J.	12	635	15	2004
Jarvela S.	12	668	19	2009
Greene J. A.	11	685	15	2005
Kramarski B.	10	548	17	2003
Littlejohn A.	10	597	11	2012
Paas F.	10	478	13	2004
Shen P. D.	10	321	15	2007
Wolters C. A.	10	1424	11	1996

Note. TC= "Total Citations", NP= "Number of Publications", PYs= "Publication Year start"

However, regardless of the h-index, the top author considering total citations is Barry J. Zimmerman (TC = 4401, h-index = 9) in SRL literature, followed by Debra Macfarlane-Dick (TC = 1952, h-index = 1) and David J. Nicol (TC = 1952, h-index= 1). After Azevedo, Monique Boekaerts (TC = 1804, h-index = 9) and Paul R. Pintrich (TC = 1723, h-index = 4) respectively ranked fifth and sixth regarding total citations in SRL research.

Top Documents

The most influential articles on SRL are determined considering their local and global citations (see Table 5). While local citations reveal the frequency of citations an article has received from the articles involved in the data set, global citations indicate the frequency of citations of an article in the whole WOS database.

Table 5

Top Five Documents by Local and Global Citations

R	Document by Local Citations	LC	R	Document by Global Citations	GC
1	"Zimmerman, B. J. (2008). Investigating Self-Regulation and Motivation: Historical Background, Methodological Developments, and Future Prospects. American Educational Research Journal."	340	1	"Nicol, D. J. & Macfarlane-Dick, D. (2006). Formative Assessment and Self-Regulated Learning: A Model and Seven Principles of Good Feedback Practice. Studies in Higher Education."	1952
2	"Pintrich, P. R. (2004). A Conceptual Framework for Assessing Motivation and Self-Regulated Learning in College Students. Educational Psychology Review."	284	2	"Zimmerman, B. J. (2008). Investigating Self-Regulation and Motivation: Historical Background, Methodological Developments, and Future Prospects. American Educational Research Journal."	1300
3	"Paris, S. G. & Paris, A. H. (2001). Classroom Applications of Research on Self-Regulated Learning. Educational Psychologist."	157	3	"Zimmerman, B. J. (2000). Self-Efficacy: An Essential Motive to Learn. Contemporary Educational Psychology."	1294
4	"Boekaerts, M. & Corno, L. (2005). Self-Regulation in the Classroom: A Perspective on Assessment and Intervention. Applied Psychology."	154	4	"Pintrich, P. R. (2004). A Conceptual Framework for Assessing Motivation and Self-Regulated Learning in College Students. Educational Psychology Review."	1106
5	"Dignath, C. & Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. Metacognition and Learning."	133	5	"Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-Motivation for Academic Attainment: The Role of Self-Efficacy Beliefs and Personal Goal Setting. American Educational Research Journal."	1023

Note. R = "Ranking", LC = "Local Citations", GC = "Global Citations"

The results indicate that Barry J. Zimmerman's (2008) article, titled "Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects" has been cited most frequently by the articles in the collection of 2197 articles in the current study (LC = 1300), followed by Paul R. Pintrich's article (2004), titled "A conceptual framework for assessing motivation and

self-regulated learning in college students" (LC = 1106). These two articles are also placed among the five most globally cited articles list. The article titled "Formative assessment and self-regulated learning: A model and seven principles of good feedback practice (Nicol & Macfarlane-Dick, 2006)", had the most global citations in the present study.

Impactful Sources

Table 6 displays the results concerning the sources of the SRL articles in the sample of analyzed 2197 studies. In the present collection of 647 sources, the top five journals where articles were most frequently published are Learning and Individual Differences (f = 58, 3%), Frontiers in Psychology (f = 57, 3%), Computers and Education (f = 49, 2%), Metacognition and Learning (f = 49, 2%), and Computers in Human Behavior (f = 48, 2%). Moreover, in the present data set, there are 20441 cited sources. Amongst them, the source that is cited most by the studies is the Journal of Educational Psychology (f = 4586, 4%), followed by Contemporary Educational Psychology (f = 2139, 2%) and Educational Psychologist -US (f = 2073, 2%).

