Metacognition in the field of international education: Bibliometric Analysis Based on Citespace and VOSviewer

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Abstract. With the development of cognitive factors in the fields of pedagogy and psychology, Metacognition has received much attention as the "cognition of cognition", This paper examines the overall development context, research hotspots and future trends of the metacognitive field from 2005 to 2023, With the help of CiteSpace and VOSviewer visual analysis software, 2143 documents from CNKI (N=348) and Web of Science (N=1795) were analyzed, The results suggest that international research on metacognition will continue to flourish in the coming years, But domestic research needs to grow. Based on the sudden analysis results of keywords, different subject integration methods, metacognitive skills and metacognitive education may become future research hotspots.

Keywords: Metacognition; Biliometric Analysis; Visualization; VOSviewer; Citespace.

1. Introducation

According to the retrieval results of the authoritative database, the current metacognition application in the field of international education has not been systematic metrology and summary, focus on this problem, this paper with the help of literature visual analysis software CiteSpace and VOSviewer analysis international 2005-2023 published high quality literature, through the cluster analysis examines the nearly twenty years of metacognition in the field of international education, in order to provide reference and reference, broaden the research ideas.

2. Methodolody

2.1. Data collection

In order to prove the international research on metacognition, China, Web of science for literature retrieval library, search way set for advanced search, the subject "metacognition" and "cognitive", "education" "teaching" "curriculum" joint word, publication time limit for 2005-2023, the database first retrieved literature by manual screening, eliminate the correlation with weak topic, repeat literature and discuss simple literature, finally get 2143 research samples.

2.2. Research question

With the help of Citespace and VOSviewer visual analysis software, they have powerful bibliometric analysis function[1], this study provides a bibliometric analysis of the theoretical and empirical studies of metacognition, and aims to address the following questions:

In terms of the number of publications, what is the research trend in the field of metacognition?

Which countries, institutions, and journals have contributed significantly to the research in the field of metacognition?

What are the current research hotspots in the field of metacognition today?

What are the future development directions in the metacognitive field?

3. Results

3.1. Literature quantitative trend

As shown in Figure 1, under the search conditions, the Chinese domestic and foreign research trends are as follows:

China: in the field of metacognitive literature number by 25 in 2005 to 2023, shows that nearly two decades metacognitive research in domestic development is slow, and has a declining trend, by contrast, 2008-2011 belong to the cognitive education start period, related literature research level and quantity peak, are around 35, and with the advancement of quality education and new curriculum reform, metacognition as one of the core elements of promoting deep learning and efficient learning, was included in the education teaching target system. However, with the rapid rate of domestic teaching reform in China, primary and secondary school teachers could not update their personal quality and ability reserves in time[2]. As a result, metacognition has not received enough attention in academic research. The research reached a low point in 2015, and the number of documents only reached 8. From 2016 to 2018, the research heat increased, but then decreased again.

Foreign countries: International research trends in 2005-2018 are very similar to Chinese domestic research trends, Both show a wavy change, But the growth is not obvious, Overall, flat, Slightly tired state, But from 2019 to 2023, The number of related literature has been on the rise, The literature growth momentum reached a peak in 2023 (219 articles), This may be due to the fact that many international organizations such as the Organization for Economic Cooperation and Development (OECD) reflect a focus on metacognitive ability in their programs such as their PISA test[3], Promoting countries to strengthen the development of students' metacognitive skills in curriculum design and educational reform. At the same time, the popularization of digital technology in education, Also led some scholars to try to combine digital education with metacognitive training[4], For example, using the e-learning environment and intelligent teaching to support students' self-monitoring and adjusting the learning process[5][6], The number of international publications is expected to continue to grow in 2024.

Figure 1 Trend chart of the number of documents published at home and abroad

3.2. Analysis of hotspot research areas based on keyword clustering

According to Figure 2 can see metacognition and different keywords form the keyword network, the total network each node reference a keyword, its size reflects the frequency, the distance between nodes represents their correlation, the longer the distance, the weaker the correlation, the last the same color keywords belonging to the same cluster. Six main lines and nodes are colored: red, blue, yellow, green, orange and purple, while pink has fewer related keyword nodes and a long distance from the central word "metacognition". Considering that these nodes need to reflect the current hot topics in metacognition research, this paper analyzes the first four clusters:

