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A Visual Analysis of Knowledge Map of International Blended-Learning Research in Recent Five Years

Yuan Tang[1,a*], Fengping Yu[2,b]

[1]School of Humanities and Arts, Jiaxing Nanhu University, Jiaxing, China
[2]School of Foreign Studies, Jiaxing University, Jiaxing, China
[a]ty0732@zjxu.edu.cn, [b]183117014@qq.com
**corresponding author*

Abstract: *Blended learning, which combines the advantages of modern online learning and traditional face-to-face teaching methods, has rapidly developed into an important field of teaching practice and educational research. In order to accurately grasp the status of blended-learning research in the world, this study takes blended learning as the theme, and investigates the literacy collected in the core journals of Web of Science and uses it as the analysis object. Using software CiteSpace, this study products a quantitative analysis on the research strength, core literacy, research hotspots and research frontiers in the field of blended learning, and describes the knowledge map of the research in this field, so as to grasp the development characters of international studies related to blended learning in recent years and offer references for the future development of blended learning research in China.*

Keywords: *Blended Learning, CiteSpace; Knowledge Map, Visual Analysis*

1. Research Background

Since Cooney M.H. put forward the concept of "blended learning" [1] in preschool education in 2000, after more than 20 years of its development, especially the development of new online learning courses such as massive open online course and Flip Classroom, blended learning has become the most popular educational concept and teaching mode at present, which is not only widely used in primary and secondary education and E-Learning training, but also attracts more and more attention from international research institutions and higher education fields, and is likely to become one of the important trends affecting the reform of higher education in the future.

As the practice of blended learning involves different courses, regions and objects, the methods and theories proposed by researchers are bound to be diversified. In 2012, Mendieta Aguila wrote “Blended Learning and Language Teachers: Literature Review” in *Colombia Applied Linguistics Journal*, and began to sort out and explore the research literature on blended learning. Halverson and other scholars wrote an article in *Distance Education* to analyze high-influence academic literature in the research field of blended learning and explore the research characteristics and trends of this field. In 2013, Guzer and Caner presented a paper on the past, present and future of blended learning at the 5th Global Conference on Science in Education. In 2014, On the basis of previous research, Halverson and Graham made a thematic analysis of the most influential and frequently cited books in the field of blended learning published internationally from 2000 to 2011, including chapters and academic papers. This paper reveals the research methods, research issues and theoretical framework used by these research results, and discusses the influence of research conclusions on blended learning research [2].

In 2015, Wang Guohua from China used content analysis to comprehensively analyze the journal papers related to blended learning research retrieved by CNKI, and pointed out that the basic research on blended learning in China is weak, focusing only on its definition and theoretical introduction. Ma Zhiqiang and others chose the dissertations in the field of educational technology in China from 2005 to 2015 as the data source to investigate the research trend of blended learning in China in recent ten years. In 2018, He Xiaoping and others used *CiteSpace* software to visually analyze the research on blended learning in China, which intuitively showed the characteristics that blended learning in China paid attention to curriculum design and other application fields, and the research on blended learning increased significantly[3]. The research results of Chinese scholars' systematic investigation of international blended learning research appeared in 2016. Cao Chuandong and Zhao Huaxin used *CiteSpace* software to visually explore the literature on blended learning in the collection of core

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journals of *Web of Science* from 2005 to 2014, so as to grasp the main strength and research hotspots of international blended research in the past decade as a whole[4].

From the above review, we can find that the research on the current situation and trend of international blended learning research mainly comes from the data before 2014, and the research method adopted is mainly to use the visualization software *CiteSpace* as an analysis tool to investigate the development characteristics of blended learning research. Because in the past five years, with the rapid development of information technology, advanced technologies such as artificial intelligence and virtual reality VR are gradually applied in the field of education and teaching, the results of blended learning research are constantly updated. Therefore, it is necessary to make a visual analysis of international blended learning research since 2015, and grasp the frontier issues in this field, which will help us understand the development characteristics of international blended learning.

2. Data sources and Research Methods

2.1. Data Source

In this study, the core collection of *Web of Science* is selected as the data source. In the retrieval, the topic is set as "Blended Learning", which spans from 2015 to 2019, and a total of 715 literature records are obtained. Set the selected language as English, the literature type as papers, exclude non-research articles such as book reviews and conference papers, and find duplicate or irrelevant documents by manual screening, and finally get 600 related documents in the field of blended learning research, which are saved in plain text format.

2.2. Research Method

In this study, the knowledge map analysis method is used, and the latest version of visual analysis software *CiteSpace5.3 R4* developed by Dr. Chen Chaomei and his team is used to quantitatively analyze the retrieved literature data. The parameters of *CiteSpace* are set as follows:

Time Slicing time zone is 2015-2019, and each zone is 1 year; Top N is 50, and the highest 50 references with high citation times are extracted from each time zone; Top N% is 10; Threshold (C, CC, CCV) thresholds are set to (2, 2, 20), (3, 3, 20), (4, 3, 20), and Pathfinder network scaling and Pruning sliced network are adopted to select "author", "country", "institute", "fund coupling" and other research forces in Term Source, "keywords", "subject co-occurrence", "cited reference" and "cit" respectively Ed author), "cited journal", etc., visualize the data and get the knowledge map for analysis.