Table 6

Most Relevant and Most Locally Cited Sources

R	Most Relevant Sources	TP	%	R	Most Locally Cited Sources	TP	%
1	Learning and Individual Differences	58	3	1	Journal of Educational Psychology	4586	4
2	Frontiers in Psychology	57	3	2	Contemporary Educational Psychology	2139	2
3	Computers & Education	49	2	3	Educational Psychologist	2073	2
4	Metacognition and Learning	49	2	4	Handbook of Self-Regulation	1996	2
5	Computers in Human Behavior	48	2	5	Computers & Education	1732	2
6	Learning and Instruction	46	2	6	Learning and Instruction	1641	1
7	Educational Psychologist	32	2	7	Educational Psychology Review	1566	1
8	Journal of Educational Psychology	30	1	8	Review of Educational Research	1237	1
9	Contemporary Educational Psychology	29	1	9	Metacognition and Learning	1181	1
10	British Journal of Educational Psychology	28	1	10	Computers in Human Behavior	1126	1

Note. R= "Ranking", TP = "Total Publications"

Keywords Occurrence

The included publications on SRL were examined considering the occurrences of author's keywords and keywords plus (see Table 7). Excluding self-regulated learning and self-regulation, the five most frequently used author's keywords in the studies include motivation ($f = 176$), metacognition ($f = 127$), self-efficacy ($f = 106$), learning strategies ($f = 105$), and higher education ($f = 86$). As technology-related content, online learning ($f = 64$) and e-learning ($f = 57$) ranked seventh and eighth in the top ten list of author's keywords in SRL research. As regards the results for keywords plus, which shows the occurrence of the words in the titles of the references of the 2197 analyzed studies, the five most relevant words are identified as motivation ($f = 529$), performance ($f = 383$), student/students ($f = 375$), strategy/strategies ($f = 363$), and achievement ($f = 346$).

Table 7

Most Relevant Author Keywords and Keywords Plus

| R	Most Relevant Author Keywords	f	R	Most Relevant Keywords Plus	f
1	Self-regulated learning	994	1	Motivation	529
2	Self-regulation	183	2	Performance	383
3	Motivation	176	3	Student/students	375
4	Metacognition	127	4	Strategy/strategies	363
5	Self-efficacy	106	5	Achievement	346
6	Learning strategies	105	6	Efficacy	261
7	Higher education	86	7	Classroom	201
8	Online learning	64	8	Education	199
9	E-learning	57	9	Model	191
10	Academic achievement	45	10	Knowledge	139

Note. R = "Ranking"

Trend Topics

The occurrences of the author's keywords were examined between 2010 and 2021 to highlight the focus of SRL research over the recent eleven years (see Figure 6). The analysis was performed with the author's keywords with at least 15 occurrences to unveil the contemporary topics that have been studied more frequently. The threshold for the number of words per year was set at 3.

