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THE HOTSPOTS AND TRENDS ON LEARNING STRATEGIES UNDER THE BACKGROUND OF BIG DATA: BASED ON CITESPACE

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ABSTRACT

Learning techniques have joined the big data era with the quick rise of the technology reform. However, there is little research on big data (Learning Strategies) from the perspectives of bibliometrics and knowledge map visualization. It is also uncommon to find substantial study on the fundamentals of learning strategies themselves. This study aims to explore the current status of learning strategies big data through visualization analysis of the journal papers related to learning strategies. The author analyzed a total of 718 articles that were downloaded from the Web of Science Core Collection and the time span was set from 2016 to 2021. The CiteSpace software 6.1.R3 was used for analysis. This paper presents numerous findings about annual trends, top players at the journal and institute levels, country-level citations, keyword distribution, co-authorship status, and the most significant journals and authors. In the end, this study points out the development status and trends in learning strategies. It can help people in the education profession to get a comprehensive understanding of the state of the art of learning strategies. Additionally, it offers reference points for the study and use of learning methodologies visualizing techniques.

KEYWORDS: Learning strategies; CiteSpace; Visualization

1. INTRODUCTION

Big data has the characteristics of the “5V” (Katal, Wazid, & Goudar, 2013):

Variety: the data is from a variety of sources, and the types and formats of data are becoming richer. It has broken through the category of structured data previously defined, including semi-structured and unstructured data.

Volume: the volume of data is huge, including the amount of data that is collected, stored, and calculated.

Velocity: it requires fast processing and fast access to high-value information for different types of data, which is fundamentally different from those traditional data mining techniques.

Value: due to the huge amount of data generated at a very fast speed and the inevitable formation of various valid and invalid data, the data density is greatly reduced. However, the rational use of big data will bring a very high value in return.

Variability: with the increasing use of social media, data load becomes challenging, which usually results in a peak load of data for certain events.

Big data has attracted researchers in all fields, especially in the field of learning strategies.

Bibliometrics is the cross-disciplinary science of quantitative analysis of all knowledge carriers by mathematical and statistical methods (Merigo, Cancino, Coronado, & Urbano, 2016). It is a technique that is frequently used to track the growth of a particular field. Early in the twentieth century, bibliometrics got its beginnings. In 1917, Cole and Eales separately concentrated on the development of writing in similar life structures through bibliographical references. In 1969, the renowned English researcher, Allen Richard, first proposed the expression "Bibliometrics" rather than "measurable catalog". The development of this term denotes the proper birth of bibliometrics. At present, more and more attention has been focused on this research. The clearest benefit of bibliometrics is that it permits researchers to concentrate on unambiguous exploration regions by dissecting references, co-references, geological circulation, and word recurrence, and make exceptionally helpful determinations. Up to now, bibliometrics has been generally utilized in area of interest research, co-origin examination, co-reference examination, and the advancement of the entire subject field.

Following the reform and opening up in the late 1970s, English as a Foreign Language (EFL) education in China has witnessed a sharp increase in popularity.

(Oxford, 1990) argued that learning strategies are steps taken by students to enhance their own learning. Strategies are especially important for language learning because they are tools for active, self-directed involvement, which is essential for developing communicative competence. Appropriate language learning strategies result in improved proficiency and greater self-confidence.

Some studies analyzed learning strategies from different perspectives. (Sarré, Grosbois, & Brudermann, 2019; Sun & Wang, 2020; F. Teng & Huang, 2018) gave out suggestions on how to improve writing skills. (L. S. Teng & Zhang, 2017; Zhang, Lin, Zhang, & Choi, 2017) analyzed the how personal motivation improve learning language. While there is no attempt to analyze the articles of learning strategies in Web of Science Core Collection.

Based on CiteSpace 6.1.R3, this article visualized 718 articles from 2016-2021 in a multidimensional and comprehensive way. By quantifying and exposing the thematic patterns and subjects of great interest to researchers to anticipate new trends in the literature, this article intends to study the

knowledge domain linked with learning strategies within the framework of learning strategies. The questions of this study were as follows:

- (1) What was the time distribution in the area of learning strategies?
- (2) What were the primary countries and institutions in the area of learning strategies from 2016 to 2021?
- (3) What were the most cited journals and references ?
- (4) Who were the most prolific and cited authors in the area of learning strategies from 2016 to 2021?
- (5) What were the hotspots in the area of learning strategies? And what the trends in learning strategies will be like?

2. METHODS

2.1 The Source of Data

Bibliographic records were collected from the Web of Science Core Collection of Thomson Reuter, consisting of a core data set and an expanded data set.

The topic was set as “Learning strategies” and “EFL”, and the source database in WOS was set as “Web of Science Core Collection” to ensure that the quality of selected papers was at a good level. The time span was set from 2016 to 2021. The document type was set as an article or review paper. Then after the scanning by researchers, some studies which were not relevant to Learning strategies or duplicated were excluded. Finally, 718 articles were selected for the visual analysis.

2.2 Tools of Visualization

CiteSpace was chosen as the visualization tool in this study. CiteSpace was widely used in the visual analysis of studies in networks including co-citation networks, keywords networks et al. In this study, based on the data from WOS, the duration in CiteSpace was set from 2016 to 2018 and the year slice was 1. The “Pathfinder” was chosen as the way of pruning in this software in the analysis of the categories, regions, and authors. However, in the keywords network analysis, the pruning sector was set as the style of minimum spanning tree to simplify the network. Meanwhile, “Cluster View-Static” and “Show Merged Network” were set as the visualization setting in CiteSpace. These parameters should be set correctly before the analysis procedure. Excel was then used to organize and display the data.

