Visualization Analysis of Research Hotspots Based on CiteSpace

Taking Research on Cross-Cultural Adaptation as an Example

Shuzhou Lin[1,2], Shaowei Xiong[1], Li Jia[3(✉)], and Lei Li[4]

[1] School of Foreign Languages and International Business, Guangdong Mechanical and Electrical Polytechnic, Guangzhou, China
[2] International College, Macau University of Science and Technology, Macau, China
[3] School of Humanities and Management, Guangdong Medical University, Dongguan, China
215759396@qq.com
[4] School of Education, South China Normal University, Guangzhou, China

Abstract. CiteSpace is a software that visualizes and analyzes trends, patterns, and relationships of scientific literature. This study aims to investigate whether CiteSpace can effectively investigate the research trends and hot topics, and identify the influential articles published in a knowledge domain. Based on CiteSpace, this study takes research on cross-cultural adaptation as an example, systematically analyzed a total of 2192 articles published from 2004 to 2022 retrieved from Web of Science. The findings indicate that 1) betweenness centrality in CiteSpace can be used to evaluate the cooperative relationships among papers, and keywords such as "questionnaire" and "translation" are found to have strong connections with other keywords; 2) Structural Variation Analysis (SVA) can be adopted to examine the changes that a newly published paper brings to the current intellectual structure, and a few papers on the cross-cultural adaptation of medical questionnaire are found to have the potential to become hot topics and research frontiers; 3) in future studies keywords should be narrowed down when using CiteSpace for knowledge mapping.

Keywords: Visual analysis · CiteSpace knowledge graph · Bibliometric analysis · Cross-cultural adaptation

1 Introduction

CiteSpace is a widely used Java application developed by Chaomei Chen. CiteSpace has two main features: network modeling, and interactive visualization [6]. Compared with traditional systematic reviews, with the help of CiteSpace researchers are able to reduce biases and explore publications from more perspectives and disciplines [2]. More importantly, CiteSpace helps to detect landmarks, hot topics, and research frontiers, and reveal various research patterns and trends in a more interactive and understandable way [4] by implementing visual analytic functions. To evaluate the effectiveness of CiteSpace, this study used "cross-cultural adaptation" as a search term to visualize and analyze

research on cross-cultural adaptation. Cross-cultural adaptation refers to the process of internal change due to the adjustment to an unfamiliar culture and a new environment [7]. Globalization increases cross-cultural interaction, however, cross-cultural competence varies due to the differences lying in economic status, educational backgrounds, and the development of societies [5]. Cross-cultural adaptation has drawn the attention of researchers. Therefore, what's the current research trend of cross-cultural adaptation? What are the hot topics and research frontiers in this field? Which newly published articles have more potential in the current network? To better identify the research trends and hot topics in the field, this study conducted a virtualization analysis of core papers on cross-cultural adaptation (published from 2004 to 2022), using CiteSpace as the knowledge mapping tool.

2 Research Methods

2.1 Data Sources

"Cross-cultural adaptation" was used as the major keyword in this paper. A total of 2192 articles (published from 2004 to 2022) were retrieved from Web of Science (WOS), which was considered as the most authoritative database, ensuring the quality and credibility of the search results. The last retrieval date was September 30, 2022.

2.2 Research Methods and Tools

In this study, the research status and development trend of cross-cultural adaptation were analyzed through a systematic literature review method based on CiteSpace. To identify the research hotspots and frontiers, and to distinguish the main research themes in the field of cross-cultural adaptation, CiteSpace and Excel were adopted to conduct in-depth mining and the visualized analysis on core papers of cross-cultural adaptation retrieved from Web of Science.

3 Data Analysis and Atlas Interpretation

Keywords are words (phases) that represent the essence of a paper, and convey the main topics of a study. High-frequency keywords reflect the research hotspots and trends in a certain field. Keywords in a paper are related. The co-occurrence frequencies of keywords in a paper indicate the connection among these keywords, e.g., higher co-occurrence frequency of keywords included in the same paper usually suggest a closer connection between the corresponding topics. Co-word analysis analyses the co-occurrences of keywords, and identifies the interactions and relationships between research topics and trends. To analyse the co-occurrences keywords from core papers in the field of cross-cultural adaptation, the interactive knowledge visualization tool CiteSpace 5 5. R2 was used in this study. The figure of atlas of keywords co-occurrence was generated by CiteSpace (see Fig. 1).