Figure 6

Trend Topics between 2010 and 2021
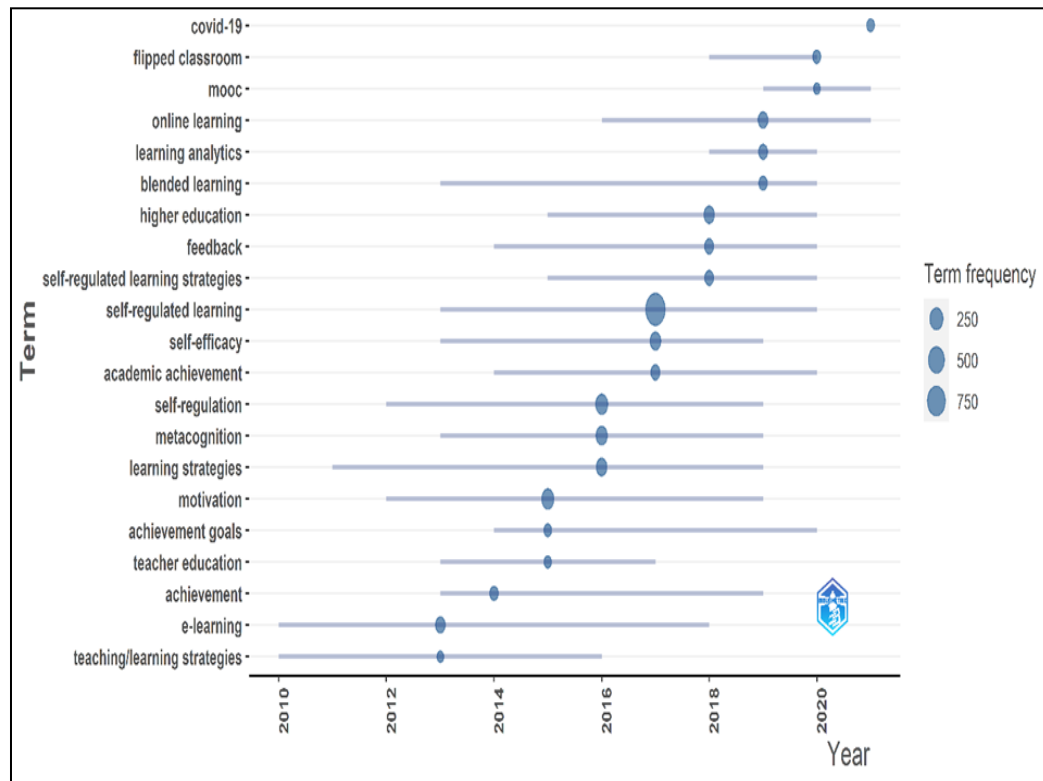
The results indicate that the last decade's research on SRL has focused on a variety of topics, including "learning strategies," "motivation," "self-efficacy," "academic achievement/achievement," and "metacognition." Also, publications on different aspects of technology-enhanced learning, such as "online learning," "blended learning," and "e-learning" have occupied an important place over the last eleven years in the SRL field. Especially, the studies on "learning analytics" (*f* = 39 in 2019), "flipped classroom" (*f* = 23 in 2020), and "MOOC" (*f* = 15 in 2020) have been noteworthy since 2018. "Covid-19" has been the salient keyword of 2021 (*f* = 19).

Conceptual Structure

A thematic map is provided based on the author's keywords (see Figure 7) to show the important themes in the SRL field. Considering the suggestion of Aria et al. (2021), the Louvain community detection algorithm was applied, and the results were interpreted based on Callon centrality and density values. All identified author's keywords (*n* = 3940) were included in the analysis. On the map, while the X-axis, representing the centrality, is a measure of interaction among the themes, the Y-axis,

standing for density, indicates the internal strength of a theme. The thematic map overall represents 21 clusters in the present study.