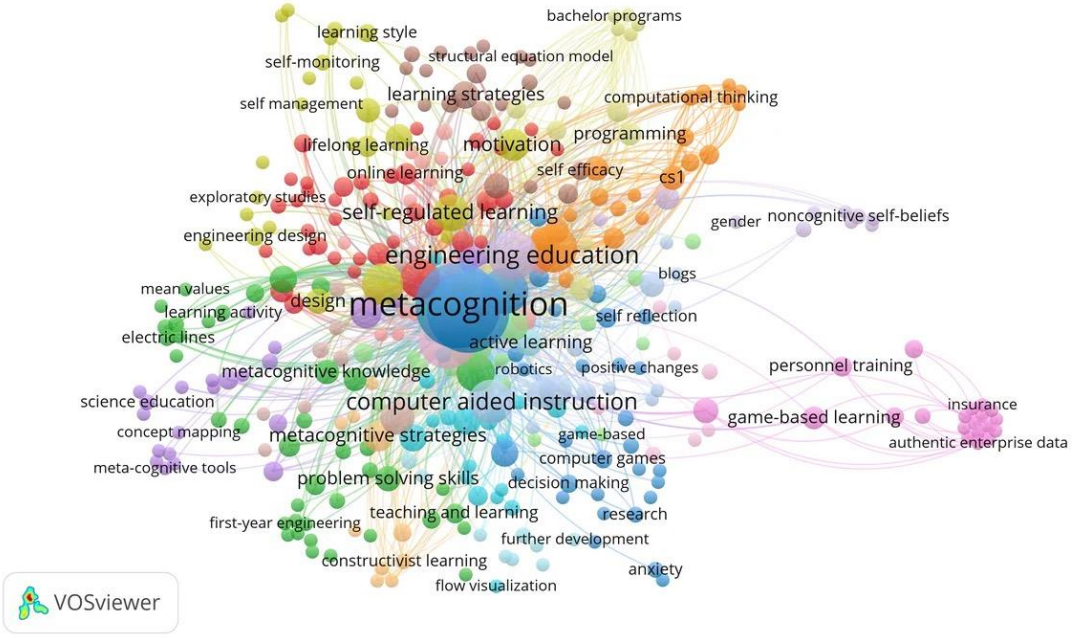

Figure 2 Co-occurrence map of key words in the international metacognitive field in 2005-2023

Cluster 1 (red): the cluster around the key words mainly "engineering education" "self learning" "online learning", metacognitive training can help engineering students identify learning strategies suitable for different engineering problems, such as self questions, concept construction, reflection diary, etc., to promote the understanding of complex engineering concept and long-term memory[7]. At the same time, in the online learning environment, metacognition not only helps individuals to better adapt to the distance teaching mode. In front of a large number of online learning materials, students with strong metacognition know how to screen effective information, how to think critically about what they have learned, and how to integrate new knowledge with the existing cognitive structure [8].

Cluster 2 (blue): the cluster around the center word key words mainly have "computer aided teaching" "computer game" "based on the game", which is closely related to digital education global change, computer education environment itself usually contains rich interactive and self feedback mechanism, this to cultivate the students' metacognitive ability provides a good platform. Students can understand their own thinking process through online courses, programming exercises and simulation experiments, such as evaluating the advantages and disadvantages of different solutions, predicting the results of code execution, and reflecting on the debugging process[9]. Gamified educational tools usually have clear goals and hierarchical systems, which help develop students' metacognitive skills, enable them to make learning plans, and adjust their goals and paths according to the actual situation[10].

Cluster 3 (yellow): the cluster around the center of keywords mainly "learning style" "self monitoring" "self management" "inquiry learning", etc., with strong metacognitive students not only understand their own learning style, also can according to the task requirements and situation change flexible adjustment learning strategy, optimization of different types of academic activities and knowledge acquisition. Based on the understanding of their own learning style, learners can combine metacognitive skills to more accurately implement self-monitoring and management,[11] and develop personalized learning plans, so as to better promote the learning process.

Cluster 4 (green): The cluster around the key words mainly "learning activities" "metacognitive knowledge" "problem solving ability" "metacognitive strategy", the metacognitive into learning activities in different situations after flexible use of these strategies, for example, in the face of complex problems take problem solving strategy, or in the summary stage using retrospective strategy,

encourage learners in the process of learning regular self reflection, thinking about how to obtain, organize and understand the information[12].

In addition, the centrality of keywords also reflects its potential to become a hot spot to a certain extent.The higher the centrality value of keywords, the more prominent its effect on the media and transmission of information flow. This study selected intermediary center degree of the top 10 keywords shown in Table 1, in addition to "metacognition", the key node (center degree is greater than 0.1)[13] is the "performance (performance)" and "memory (memory)", the rest of the keywords in the frequency and center degree is generally small, that other keywords is not enough to become a research hotspot, the scholars mainly focus on the concept of metacognition itself connotation and its possible role, has not been widely applied to other areas, back related field of research literature, metacognition has played an important role in media and transmission.