3. RESULTS AND DISCUSSION

3.1 The Analysis of Time Distribution

Fig 1 depicts the annual learning strategies-related publications from 2016 to 2021, in 2016 the publications are only 27, notably, the total publication numbers increased dramatically since 2017. In 2017, the number of publications increased to 237. There are several reasons for this trend. Firstly, as exchanging information and conducting cooperation become more convenient, learning strategies

gained great success by interacting with other disciplines, the study of learning strategies in the field of education has provided many methods on how to learn a language. (Shadiev, Wu, & Huang, 2017) made great contribution to this field. Secondly, learning strategies is combined with other disciplines, for example, education. The emergence of learning strategies has implications for teaching prepositions. (Wang & Bai, 2017) is the leading scholar. From 2018 to 2021, the publications keep increasing by years, which implied high research value in that field.

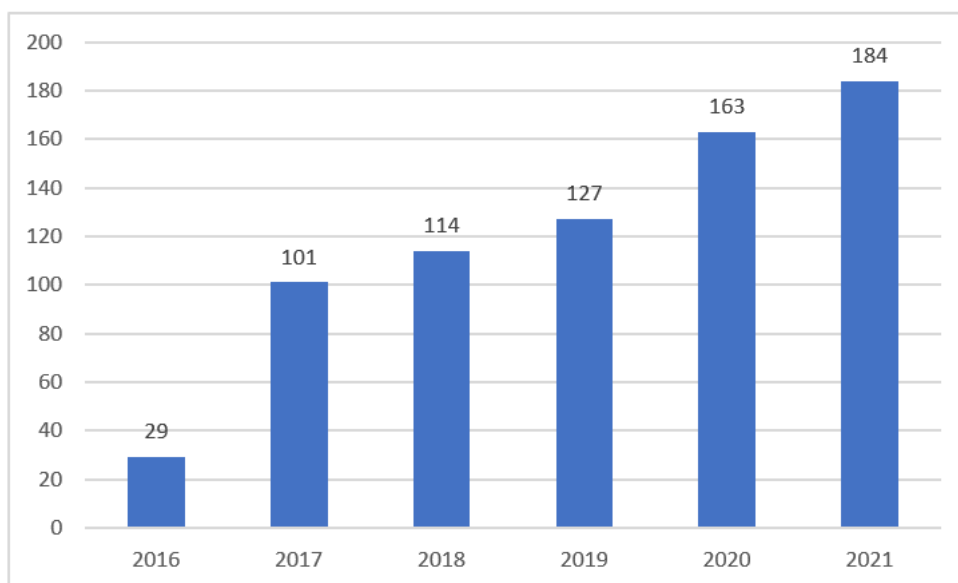


Fig 1. Publications of Learning strategies from 2011-2021

3.2 The Analysis of Countries

Fig. 2 presents the number of publications based in different countries. This map consists of 89 nodes and 82 links from 2016 to 2021. The USA ranked first with a total number of 306, followed by Russia with 283 publications. 990 articles by institutions in Europe were published, which indicates that over the previous ten years, a lot of academics in Europe have focused on that area.

Although the USA ranked first in the number of publications, the centrality is observed at less than 0.2. (Chen, 2006) argued that the centrality of a node is a graph-theoretical property that quantifies the importance of the node's position in a network. The articles from Australia and Finland were 0.77 and 0.71 respectively, which shows the high quality of the articles.

In terms of international collaboration, Despite the vast volume of articles, Fig. 1 and Table 1 show that the USA and China did not establish close cooperative relationships with other nations. For

example, Chinese scholars had more cooperation with scholars from the Taiwan region while USA scholars had closer cooperation with Norway and Jordan researchers. At the same time, the Australian scholars had wide cooperation with other countries, such as Switzerland, China, Finland, Sweden, France, and Brazil. People from all backgrounds have become interested in the study of learning strategies. More and more countries have begun to devote themselves to the research and applications of learning strategies.