Figure 7

Thematic Map of Author's Keywords for SRL Research
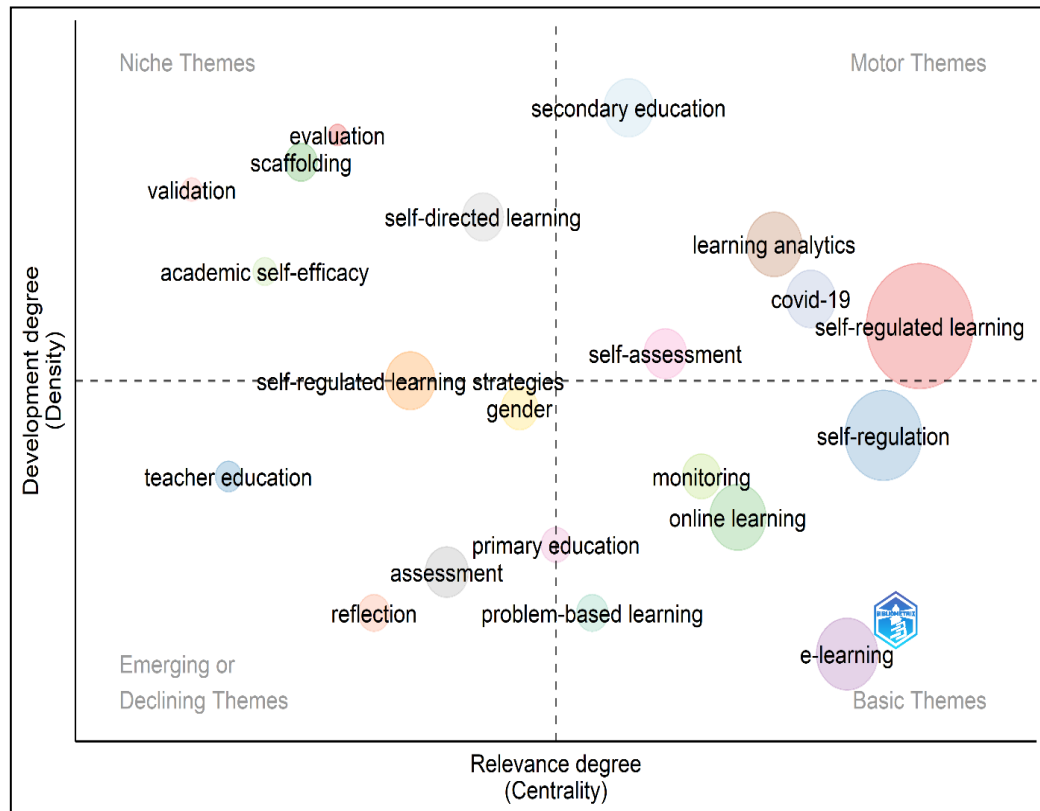
The first quadrant (high centrality, high density) shows the well-developed themes for the SRL field. These themes also have important links with other themes on the map. Five motor themes are identified in this quadrant in the present study. The cluster with the highest word occurrence ($f = 1991$) in this quadrant comprises 34 words. The five most frequently co-occurring words in this developed cluster are "self-regulated learning," "motivation," "metacognition," "self-efficacy," and "learning strategies." The cluster with the second highest word occurrence ($f = 90$) in the first quadrant includes the co-occurring words "learning analytics," "goal orientation," "collaborative learning," "workplace learning," and "process mining." The other three developed and important clusters for the SRL research include (1) the cluster with the co-occurring words "self-assessment" and "problem-solving," (2) the cluster with the co-occurring words "Covid 19," "learning environment," and "self-determination theory," and "distance learning," and (3) the cluster with the co-occurring words "secondary education," "teaching/learning strategies," "interactive learning environments," "self-regulated learning skills," and "intelligent tutoring skills."

The second quadrant (low centrality, high density) reveals the developed themes that do not have strong external links with other themes on the map. The results present five isolated themes in the present study. In this quadrant, one isolated cluster includes the words "self-directed learning," "instructional design," and "active learning." The

other four isolated clusters involve (1) the cluster with co-occurring words "scaffolding" and "learning achievement," (2) the cluster with the word "academic self-efficacy," (3) the cluster with the word "validation," and (4) the cluster with the word "evaluation." It must be noted that the cluster with co-occurring words "self-regulated learning strategies," "learning outcomes," and "epistemological beliefs" is positioned between the second and the third quadrant; therefore, it is not interpreted.

The third quadrant (low centrality, low density) involves the weakly developed and marginal themes. The thematic map plots four themes in this quadrant. The cluster with the highest word occurrence ($f = 44$) includes the recurrent words "assessment" and "structural equation modeling." The other emerging or declining three clusters in this quadrant include (1) the cluster with co-occurring words "gender" and "distance education," (2) the cluster with the word "teacher education," and (3) the cluster with the word "reflection." The cluster with the word "primary education" is identified between the third and the fourth quadrant.

The fourth quadrant (high centrality, low density) represents the clusters likely to be transversal to different research areas. There are five clusters in this quadrant in the present study. The cluster with the highest word occurrence ($f = 332$) includes the words "self-regulation," "learning," "formative assessment," and "medical student" as the most co-occurring four terms. The other basic four themes for the SRL field include (1) the cluster with the co-occurring words "e-learning," "feedback," and "blended learning," (2) the cluster with the co-occurring words "online learning," "satisfaction," and "MOOC," (3) the cluster with the co-occurring words "monitoring" and "education," and (4) the cluster with the word "problem-based learning."