3. Knowledge Map Analysis

3.1. Research Strength Analysis

Select "Author" from Term Source to get the knowledge map of researchers:

The large dark purple nodes in Figure 1 are: C. R. Graham, D.Ilic, Salla Atkins and Chang Zhu, which shows that these scholars have a high number of articles. The most published papers are C. R, head of the Department of Educational Psychology and Technology at Brigham Young University in the United States.Graham (9 articles). The other three are Zhu Chang, head of the Department of Educational Sciences, Free University of Brussels, Belgium (6 articles), Salla Atkins, Karolinska Institute, Sweden (5 articles), and D. Ilic, Department of Epidemiology and Preventive Medicine, Monash University, Australia (4 articles). According to Cao Chuandong's statistical results of blended learning research literature from 2005 to 2014, Graham published the highest number of articles (6 articles) in the previous ten years. In the past five years, he has continued to maintain the leading level, reflecting his core position in the field of blended learning research.

The graph shows that the collaborative research among these scholars is not obvious, and the related peripheral nodes are also in the same institution. For example, Rechard E.West, who published the most papers, is in the department of Educational Psychology at Brigham Young University with Graham. Merrick Zwarenstein, near the Atkins node, works with him in family medicine and public medicine.

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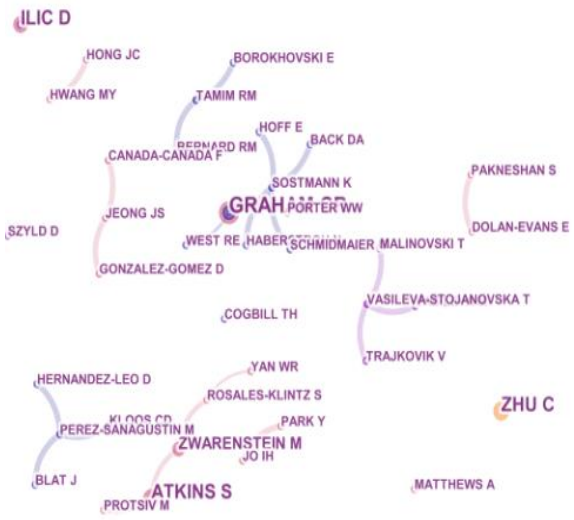

Figure 1: The Blended Learning Researchers

3.2. Core literature Analysis

By analyzing the key points with high citation frequency and centrality in the knowledge map of co-cited documents in blended learning, it can reflect the distribution of core documents in the research field of blended learning.

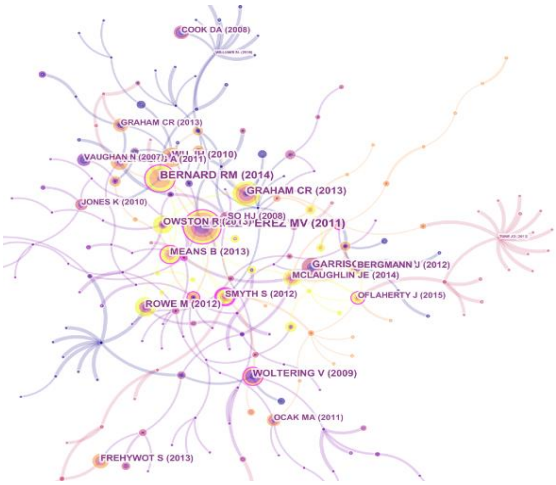

Figure 2: The co-cited documents in blended learning

The larger purple circle nodes in Figure 2 are Lopez-Perez MV (2011), Bernard RM (2014), Graham CR (2013), Rowe M (2012), Wu JH (2010), Garrison DR (2012), etc., reflecting the importance of these literature. The most frequently cited literature is *Students' perceptions and their relationship to outcomes* by Lopez-Perez in 2011, which discusses the cognition of higher education students on blended learning and the relationship between blended learning and goal achievement. He conducted a blended learning experiment in Granada University, Spain, and investigated 1431 students. The results show that blended learning has a positive effect on reducing students' dropout rate and improving test scores. Students' cognition of blended learning is also closely related to students' age, background and participation in learning activities[5]. The second most frequently cited document is written by Bernard R.M. in 2014. Through a comparative study of blended learning and classroom teaching in higher education, this article demonstrates the positive influence of science and technology on learning effect in blended learning. Bernard holds that blended learning is superior to traditional classroom teaching in learning effect [6]. The third most frequently cited document is published by Graham C.R. in 2013. By investigating the cases of blended learning in six higher education institutions, Graham discusses the strategies and supporting methods of blended learning in higher education institutions at different application stages, so as to describe the application of blended learning in higher education in a framework and guide education administrators to make better use of

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blended learning[7]. On the base of social cognitive theory, Wu Jen-Her from National Sun Yat-sen University, Taiwan, has designed a research model and investigated students' learning satisfaction in the online blended learning environment. The empirical results show that students' self-efficacy, expectation, system function, learning interaction and atmosphere are the main factors affecting students' learning satisfaction. Learning climate and academic achievement expectation have significant influence on learning satisfaction, while self-efficacy, system function and interaction have significant influence on expectation. Learning climate and interaction are closely related. A deep understanding of these factors is an important prerequisite for planning and implementing an online blended learning system[8].