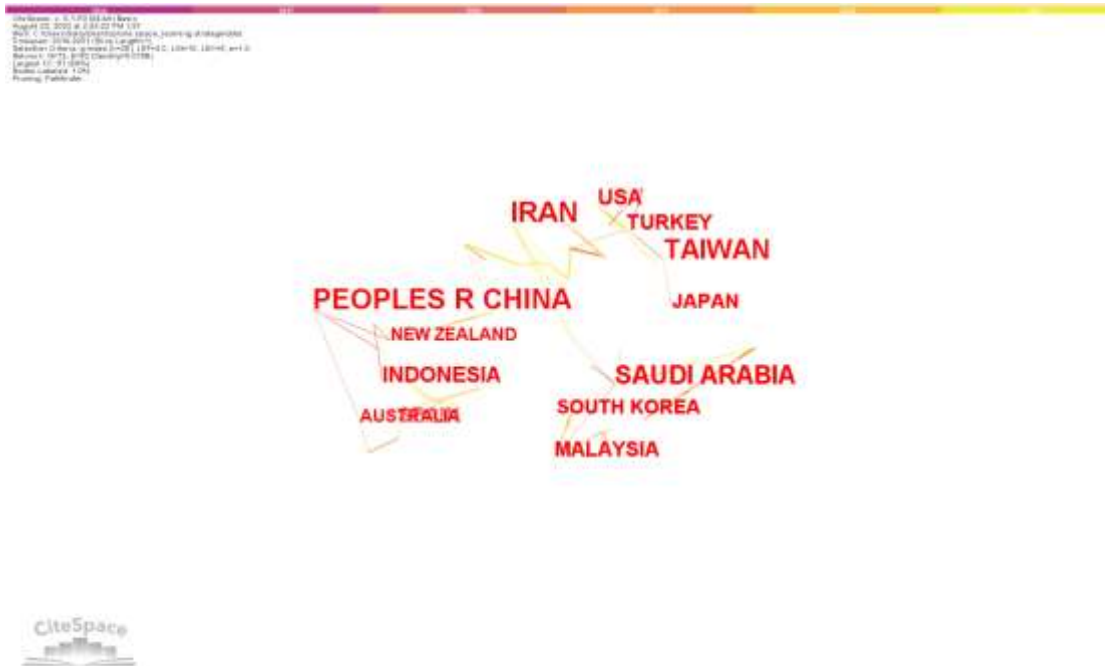


Fig .2. The Network of Countries for Learning strategies research

Table.1 Learning Strategies Research Distribution by countries

Countries	Frequency	Countries	Centrality
PEOPLES R CHINA	117	SLOVAKIA	0.63
IRAN	112	IRAN	0.5
TAIWAN	93	CZECH REPUBLIC	0.46
SAUDI ARABIA	69	SAUDI ARABIA	0.45
USA	38	ENGLAND	0.45
INDONESIA	36	LATVIA	0.45
SPAIN	31	NEW ZEALAND	0.41
TURKEY	30	VIETNAM	0.41
MALAYSIA	28	TUNISIA	0.41
SOUTH KOREA	23	PEOPLES R CHINA	0.34

3.3 The Analysis of Institutions

Regarding influential institutions, the Islamic Azad Univ ranked first with 49 articles, followed by Natl Taiwan Univ Sci & Technology (16) and Natl Taiwan Normal University (15). However, the high publications didn't contribute to the high burst. Burst analysis is one of the common functions of CiteSpace software. Real difficulties and research hotspots in a specific time period can be represented by the start and finish times of burst words. In order to examine its contribution, this part draws on a variety of institutions. In terms of burst, the top three institutions were Taif Univ (3.14), University Sains Malaysia (1.43), and Natl Taiwan Normal Univ (1.13). Although Islamic Azad Univ had prolific publications its bust didn't rank among the top 10 institutions with the strongest citation burst. It shows that these three institutions have strong research potential in the direction of learning strategies. The burst period for Taif University was 2017-2018 and the burst period for University Sains Malaysia was 2019-2021, which depicted the university's strong influence in learning strategies in recent years. More details show in fig.3 and table.2.

In terms of regional distribution, University Sains Malaysia, Taif University, and Natl Taiwan Normal University are from Asia which reflected the importance of Asia in the field of learning strategies.



Fig. 3 The Top 10 Institutions with learning strategies-related publications

Table 2. Contributing Institutions by Frequency and Burst.

Institutions	Frequency
Islamic Azad Univ	49
Natl Taiwan Univ Sci & Technol	16
Natl Taiwan Normal Univ	15
Chinese Univ Hong Kong	13
Beijing Normal Univ	12
Educ Univ Hong Kong	11
Univ Macau	11
Univ Auckland	10
Beijing Univ Posts & Telecommun	7
Taif Univ	7

Institutions	Burst
Taif Univ	3.14
Univ Sains Malaysia	1.43
Natl Taiwan Normal Univ	1.13
Alzahra Univ	1
Chung Ang Univ	0.88
Hong Kong Polytech Univ	0.85
Feng Chia Univ	0.6
Guangdong Univ Foreign Studies	0.6
Curtin Univ	0.57
Arak Univ	0.57

3.3 The Analysis of Authors

Country co-authorship analysis is an important form of co-authorship analysis. It can present the degree of communication between countries as well as the persuasive countries in this field. Based on the data collected from 2016-2021, Bai B and Zhang L published 9 articles and ranked at the top, followed by Hwang G (8) and Bagheri R (7). There are more details in fig.4 and table.3.

Since 2017, Bai B has published 9 articles in journals such as the *Tesol Quarterly*, *Language Teaching Research and System*, and *Computer Assisted Language Learning*, as the first author and co-author, in-depth discussions and analyses on computer-mediated collaboration in foreign language writing, motivation, belief, and self-regulated learning strategies are conducted.

Zhang L mainly analyzed the Chinese university learners, metacognition, and validation of questionnaire. Hwang G studied the learning environment, pedagogical issues virtual reality and peer tutoring.

The cooperation of authors is crucial to a field's development. Figure 4 shows a loose network of researchers, with a few networks of collaboration. It shows that many academics are capable of working independently, and authors have a great chance to establish close networks of collaboration in the future.



Fig. 4 The Network of Contributing Authors

Table.3 The Top 10 Authors

Authors	Publications	Year Begin
BAI B	9	2017
ZHANG L	9	2016
HWANG G	8	2019
BAGHERI M	7	2017
SADIGHI F	6	2017
ALMUSHARRAF N	6	2020
WANG J	6	2020
CHEN M	4	2019
CHEN C	4	2020
CHEN Y	4	2021

3.3 The Analysis of Cited References

Generally, research articles published in journals represent the trend and hotspot of certain subjects, and the references cited in these papers serve as their knowledge foundation. The whole 718 bibliographic records of the combined core data set visualized by CiteSpace, generating the document

co-citation network as shown in Fig.4. The author could group references that are frequently cited in the field of learning strategies and find co-citation clusters with the aid of specific computer software. This step is crucial for determining the fundamental understanding of learning strategies research, and it can be completed by using journal articles to visualize existing knowledge. The following parameters in CiteSpace were used: (1) Timeslice from 2016 to 2021; (2) Term source = title/abstract/author keywords/keywords plus; (3) Node type = cited reference; (4) Pruning = pathfinder/pruning the merged network; (5) Select 50 most cited articles per slice. After running CiteSpace, the author got the map shown in Fig. 2. The clustering function was performed by choosing 'T' as the labeling source and log-likelihood ratio as the method. The results returned 12 knowledge clusters and two of them are major clusters based on co-citation cluster information. The Modularity Q is a value ranging from 0–1 and values close to 1 reveal closer relationships and connections within clusters. Generally speaking, Modularity Q values between 0.4–0.8 are acceptable. The values of Mean Silhouette should be between –1–1. Values close to 1 mean articles within a cluster are highly consistent or similar in terms of content. Fig. 5 and Table 4 show that the Modularity Q value is 0.8598 and the Mean Silhouette is 0.9628. All 12 major clusters' Silhouette values are greater than 0.8. This indicates a high-quality cluster analysis of the learning strategies knowledge mapping.