Discussion and Conclusion

The current study presents an overview of SRL research based on the 2197 articles included in the WoS database. The paper overall presents imperative findings regarding scientific productivity over the years, the most contributing countries, authors, articles, and journals to the SRL literature, and the influential topics and themes in the field. As expected, the results indicate that the number of manuscripts on SRL has risen in the field over 32 years between 1990 and 2021. Based on this growing trend of productivity, especially from 2001 and onwards, it can be claimed that SRL has constituted an important area of study in educational research since the beginning of the second millennium. Why SRL has gained increased attention with the beginning of the 21st century can be attributed to the characteristics of this era that has made us rethink learning, teaching, and the education of individuals. As Trilling and Fadel (2009) explain, with the shift from Industrial Age to Knowledge Age in the 21st century, the development of the so-called 21st-century skills has been an important aim for countries to meet the demands and achieve progress. As part of the 21st-century skills, individuals are expected to manage goals and time, work autonomously, direct their learning, expand their learning, and show commitment to learning as a lifelong process (Trilling & Fadel, 2009).

The results indicate that the three prominent countries in SRL research are the USA, China, and Canada, given the number of publications by the corresponding author's country in the analyzed collection of the articles. Several European countries, including Germany, the Netherlands, and the United Kingdom, have also contributed to

the SRL literature, albeit less frequently than these three countries. The previous studies have consistently mentioned that the USA produces most of the scientific publications in all fields in the world (e.g., Man et al., 2004; Tasli et al., 2012). There may be an interconnectedness between SRL research, the development of 21st-century skills, and the broader goals of societal progress and economic advancement. It can be argued that the countries that produce most in SRL are strategically aligning themselves with the needs and demands of the 21st century, where the ability to learn, adapt, and innovate are increasingly crucial for success. By valuing and prioritizing SRL research, these countries may demonstrate their commitment to fostering a highly skilled workforce, promoting lifelong learning, and preparing individuals to thrive in a knowledge-based economy. Furthermore, scientific productivity often reflects factors such as research funding allocation, scholars' work conditions, and researchers' qualifications in countries (Tasli et al., 2012). Moreover, Man et al. (2004) argue that scholars from English-speaking countries may have a distinct language advantage in publishing their studies, as many journals accept articles written in English. It seems that China, emerging as an influential country in the context of SRL research, has effectively overcome language barriers for publication. China's scientific productivity can also be attributed to the government's efforts to improve the reputation of the universities since 1998, including encouraging higher education institutions to publish in internationally refereed journals and attracting talented scholars to work in Chinese universities (Yang & You, 2018).

Knowing the leading authors and their research is considered important for scholars to gain insights into the basics, guiding ideas, and the areas open to improvement in a field of study. The impactful documents in a research area can lay the foundation for more innovative studies; thus, they constitute the primary sources to refer to in a research study. In the present study, the three giants of the SRL field are identified as Chia-Wen Tsai, Philip H. Winne, and Roger Azevedo, considering their number of publications and h-index. Winne's studies are likely to focus on the cognitive and metacognitive dimensions of SRL. Apparently, Tsai has been more interested in the study of SRL in relation to web-based and online learning. The featured topics of Azevedo's studies on SRL include scaffolding and hypermedia learning. Among these authors, Winne can be introduced as the pioneer of SRL research as he produced the earliest publications and has been studying SRL for a longer time compared to Tsai and Avezedo.

In addition, this study shows that scholars should pay attention to the work of Barry J. Zimmerman, the scholar with the most total citations, and especially to his manuscript on self-regulation and motivation, the most cited document in the analyzed set of documents in the present study. Schunk and Usher (2013) similarly recognized the legacy of Zimmerman for the SRL research as they figured out that Zimmerman has made remarkable contributions to the development of SRL research by building a social-cognitive theory of SRL, explaining the operation of self-regulatory processes, and offering applications for improving student achievement based on the SRL processes. Moreover, as the second most locally cited publication in the present study, Paul R. Pintrich's publication on assessing motivation and SRL requires close examination. This seminal work presents a conceptual framework from the SRL perspective for developing tools to determine college students' motivation and learning

and discusses its relation to the "Motivated Strategies for Learning Questionnaire (MSLQ)." Schunk (2005) as well introduces Pintrich as a prominent figure in SRL research by touching on some of his major contributions, such as developing a conceptual framework regarding the phases of SRL, explaining the role of motivation in SRL, examining the influence of classrooms and schools and the interventions on self-regulatory processes, and developing MSLQ to measure SRL. Furthermore, the current study highlights the study by David J. Nicol and Debra Macfarlane-Dick on formative assessment and SRL as the document with the most global citations. This influential publication mainly discusses the seven principles of effective feedback to support SRL. The impact of this article in the field is likely to show that formative assessment and feedback comprise a distinct and significant area of research in SRL literature.