Keywords relevant to the topic of "cross-cultural adaptation" include: "cross-cultural comparison", "acculturation", "cross-cultural adaptation", "cross-cultural validation",

Fig. 1. The map of keywords Co-occurrence network

and etc. As can be seen in Fig. 1, the node of the main search term "cross-cultural adaptation" is clearly shown, with a betweenness centrality score of 0.22. The keyword "cross-cultural adaptation" appeared for the first time in the year 2004, and has appeared 272 times, forming the node network with other related keywords, indicating that cross-cultural adaptors need to learn cultures, customs, and languages of different countries and regions to adapt themselves to new cultural environments.

Keywords such as "reliability", "validity", "validation", "validation study", and "questionnaire" have shown high frequencies in Fig. 1, suggesting that empirical approaches are widely used in the researches of cross-cultural adaptation. For example, Koopmans and others cross-culturally adapted the Individual Work Performance Questionnaire (IWPQ), originally developed in The Netherlands, from the Dutch to the American-English language. In Koopmans's study, 40 American workers were interviewed to evaluate the comprehensibility, applicability and completeness of the questionnaire [8].

High-frequency keywords related to psychological measurement and health include: "psychometric property", "psychometrics", "outcome measure", "health status", "health survey", and etc. For example, Yang and others (2022) discussed the relationship between perceived discrimination and cross-cultural adaptation among 335 international students in China, and found that autonomous orientation and integration strategy had a positive impact on the cross-cultural adaptation [12].

The betweenness centrality is considered an important index to measure the influence of a node in a network, e.g., a strong betweenness centrality score indicates that the node has a great influence on how information flows through it [2]. Citespace detects and evaluates the influences of papers based on the betweenness centrality. In Fig. 1, the circles around the nodes were colored in purple, and the darker the color, the higher the betweenness centrality score. Among the keywords relevant to cross-cultural adaptation, "questionnaire" has the highest betweenness centrality score, suggesting the strong connections with other keywords. The betweeness centrality scores of keywords including "translation", "responsiveness", "validity", "health status", and "health survey" are

Table 1. Top 10 Ranking of Betweeness Centrality

No.	Keywords	Occurrences	Betweenness Centrality
1	questionnaire	453	0.68
2	translation	443	0.66
3	responsiveness	141	0.56
4	validity	647	0.47
5	health status	20	0.42
6	health survey	7	0.42
7	scale	149	0.36
8	instrument	176	0.33
9	reliability	703	0.3
10	shoulder	18	0.25

above 0.40 (see Table 1), indicating the close relationships with other keywords and a positive impact on the cooperative relationships among papers.

4 Structural Variation Analysis

After Structural Variation Analysis (SVA) in citation network is mainly adopted to evaluate the changes that a newly published paper brings to the current intellectual structure, and monitor the paper's potential to the intellectual space. SVA is theoretically based on the boundary-spanning mechanism, which conceptualizes the development of scientific knowledge as a process of interplay between the intellectual structure and the new ideas conveyed in newly published articles [3]. According to Chen (2012), the three metrics of structural variation are modularity change rate ($\triangle M$), cluster linkage ($\triangle CLw$), and centrality divergence ($\triangle Ckl$) [3].

The modularity change rate ($\triangle M$) measures the relative structural change exerted by additional information conveyed in the published article to a baseline network. Higher modularity change rate suggests the greater extent of relative structural changes in the network, and the article's greater potential of becoming the research frontier to its knowledge domain. Fourteen published core papers with $\triangle M$ above 0 were distinguished among papers about "cross-cultural adaptation", and the top 5 articles are listed in Table 2.

The paper of Mikkonen and others [9] scored highly for modularity change rate where it ranked no. 1, followed by that of Praveen and others [10] with a rate of 77.9255. The links were significantly increased after this article was introduced to the network of co-cited references, and they are connected to the clusters "#0 cross-cultural adaptation" and "#6 chronic pain" (see Fig. 2). Mikkonen and others (2021) successfully translated, cross-culturally adapted, and validated the Central Sensitization Inventory (CSI) into Finnish (CSI-FI), and the test results suggested the validity and reliability of CSI-FI as the psychometric properties and scores were in line with previous CSI validations [9].