Specifically speaking, from table 4 we can see that cluster ranked first was Chinese EFL Context (#0). This knowledge cluster contains studies on mixed-methods approach, investigating motivational regulation strategies, speech act, understanding foreign language learners' perception. This cluster contains 34 articles, mostly published around 2019. The silhouette value of the cluster was 0.881, indicating high consistency among the 32 articles in this cluster. The major citing article of the cluster is: TORRES- BAI, B (2020.0) Hong Kong primary students' self-regulated writing strategy use: Influences of gender, writing proficiency, and grade level which was published in the Studies in Educational Evaluation.

The second largest cluster (#1) contains 32 articles with a silhouette value of 0.957. CHU, H (2019.0) paper on map-based collaborative mobile gaming, which was published on Educational Technology & Society, was the most cited. This implied in 2019, the scholars mainly studied how to combine language learning with modern technology. The third largest cluster (#2) contains 31 articles with the silhouette value of 0.957, which indicated the high consistency of this cluster. The most cited article was BAI, B (2021.0) An intervention study to improve primary school students' self-regulated strategy use in English writing through e-learning in Hong Kong. It's worth noticing that the research mainly focused on online teaching (#5) and virtual reality (#11) in 2020. The 5th largest cluster (#5) has 18 members and a silhouette value of 0.994. It is labeled as online teaching. The major citing article of the cluster was INAN-KARAGUL, B (2021.0) Improving Language Learners' Use of Self-Regulated Writing Strategies Through Screencast Feedback. School closures due to the Covid-19 pandemic brought surmounting challenges at higher education level to both learners and educators. (Inan-Karagul & Seker, 2021) The fifth largest cluster (#11) has 14 members and a silhouette value of 0.947. It is labeled as English-speaking performance. The most cited article

was CHIEN, S (2020.0) Effects of peer assessment within the context of spherical video-based virtual reality on efl students' English-speaking performance and learning perceptions. (Chien, Hwang, & Jong, 2020) conducted spherical video-based virtual reality (SVVR) environment was developed to situate students in authentic English-speaking contexts. This implied that language teaching will more emphasize real environment.

Burst detection can be used to investigate a field's research patterns, and previous and current bursts can, to some extent, predict future trends. This study also adopted this algorithm to extract citation bursts, and all citation bursts since 2016 were selected to be analyzed to explore the emerging trends of learning strategies. By analyzing the references that experienced sudden increase in their citations during a certain time period, we can roughly explore the present research interests and future trends of a certain knowledge domain. The burst group with an end year of 2021 suggests that their citation burst will probably continue in the future, as well as the popularity of their research topics. The top-ranked item by citation bursts was Nation IS, (2013) with a burst value of 3.24. The citation burst is an indicator of a highly active area of research and shows that a particular publication is associated with a surge of citations. Table 3 shows the top 16 authors and studies based on bursts. More details show in table.4 and table.5.

In conclusion, the studies to forecast research orientations in the future have been made possible by the citation burst as an indicator of recognizing upcoming research trends. By classifying the studies with the most recent citation burst from 2016, it is obvious to us that the study concerning the role of simulation in online teaching and real learning environment will still appeal to researchers in the coming years.