The keyword analysis in the present study helps us understand what has been at the heart of the research in the SRL literature to date. The results for the author's keywords demonstrate that the studies on SRL have been more frequently conducted in relation to motivation, metacognition, self-efficacy, and learning strategies. In addition, considering the thematic analysis results, these five terms frequently co-occur in author's keywords and form a well-developed theme that connects with other defined themes in the present study. These results are expected considering that the terms, "motivation", "metacognition," "self-efficacy," and "learning strategies" comprise the main characteristics that define SRL, which is about an individual's capability to monitor and control cognition and motivational beliefs including self-efficacy and to use strategies that result in better performance (Pintrich, 1995). Moreover, the results regarding both author's keywords and keywords plus indicate that achievement or performance are remarkable terms frequently occurring in SRL research. It can be claimed that to what extent and how SRL is related to an individual's academic achievement or performance have constituted important questions in SRL research.

Based on the results for the keywords plus, it must be noted that SRL has often been studied in the context of classrooms and with students. Among different levels of education, it seems that higher education has been an area SRL researchers have examined more frequently than primary and secondary education levels. The results indicate that "medical students" constitute a special target group for SRL research at the higher education level. The existence of earlier review studies on SRL in medicine education (e.g., Cho et al., 2017; van Houten-Schat et al., 2018) consistently supports the argument that medicine education is an important strand in SRL research. Cassidy (2011) similarly underlines that SRL is a considerably relevant concept in higher education. The scholars' interest in higher education for the study of SRL may be because college students are highly expected to take ownership of their learning and be autonomous and lifelong learners. Yet supporting students' self-regulated learning before higher education could produce more fruitful results for learning and performance.

The analyzed studies' publication frequently in Learning and Individual Differences: Journal of Psychology and Education, Frontiers in Psychology, and Metacognition and Learning indicate that SRL is a main topic of educational psychology. Yet two journals among the five most relevant journals in the present study are Computers and Education and Computers in Human Behavior, which means SRL is also a topic of educational technology. The results provide clear evidence that SRL has

often been examined in relation to technology-based contexts such as online learning, e-learning, blended learning, flipped classrooms, MOOC, and learning analytics. The existence of several review studies on SRL and different aspects of technological environments (e.g., Broadbent & Poon, 2015; Garcia et al., 2018; Guo, 2022; Villatoro Moral & De Benito, 2021) is considered compatible with this finding. In today's digital world, the increased interest in integrating technology into education and the rising value of distant and open education in the current era may explain the interest in studying technology-enhanced learning environments in SRL research. These environments, by their nature, are highly relevant to SRL research because they are less teacher-centered and more learner-centered, which makes the use of self-regulatory skills more critical for achieving goals (Steffens, 2006).

Implications

Since developing self-reliant and independent learners remains a requirement and challenge for societies, SRL is expected to remain an important construct in educational research. It is recommended that researchers examine the studies of the influential authors in the filed when planning their research on SRL. Notable researchers such as Chia-Wen Tsai, Philip H. Winne, Roger Azevedo, Barry J. Zimmerman, and Paul R. Pintrich have made significant contributions to the study of SRL and can serve as valuable sources of insights and inspiration for future investigations. Although the results underline some collaborations between the countries, it seems that single-country publications are still dominant in the field of SRL. Future research that adopts a cross-cultural study approach can increase our knowledge about the influence of culture on self-regulatory processes. In the present study, the word "primary education" or "young learners" do not occur as frequently as the words "higher education" or "college students," which is likely to show a need for delving more into the study of SRL in early grades in future research.

Notably, the less frequently occurring and co-occurring terms and the less developed and important themes in SRL research offer significant implications for future research. Given the phases of SRL defined by Zimmerman (2002), the keywords related to the self-reflection phase, such as "self-evaluation," "causal attribution," "self-satisfaction," and "affect regarding performance," have occurred less frequently in the analyzed collection of the studies in the present research, compared to the keywords related to forethought and performance phases. In support of this argument, despite being an important component of SRL, the results show that "reflection" is an emerging or declining theme in the SRL field. This underscores the importance of giving more consideration to the self-reflection phase and exploring its role and impact on self-regulated learning processes in depth. Also, it must be noted that SRL, an important construct for teaching, has been less frequently explored in teacher education, one of the themes that appear in the third quadrant of the thematic map in the present study. Future studies can increase our understanding of teacher education curriculum and course practices concerning the support for teacher candidates' self-regulated learning and the effective ways for developing teacher candidates' qualifications for teaching SRL in the future.