Table 2. The modularity change rate

NO.	Modularity change rate	Articles
1	82.8309	MIKKONEN J 2021 BMC NEUROL V21 P DOI 10.1186/s12883-021-02151-6
2	77.9255	PRAVEEN S 2021 INT J ENV RES PUB HE V18 P DOI 10.3390/ijerph181910422
3	77.9254	NOOROLLAHZADEH K 2021 MUSCULOSKEL SCI PRAC V51 P DOI 10.1016/j.msksp.2020.102314
4	71.6184	KLUTE M 2021 BMC MUSCULOSKEL DIS V22 P DOI 10.1186/s12891-021-04481-5
5	71.6184	MADI M 2021 DISABIL REHABIL V0 P DOI 10.1080/09638288.2021.2006322

The paper of Praveen and others (2021) also increased the links significantly after it was introduced into the co-citation network [10]. In Praveen's study (2021), the quality of cross-cultural adaptation and the psychometric properties of the translated versions of oral health literacy assessment tools were analyzed and evaluated; since the instruments appraised were not satisfying, it is suggested that when using oral health literacy tools in cross-cultural environment, researchers and clinicians should evaluate psychometric properties, and follow the standard guidelines for cross-cultural adaptation [10].

The cluster linkage ($\triangle$CLw) is the metric measuring the new connections added between clusters due to an article introduced to the baseline network, and reflecting the overall structural change in the network [3].

High CL score indicates that a paper has introduced many novel co-citation links which made connections among disparate clusters. The extent of boundary spanning can serve as an index of research frontier. In this study, 16 core papers with CL scores above 0 are distinguished, and the top 5 articles are listed in Table 3.

For example, Fig. 3 visualizes the new links introduced by the paper of Sharma and others (2021) [11]. The paper spans over the boundaries of Cluster "#0 cross-cultural adaptation" and Cluster "#6 chronic pain", indicating that this research is interdisciplinary as it integrates knowledge from different domains. Sharma and other researchers adopted the Functional Assessment of Chronic Illness Therapy (FACIT) translation methodology and successfully translated and cross-culturally adapted five short forms of Patient-Reported Outcomes Meaurement Information System (PROMIS (R)) into Nepali [11].

Centrality divergence ($\triangle$Ckl), the third metric, measures the structural variations induced by a published article in terms of the divergence of the distribution of betweenness centrality of nodes in the baseline network [3]. A higher $\triangle$Ckl score indicates the greater impact of a paper on the divergence of the distribution of betweenness centrality of nodes in its network, which means that the topic of a paper with a high $\triangle$Ckl score has greater potential to become a hot research topic in this field. Among core papers of

Table 3. The cluster linkage rate

No.	The cluster linkage	Articles
1	89.9205	SALIHU D 2022 SLEEP MED V96 P57 = DOI 10.1016/j.sleep.2022.03.011
2	89.9205	SOYLEMEZ B 2022 EDUC GERONTOL V0 P DOI 10.1080/03601277.2022.2063624
3	89.1066	ALMUTAIRI B 2021 PHYSIOTHER THEOR PR V0 P DOI 10.1080/09593985.2021.2005196
4	89.1066	CHALA M 2021 BMC MUSCULOSKEL DIS V22 P DOI 10.1186/s12891-021-03985-4
5	89.1066	FATIMA S 2021 BMC MUSCULOSKEL DIS V22 P DOI 10.1186/s12891-021-04477-1

cross-cultural adaptation analyzed in this study, 15 papers with $\triangle$Ckl scores above 0 are found and the top 5 articles are listed as below (see Table 4).

For example, the CL score of paper of Angst and others (2007) greatly stands out, suggesting a significant influence on the centrality divergence in the baseline network, and a greater potential to become a hot research topic in the field of cross-cultural adaptation [1]. This paper is found to appear in Cluster #4 health status indicators, and connect to Cluster #7 low back pain (see Fig. 4). Using the six-step cross-cultural adaptation procedure, Angst and others (2007) successfully cross-culturally adapted the Shoulder Pain and Disability Index (SPADI) from English into German, and confirmed the reliability, validity, and practicability of the German SPADI as a self-assessment instrument of shoulder pain and function [1].

According to the SVA metrics (i.e. modularity change rate, cluster linkage, and centrality divergence), the high rankings of papers of Praveen and others [10], and Mikkonen