Fig. 4 Timeline of Cited References

Table.3 Detail of Knowledge cluster

ClusterID	Size	Silhouette	MeanYear	Label(LR)	Label(SI)	Label(M)
0	34	0.981	2019	chinese eff context (56.35, 1.0E-4); english language learner (39.15, 1.0E-4); predictive effect (28.13, 1.0E-4); formulae sequence (35.89, 1.0E-4); teaching (2 (35.99, 1.0E-4)	chinese eff context; motivational strategies; predictive effect; english language learner; formulae sequence (hong kong; eff writing; self-regulated writing strategy use; grade level; profiling chinese eff student	mixed-method approach (1.83); investigating motivational regulation strategies (1.81); speech act (1.81); understanding foreign language learners' perception (1.81); language-related pedagogical practice (0.81)
1	32	0.957	2018	map-based collaborative mobile gaming (41.11, 1.0E-4); digital pen-based learning system (35.17, 1.0E-4); reward mechanism (35.17, 1.0E-4); english grammar (32.21, 1.0E-4); eff student (30.27, 1.0E-4)	eff student; english grammar; learning performance; map-based collaborative mobile gaming; digital pen-based learning system (learning perception; facilitating eff student; contextual gaming approach; reward mechanism; learning approach	learning activities (0.2); english writing course (0.2); assessment approach (0.2); speech act (0.2); understanding foreign language learners' perception (0.2)
2	31	0.957	2020	english writing (53.35, 1.0E-4); writing competence (51.95, 1.0E-4); motivational belief (31.06, 1.0E-4); self-regulated learning strategy use (31.06, 1.0E-4); secondary student (31.06, 1.0E-4)	english writing; hong kong; eff writing; writing competence; motivational belief (self-regulated writing strategies; screencast feedback; intervention study; writing strategies; self-regulated strategy use	language-related pedagogical practice (0.72); understanding subject teacher (0.72); learning classroom (0.72); speech act (0.71); understanding foreign language learners' perception (0.71)
3	36	0.996	2016	questionnaire-based validation (41.76, 1.0E-4); motivational regulation questionnaire (34.7, 1.0E-4); fostering strategic learning (34.7, 1.0E-4); oral skill (27.69, 1.0E-4); selective strategy use (27.69, 1.0E-4)	writing strategies; fostering strategic learning; motivational regulation questionnaire; using categorical modification; eff course book (questionnaire-based validation; self-regulated learning strategies; corrective feedback; using categorical modification; writing strategies	eff teachers' belief (0.1); speech act (0.1); understanding foreign language learners' perception (0.1); language-related pedagogical practice (0.1); saudi university eff student (0.1)
4	22	1	2019	critical review (50.98, 1.0E-4); saudi college level student (41.52, 1.0E-4); drafting argumentative writing (41.52, 1.0E-4); teaching practice (34.51, 1.0E-4); saudi universities (34.51, 1.0E-4)	critical review; saudi college level student; drafting argumentative writing; teaching practice; saudi universities (reading comprehension; eff learning; saudi arabia; saudi college level student; learning strategies	investigating saudi eff students' knowledge (0.1); reading comprehension (0.1); speech act (0.1); understanding foreign language learners' perception (0.1); language-related pedagogical practice (0.1); saudi university eff student (0.73); understanding english item (0.73); speech act (0.73); understanding foreign language learners' perception (0.73); language-related pedagogical practice (0.73)
5	18	0.994	2020	online teaching (31.08, 1.0E-4); writing feedback orientation (31.08, 1.0E-4); chinese university student (31.08, 1.0E-4); self-regulated writing strategies (30.73, 1.0E-4); screencast feedback (30.73, 1.0E-4); emerging methodologies (40.35, 1.0E-4); research trend (40.35, 1.0E-4); recent research (40.35, 1.0E-4); eff motivation (40.35, 1.0E-4); self-directed learning (34.52, 1.0E-4)	hong kong; self-regulated learning; screencast feedback; self-regulated writing strategies; writing feedback orientation (self strategies; self-regulated strategy; eff writing; individual difference; indonesian university student	understanding foreign language learners' perception (0.21); educational technology (0.21); specific reference (0.21); teachers' practice (0.21); speech act (0.21)
6	18	0.982	2020	learning (18.39, 1.0E-4); meta-analysis (18.39, 1.0E-4); integrating mobile device (18.39, 1.0E-4); teaching (18.39, 1.0E-4); research synthesis (18.39, 1.0E-4)	effect; meta-analysis; integrating mobile device; teaching; learning (concept-mapping strategy; student; effect; mobile english vocabulary learning; meta-analysis	mobile english vocabulary learning (0.02); concept-mapping strategy (0.02); speech act (0.02); understanding foreign language learners' perception (0.02); language-related pedagogical practice (0.02)
7	17	0.987	2016	language teaching (39.62, 1.0E-4); learning english language (39.62, 1.0E-4); cram school context (31.73, 1.0E-4); english language education (31.73, 1.0E-4); listening strategy (31.73, 1.0E-4); self-regulated strategy (29.58, 1.0E-4); mixed-method study (29.58, 1.0E-4); text revisor (26.59, 1.0E-4); foreign-language students self-efficacy (26.59, 1.0E-4); development-based revision instruction (26.59, 1.0E-4); motivational facet (26.59, 1.0E-4); sarjan university student (26.59, 1.0E-4); emotional metacognitive (36.59, 1.0E-4); chinese students' use (29.18, 1.0E-4); school context (29.18, 1.0E-4)	language teaching; english language education; listening strategy; learning style; cram school context (learning english language; motivational strategies; saudi learner; learning strategies; language teaching; text revision; development-based revision instructor; self-regulated strategy; mixed-method study; sustainable learning (foreign language learner; investigating student; writing metacognitive experience; questionnaire; metacognitive experience; secondary school learner; sarjan university student; academic achievement; motivational facet; learning strategies; student learns achievement; dimeson (english learning; school context; learning strategies; vocabulary strategies; sudanese eff learner	psychological autonomy (0.05); investigating reading (0.05); reading content (0.05); saudi learner (0.05); speech act (0.05); speech act (0.25); understanding foreign language learners' perception (0.25); language-related pedagogical practice (0.25); saudi university eff student (0.25); eff adult learner (0.25); eff adult learner (0.01); student; teams achievement dimeson (0.01); vocabulary learning (0.01); speech act (0.01); understanding foreign language learners' perception (0.01)
8	17	0.972	2017	english-speaking performance (29.55, 1.0E-4); learning perception (29.55, 1.0E-4); spherical video-based virtual reality (29.55, 1.0E-4); facilitating eff student (22.9, 1.0E-4); contextual gaming approach (22.9, 1.0E-4)	eff student; learning perception; english-speaking performance; spherical video-based virtual reality; english grammar (speech act; video clip; sociopragmatic knowledge; using short stories v. upper-intermediate eff student	speech act (0.1); using short stories v (0.1); upper-intermediate eff student (0.1); sociopragmatic knowledge (0.1); video clip (0.1)
9	15	0.988	2020	cognitive intelligence emotional intelligence (37.06, 1.0E-4); language learning strategies (37.06, 1.0E-4); cooperative learning (29.55, 1.0E-4); eff classroom (29.55, 1.0E-4); individual accountability (29.55, 1.0E-4)	language learning strategies; eff learner; learning style; foreign language; eff classroom (cooperative learning; individual accountability; eff classroom; compulsory english course; foreign language	language student (0.08); progressive behavioral pattern (0.08); learning performance (0.08); problem-based gaming (0.08); learning anxiety (0.08)

Table.4 Details of Knowledge Clusters

Coverage	Author and Year	Articles
Cluster #1	BAI, B (2020.0)	Hong Kong primary students' self-regulated writing strategy use: Influences of gender, writing proficiency, and grade level
Cluster #2	CHU, H (2019.0)	Impacts of concept map-based collaborative mobile gaming on english grammar learning performance and behaviors
Cluster #3	BAI, B (2021.0)	An intervention study to improve primary school students' self-regulated strategy use in English writing through e-learning in Hong Kong
Cluster #4	TENG, L (2016.0)	A Questionnaire-Based Validation of Multidimensional Models of Self-Regulated Learning Strategies