Table 1 Ranking of keyword mediation center degree in the metacognitive field

No.	Frequency	Centrad	Keyword
1	1204	0.07	metacognition
2	202	0.1	knowledge
3	196	0.05	schizophrenia
4	183	0.11	performance
5	163	0.14	memory
6	154	0.05	confidence
7	140	0.08	cognition
8	125	0.06	strategy
9	119	0.07	model
10	107	0.04	student

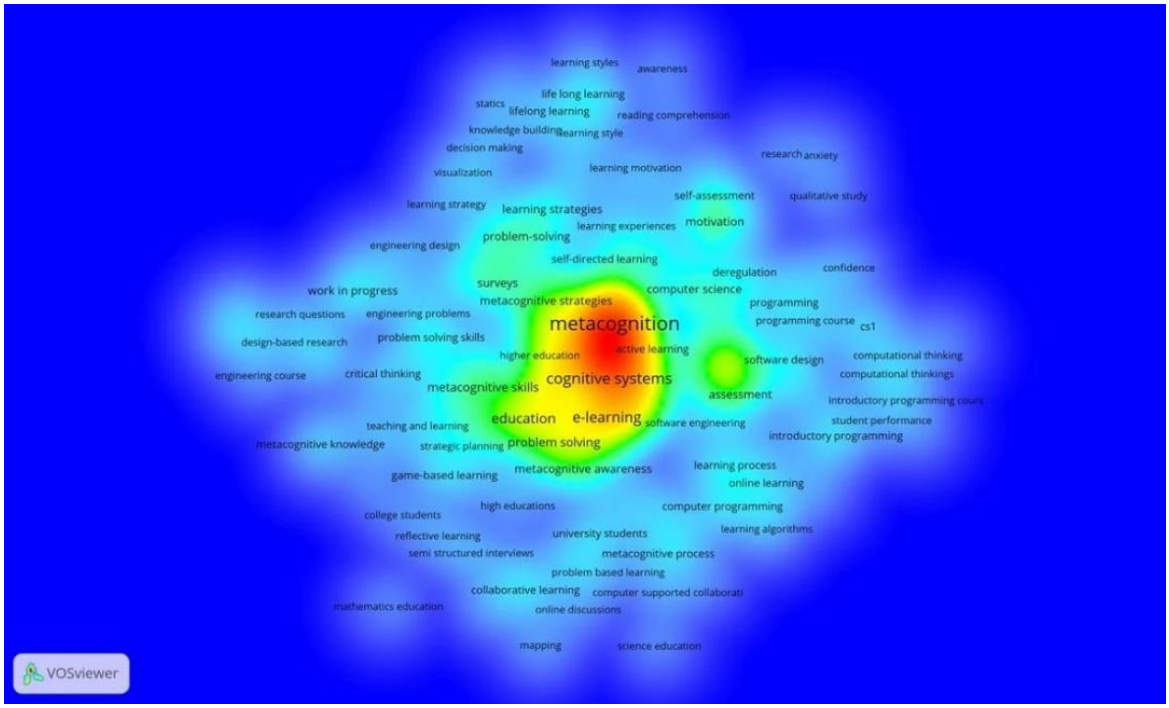

Figure 3 Heat map of keyword density in the international metacognitive field from 2005 to 2023

A heat map is a data visualization tool that is commonly used to demonstrate the intensity, density, or frequency distribution of a large amount of data[14]. Color coding represents the high and low expression of each keyword in the study sample, red usually represents high frequency, green represents medium frequency, and other colors may represent low or no expression（Figure 3）. The main keywords include "cognitive system", "higher education", "metacognitive skills", "digital learning" and "active learning", which show that with the in-depth understanding and application of

cognitive science by educational theory and practice, more and more teaching methods and technologies begin to integrate metacognitive elements. In the current background of advocating personalized and autonomous learning, the importance of metacognitive education is becoming increasingly prominent.

4. Conclusion

This study used bibliometric methods to analyze research in the metacognitive field and get a comprehensive understanding of its development. After nearly 20 years of development period from 2005 to 2023, metacognition research has obvious interdisciplinary characteristics and helps to understand the metacognitive development of individuals.

According to the evolution of metacognitive research, it is important to construct a sustainable metacognitive training system, which requires the joint efforts of academia, individuals and society. Future research could integrate research advances in other disciplines, such as sociology, psychology, physiology, and brain science, and fully recognize the independence and social existence of individuals. Apply more diverse and comprehensive research methods, especially focusing on the measurement of potential factors, to fully understand individuals in different aspects, and deeply explore the development path of metacognition at different cognitive levels.

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