The study is limited to studies written in English and Turkish. The search was restricted to the WoS database. Scholars can replicate this study with other databases

and languages. Moreover, this study started at the beginning of 2022, and therefore, the studies conducted in 2022 could not be included in the analyses. It is important to focus on the studies from 2022 onwards in subsequent bibliometric analyses to identify developments and changes in the field.

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Statement of Responsibility

Dr. Rahime Cobanoglu contributed to the conceptualization of the paper, methodology, literature review, examination-selection of the studies with respect to the inclusion criteria, interpretation and discussion of the results, and writing-editing process.

Dr. Serap Buyukkidik contributed to the conceptualization of the paper, methodology, examination-selection of the studies with respect to the inclusion criteria, data analysis and visualization with R programme, interpretation of the results, and writing-editing process.

Dr. Gulfem D. Yurttas Kumlu contributed to the conceptualization of the paper, methodology, literature review, examination-selection of the studies with respect to the inclusion criteria, interpretation of results, and writing-editing process.

Conflicts of Interest

The authors declare that they have no personal and financial conflict of interest associated with this publication to disclose.

Author Bios:

Dr. Rahime Cobanoglu obtained her MS and PhD degrees in Curriculum and Instruction at Middle East Technical University, Türkiye. In her dissertation, she conducted a mixed-methods research on teacher-child interaction quality in preschool classrooms. During her graduate education, she studied at Utrecht University in the Netherlands as an Erasmus student for a semester and at Indiana University, Bloomington in the USA for eleven months as a visiting scholar. She presented several papers at international educational conferences such as Annual Meeting of American Educational Research Association and European Conference on Educational Research. Her research interests include teacher beliefs, teacher efficacy, teacher practices, early childhood education quality, curriculum implementation, and hidden curriculum. She offers a range of courses for teacher education programs such as Principles and Methods of Teaching, Educational Philosophies, Extra Curriculum Activities, and Introduction to Education. She currently works as an Assistant Professor of Educational Sciences at Sinop University, Türkiye.

Dr. Serap Buyukkidik graduated from Hacettepe University, Department of Mathematics Education in 2010. She received a scholarship from the Ministry of Education during her undergraduate education. She completed her Master's degree in Educational Measurement and Evaluation at Hacettepe University in 2012. She was supported by The Scientific and Technological Research Council of Turkey

(TÜBİTAK) with 2228/A Graduate Scholarship Program. She successfully completed her PhD at Gazi University in the field of Educational Measurement and Evaluation, with the 2211/A PhD Scholarship Program of TÜBİTAK. During her Ph.D. study, in 2018, she obtained the support of TÜBİTAK-2214/A International Research Fellowship and studied with Prof. Dr. Mark J. Gierl at the University of Alberta faculty member in Centre for Research in Applied Measurement and Evaluation. She has several articles published in SSCI, ESCI, and other international/national indexed journals. She is currently a faculty member at the Department of Educational Sciences at Sinop University.

Dr. Gulfem D. Yurttas Kumlu graduated from the Department of Science Education in 2007. She obtained her Master's Degree in Science Education at Muğla University in 2010 and completed her PhD degree in the same area at Gazi University in 2016. She investigated the impact of explicit reading strategy instruction and peer tutoring on pre-service science teachers' conceptual understanding about heat-temperature via qualitative methods in her doctoral dissertation. She also obtained Master's Degree in Educational Measurement and Evaluation at Hacettepe University in 2018. She worked as a research assistant at Muğla University, Sinop University, and Gazi University. She currently works at the department of Science Education at Sinop University. She carries out research on science education, concept teaching, misconceptions, conceptual change, metacognition, cognitive and metacognitive strategies, and metaconceptual activities. She has offered various courses such as Science Laboratory Practices, Instructional Technologies and Material Design, Teaching Practices and Scientific Reasoning Skills.

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