Table 5. Top 16 References with Strongest Citation

References	Year	Strength	Begin	End
Nation IS, 2013, LEARNING VOCABULARY, V0, P0	2013	3.24	2017	2018
Dornyei Z, 2015, PSYCHOL LANGUAGE LEA, V0, P0	2015	2.59	2018	2019
Alrabai F, 2016, APPL LINGUIST, V37, P307	2016	2.58	2019	2021
Rose H, 2012, APPL LINGUIST, V33, P92	2012	2.52	2016	2017
Richards JC, 2014, APPROACHES METHODS L, V0, P0	2014	2.49	2018	2019
Zhang X, 2013, SYSTEM, V41, P164	2013	2.3	2017	2018
Moskovsky C, 2013, LANG LEARN, V63, P34	2013	2.3	2017	2018
Le TCN, 2013, LANG TEACH RES, V17, P9	2013	2.25	2016	2018
Hwang GJ, 2017, COMPUT EDUC, V106, P26	2017	2.25	2019	2021
Kormos J, 2014, TESOL QUART, V48, P275	2014	2.12	2017	2019
Kormos J, 2012, J SECOND LANG WRIT, V21, P390	2012	2.01	2016	2017
Boo Z, 2015, SYSTEM, V55, P145	2015	1.93	2019	2021
Kizilcec RF, 2017, COMPUT EDUC, V104, P18f	2017	1.85	2018	2019
Lamb M, 2017, LANG TEACHING, V50, P301	2017	1.6	2019	2021
Hwang GJ, 2016, COMPUT EDUC, V102, P188	2016	1.6	2019	2021
Mayo MDG, 2015, SYSTEM, V54, P40	2015	1.55	2018	2021

3.3 The Analysis of Cited Journals

The journal co-citation analysis not only exposes the overall structure of the subject and the features of a journal, it is also an effective approach to examine the structure and characteristics of a subject. The size of node represents the activity of the journal and the number of published papers. The separation between two nodes is also crucial. In general, the citation frequency increases as the distance between two nodes decreases. Articles from the System have a total citation of 374. Articles from Tesol Quarterly have a total citation of 350, articles from Modern Language Journal have a total citation of 342. The citation frequency ranking is consistent with the overall ranking of the journal by SSCI, which also indicated the appropriateness of journals' inclusion in this study.

However, from 2016 to 2021, in terms of the burst, Motivation Second Language ranked first with a burst value of 5.13 between 2017 and 2018. Other journals that have relatively high burst values include Teaching Principles, Psychol language Teaching.

In terms of centrality, most journals are applied to related journals. this finding suggests that learning strategies research moved to how to use rather than explore the internal structure of strategies. Based on the discipline category information from the web of science, the researches of learning strategies are mainly from education and humanities multidisciplinary and psychology. For the duration (2018-2019), the studies on motivation and have become popular, reflecting the changing focus of learning strategies at different time stages. More details contain in table. 6 and table. 7.

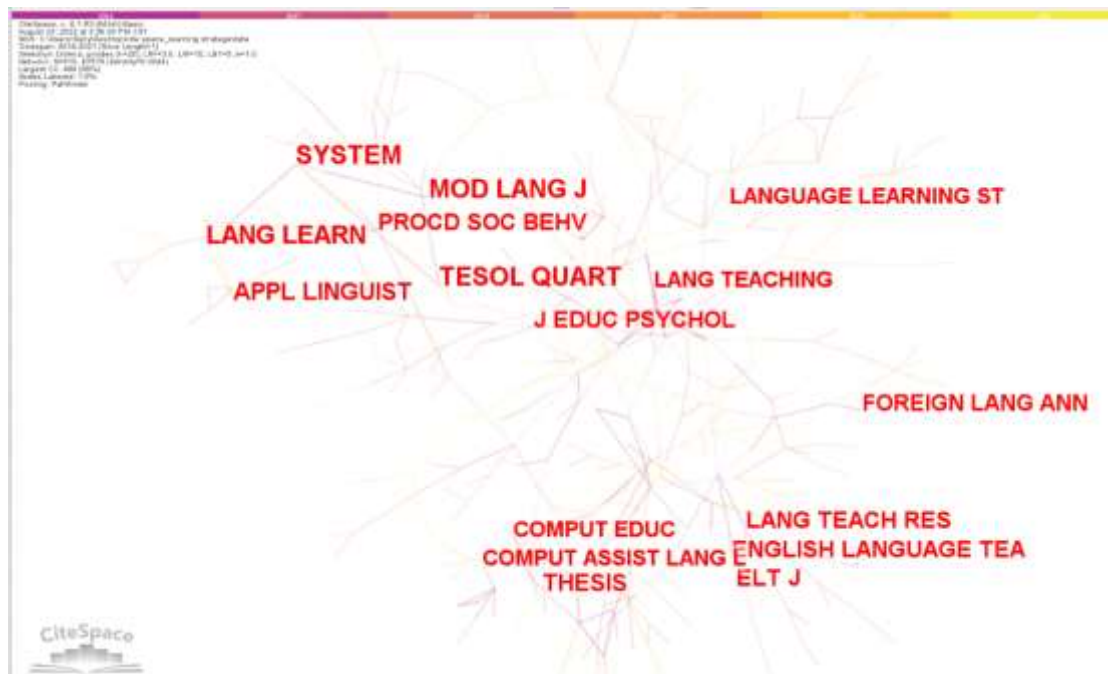


Fig.5 The Network of Cited-Journals

Table 6. The Top 10 Sources by Frequency

Source	Frequency	Year
SYSTEM	374	2016
TESOL QUART	350	2016
MOD LANG J	342	2016
LANG LEARN	303	2016
THESIS	259	2016
APPL LINGUIST	255	2016
LANG TEACH RES	209	2016
ELT J	199	2016
ENGLISH LANGUAGE TEA	191	2016
J EDUC PSYCHOL	188	2016