Table 4. The Centrality divergence of papers of cross-cultural adaptation

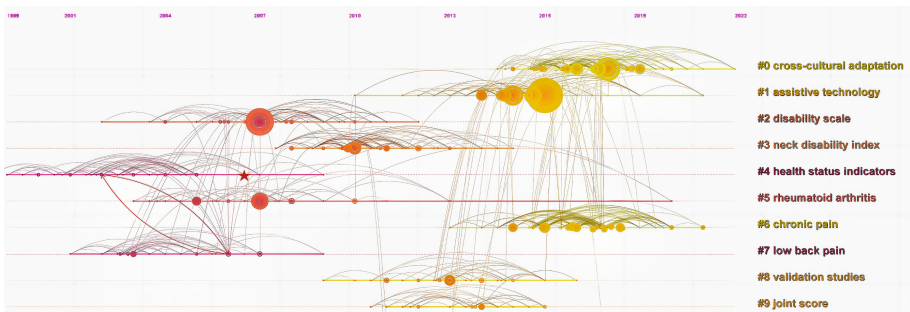| No.	Centrality divergence	Articles
1	1.0971	ANGST F 2007 RHEUMATOLOGY V46 P87 DOI 10.1093/rheumatology/kel040
2	0.1812	BATISTA CAMPOS L 2019 ASSIST TECHNOL V34 P54 DOI 10.1080/10400435.2019.1697906
3	0.1189	WIANGKHAM T 2021 BMC MUSCULOSKEL DIS V22 P DOI 10.1186/s12891-021-04347-w
4	0.0973	GOH K 2019 BMC NEPHROL V20 P DOI 10.1186/s12882-019-1397-8
5	0.0484	HAUKELAND-PARKER S 2021 PHYSIOTHER THEOR PR V0 P DOI 10.1080/09593985.2021.1911012
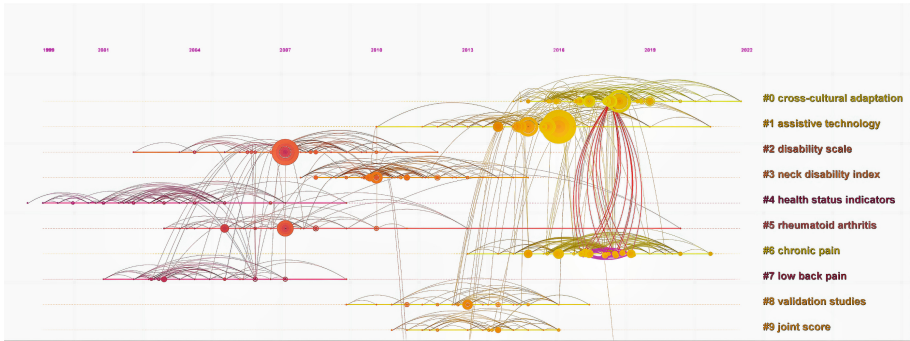
Fig. 2. Links increased by the paper of Mikkonen, J. (2021)

and others [9] indicate that these papers have a greater significance and influence in the research field of cross-cultural adaptation.
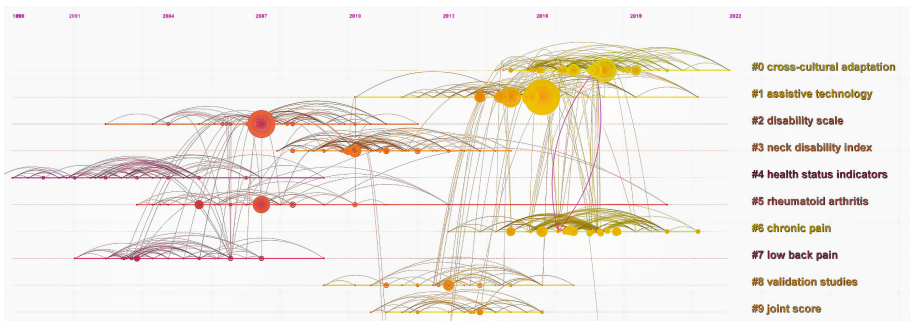
Fig. 3. Spanning among boundaries of the paper of Sharmas, S. and others (2021)

Fig. 4. Centrality divergence of the paper of Angst, F. and others (2007)

5 Conclusions

With the help of CiteSpace, the study of core articles in the field of cross-cultural adaptation (published from 2004 to 2022) provides a unique snapshot of the knowledge domain. CiteSpace is proved to be an effective tool to reveal and visualize research frontiers, hot topics, research trends, and the connections between articles. Conclusions can be drawn from the results generated by the SVA model: 1) a large number of studies in this field focused on the cross-cultural adaptation and translation of scales, questionnaires, and measures in medical health and psychology domains, where empirical approaches are widely adopted; 2) SVA scores help identify newly published articles which are more influential, and suggest that they have connections to other domains.

In further research on cross-cultural adaptation based on CiteSpace, search results in database can be narrowed down by introducing more specific keywords in order to detect the research frontiers and hot topics within specific research disciplines (e,g., the aspect of cross-cultural translation).

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