Table. 7 The Top 10 Journals by Strength and Centrality

Journals	Strength
MOTIVATION 2 LANGUAG	5.19
LEARNER STRATEGIES L	4.57
CANADIAN MODERN LANG	4.23
2 LANGUAGE ACQUISITI	4.13
SOCIAL PSYCHOL 2 LAN	3.88
AUTONOMY INDEPENDENC	3.82
THESIS	3.79
SOCIAL FDN THOUGHT A	3.62
INTERNET TESL J	3.55
TEACHING PRINCIPLES	3.3

Journals	Centrality
DISCOVERING STAT USI	0.43
TEACHING RES MOTIVAT	0.39
MOTIVATION SELF REGU	0.36
J EXP EDUC	0.34
J EDUC PSYCHOL	0.33
COMPUT HUM BEHAV	0.32
INTRO APPL MULTIVARI	0.26
APPL MISSING DATA AN	0.26
EDUC PSYCHOL-US	0.24
MOTIVATION 2 LANGUAG	0.23

3.4 The Analysis of Keywords

By using the node type of the Cite pace operation interface as the keyword to conduct a visual analysis of the scientific graph, the keyword co-occurrence graph displayed in Figure 6 can be created. This

graph effectively reflects the research hotspots in the disciplinary fields. The link strength between two nodes refers to the frequency of co-occurrence. It can be used as a quantitative index to depict the relationship between two nodes. The keywords in the map are clustered and summarized according to the relevant algorithms, and the keyword clustering map as shown in Figure.7 below is obtained. The cluster map focuses on reflecting the structural characteristics between clusters, highlighting key nodes and important connections. Combining the relevant keyword data in the two figures, we can analyze the main research areas of learning strategies in the core research circle.

Co-occurring network analyses were performed using keywords such as “node type” Fig.6 shows that recent popular research topics in the learning strategies field include motivation, performance, reading comprehension, knowledge. Topics with high centrality include attitude, academic, achievement, comprehension, environment and efficacy. the author selected keywords that appeared more than 20 times, and then checked whether these keywords showed centrality. We list these keywords based on years in Table 6. Table.7 shows the first time each research topic appeared and its duration. For example, communication strategy has a long duration from 2016 to 201, while from 2019 to 2021 the hot topics include interactive learning environment, English proficiency, applied in subject area. Research topics between 2019 and 2021 were focused on interactive technology and application.

From the analysis of keywords of these studies, hotspots and maybe future trends could be discussed on the learners’ proficiency, motivation and interaction.



Fig.6 The Network of Keywords

Table.8 The Frequency of Keywords by Centrality

Keywords	Frequency	Centrality	Begin
attitude	20	0.41	2016
academic achievement	7	0.29	2017
comprehension	32	0.22	2016
environment	5	0.22	2020
efficacy	23	0.21	2016
construction	4	0.19	2020
anxiety	11	0.18	2016
mobile learning	4	0.17	2016
efl writing	13	0.16	2016
text	12	0.15	2017
technology	20	0.14	2016
impact	23	0.13	2016
learning	6	0.13	2019
motivation	81	0.12	2016
intrinsic motivation	5	0.12	2017
recast	4	0.12	2018
learner	16	0.11	2017
autonomy	15	0.11	2017
self regulation	5	0.11	2017
succe	13	0.1	2018
self efficacy	8	0.1	2016
design	6	0.1	2019
teaching/learning strategy			

Table.9 25 Keywords with the Strongest Burst

Keywords	Strength	Begin	End
communication strategy	1.44	2016	2019
cognitive strategy	1.27	2016	2017
cognitive load	1.11	2016	2017
comprehension	1.04	2016	2017
2nd language	3.25	2017	2018
university	2.96	2017	2018
framework	2.54	2017	2018
vocabulary learning	2.11	2017	2018
strategy use	1.78	2017	2018
variable	1.74	2017	2019
school student	1.49	2017	2019
pattern	1.3	2017	2018
proficiency	0.99	2017	2018
learning strategy	4.58	2018	2019
self	1.99	2018	2019
metacognitive awareness	1.94	2018	2019
negotiation	1.85	2018	2019
pedagogical issue	1.48	2018	2019
recast	1.48	2018	2019
text	0.96	2018	2019
interactive learning	1.91	2019	2021
environment			
teaching/learning strategy	1.63	2019	2021
foreign	1.09	2019	2021
english	1.09	2019	2021
proficiency			
applications in subject area	1.09	2019	2021

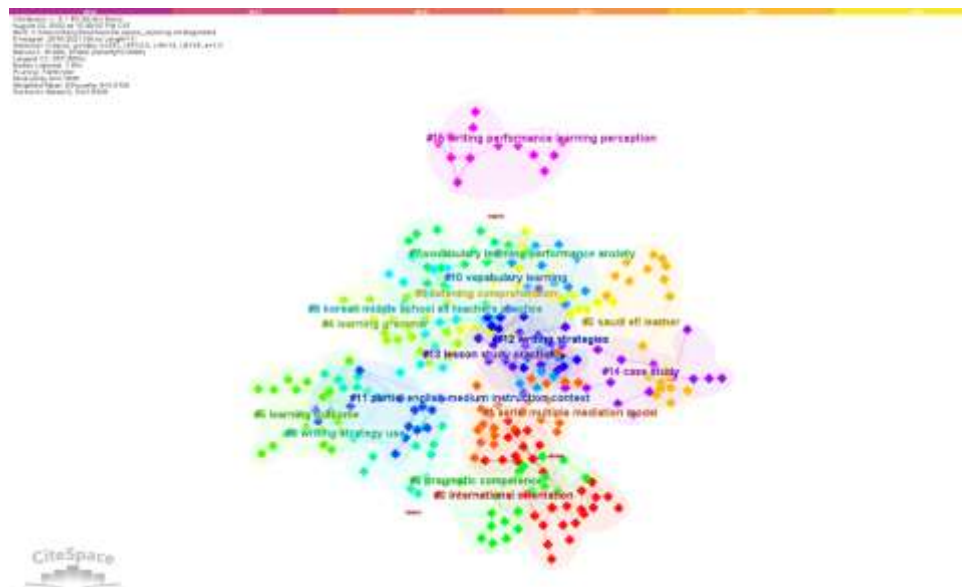


Fig.7 The Cluster of Keywords

Table.10 The Cluster of Keywords by MI

Cluster ID	Size	Silhouette	Average Year	Keywords
0	30	0.948	2018	high school student (0.64); japanese junior (0.64); fifth language skill (0.64); exploring reading strategy use (0.64); professional knowledge (0.64)
1	24	0.893	2018	consecutive bilingual instruction (0.25); balancing nests language use (0.25); high school student (0.25); japanese junior (0.25); fifth language skill (0.25)
2	21	0.949	2018	major graduate (0.24); female saudi (0.24); high school student (0.24); japanese junior (0.24); fifth language skill (0.24)
3	20	0.87	2018	high school student (0.4); japanese junior (0.4); fifth language skill (0.4); exploring reading strategy use (0.4); professional knowledge (0.4)
4	20	0.868	2017	offline blended teaching mode (0.44); high school student (0.44); japanese junior (0.44); fifth language skill (0.44); exploring reading strategy use (0.44)
5	19	0.962	2018	school achievement (0.12); high school student (0.12); japanese junior (0.12); fifth language skill (0.12); exploring reading strategy use (0.12)
6	19	0.914	2018	high school student (1.82); japanese junior (1.82); fifth language skill (1.82); exploring reading strategy use (1.82); professional knowledge (1.82)
7	18	0.962	2018	efl email (0.25); high school student (0.25); japanese junior (0.25); fifth language skill (0.25); exploring reading strategy use (0.25)
8	18	0.849	2017	fifth language skill (0.2); successful learning experience (0.2); endowing efl learner (0.2); high school student (0.2); japanese junior (0.2)
9	18	0.94	2019	pragmatic consciousness-raising task (0.21); efl learners speech act (0.21); high school student (0.21); japanese junior (0.21); fifth language skill (0.21)
10	17	0.762	2018	pre-service efl program (0.14); high school student (0.14); japanese junior (0.14); fifth language skill (0.14); exploring reading strategy use (0.14)
11	16	0.928	2018	professional knowledge (0.09); teacher education philosophy (0.09); postmethod perspectivisation (0.09); high school student (0.09); japanese junior (0.09)

In an additional step, the author formed a keywords cluster (Fig. 7), the clustering obtained the evaluation index of network modularity (Modularity) $Q=0.7695$, the mean value of network homogeneity Mean Silhouette= 0.9126 , indicating that the graph network clustering is good, the homogeneity is high, and the clustering results are reasonable. Keywords cluster can reveal the study area in a certain period. The development of learning strategies can be divided into two stages. The first stage is from 2016-2017, most studies were about exploring reading strategy use, fifth language skill, offline blended teaching mode, from 2018-2019 the research mainly on the high school student, pre-service efl program, consecutive bilingual instruction, pragmatic consciousness-raising task. More details show in table.10.

DISCUSSIONS AND CONCLUSIONS

This study conducted a bibliometric analysis and visualization of publications that dealt with learning strategies. The following is a summary of the author's interesting findings on publications on learning strategies: First, the learning strategies-related publications fluctuated at a low level between 2016 and 2017. However, after 2017, the number of publications grew rapidly. In terms of institutes, the Islamic Azad University has the highest number of publications. Asian institutes ranked in the top 10 regarding the number of learning strategies-related publications. The journal, System, ranks first among the learning strategies-related journals. The Asian publications ranked second, which has the highest citation frequency and H-index. It implies that in this field, Asia is the leading region. China has a large number of publications, while Chinese scholars should pay attention to the quality of their papers. Second, through the analysis of keywords, we have found that learning strategies is moving from attitude, anxiety toward an interactive model and combine with modern technologies. Until now, personal-interactive learning strategies is heating up. The main obstacle that people must overcome is the technological assistance of learning strategies study.

Third, in the learning strategies field, the phenomenon of collaboration between several authors is pervasive. All the top 10 publications with the highest number of citations were completed with more than one author. However, international cooperation is not universal.

The technical difficulties in using and creating learning strategies cannot be disregarded given the context of Big Data. (1) First, from the standpoint of data collection, extensive data is gathered from a variety of data sources, including the Internet, mobile phones, classrooms, and the scientific community. These sources are then used to build specialized databases or to analyze specific languages using tools like Python or other programming languages. (2) To support the big data era, there were a number of additional issues in both data management and data analysis, such as processing highly distributed data sources, tracking data sources, and building parallel and distributed architecture methods.

Although the bibliometric analysis and visualization of articles relevant to learning strategies produced some intriguing results, this study has some flaws. The author downloaded the documents from Core

Collection databases via Web of Science and more than 99% of the articles were written in English. This leads to the underestimation of researchers who use other languages.

The collective efforts and interests in this scientific field from 2016 to 2021 have been outlined by the bibliometric review of learning strategies. On the basis of the presented visualization by CiteSpace, the bibliometric evaluation of learning strategies has detailed the collective efforts and interests in this scientific topic from 2016 to 2021. In order to discover the theme patterns and new trends in the knowledge domain of learning strategies, an effective and quantitative method is provided by the current study.

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