By checking the centrality of cited documents in *CiteSpace* co-cited documents map, we can see that the document with the highest citation frequency is *Blended learning in higher education: students' perceptions and their relationship to outcomes* (Lopez-Perez, 2011), which shows that this paper is in a very important position in the field of blended learning research. The second most frequently cited literature, *A meta-analysis of blended learning and technology use in higher education: From the general to the applied* (Bernard R.M., 2014) ranks 4th in centrality of co-cited documents, which is also a very important core document in this field. The article ranking first in centrality is Smyth S.'s *Studies' experiences of blended learning across a range of postgraduate programs in 2012*. This paper introduces the experience of students taking a postgraduate course of blended learning in the School of Nursing and Midwifery. As a teaching tool, blended learning has the potential to promote and improve nursing and midwifery practice and strengthen students' learning. By introducing blended learning into nursing teaching, it is observed that students respond positively to blended learning experience, and online learning means little learning time for students, which indicates that online learning is more invasive to their daily life. This paper provides guidance for the further development and improvement of using virtual learning environment (VLE) and blended learning in nurse education[9].

Shea P. (2010) is The top cited article. He conducted a random survey of 3,165 students who participated in online and mixed courses in 42 two-year and four-year educational institutions in New York State. He analyzes the relationship between students' self-efficacy, self-existence and learning effect in virtual learning environment, and holds that this analysis of the positive role of online learners is helpful to explain knowledge construction in technology-mediated environment more comprehensively, and can expand the descriptive and explanatory power of community survey framework [10].

3.3. Research Hot Spots Analysis

In the keyword map of blended learning research literature in Fig. 3, the purple outer ring node blended learning (291), Education (127), Student (98), Higher education (77), Online (64) are the key nodes. It shows that the research on blended learning in recent years focuses on the core concepts of "blended learning", "education", "students", "higher education" and "online learning". The "e-learning", "educational technology", "teaching environment", "flipped classroom" and "learning performance", "student cognition", "learning outcome" and "learning model" related to learning effect are also one of the hot spots in blended learning research. It reflects that blended learning research goes deep into the fields of technology application, subject cognition and application performance with the development of technology.

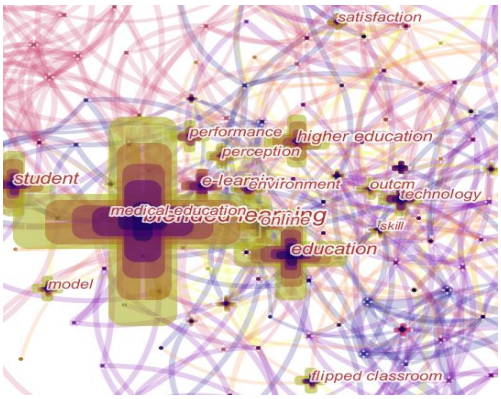

Figure 3: Keyword map of blended learning research literature

In order to further analyze the hot spots of blended learning research, the study lists top 10

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keywords with high frequency and top 10 keywords with centrality.

Table 1: Word frequency of keywords in blended learning research literature

	Frequency	Centrality	Keywords		Frequency	Centrality	Keywords
1	77	0.03	Higher education	6	40	0.01	Model
2	52	0.13	Technology	7	38	0.16	Outcome
3	50	0.09	Performance	8	37	0.01	Flipped classroom
4	48	0.06	Environment	9	36	0.12	Medical education
5	46	0.04	Perception	10	35	0.08	Satisfaction

Table 2: Centrality of keywords in blended learning research literature

	Centrality	Frequency	Keywords		Centrality	Frequency	Keywords
1	0.18	13	Self-effectiveness	6	0.13	20	Impact
2	0.16	38	Outcome	7	0.12	36	Medical education
3	0.14	13	Distance education	8	0.12	27	Knowledge
4	0.13	52	Technology	9	0.12	23	Meta-analysis
5	0.13	24	Curriculum	10	0.11	32	Skill

It can be seen from the above two tables that "educational technology", "learning outcome" and "medical education" all appear in the top ten in the list of word frequency and centrality at the same time, indicating that the researches on technology, learning effectiveness and medical application are hot fields of blended learning in recent years. Combined with other key words in the two tables and related literature, we can know that the international research hot spots of blended learning are mainly reflected in higher education, distance education, medical education, blended learning environment construction and its application effect.

3.4. Research Frontier Analysis

High-frequency keywords reflect the academic hot issues of existing research, and the analysis of research frontiers can help researchers understand the future development trend and direction of this academic field. *CiteSpace* has the function of detecting the burst terms, that is, it uses terms with sudden increase in frequency or sudden appearance in a short time to arrange time, which can clearly reflect the research frontier and development trend in this field.

We use *CiteSpace* software to extract burst terms from the keywords of the international blended learning research literature data, and get Figure 4:

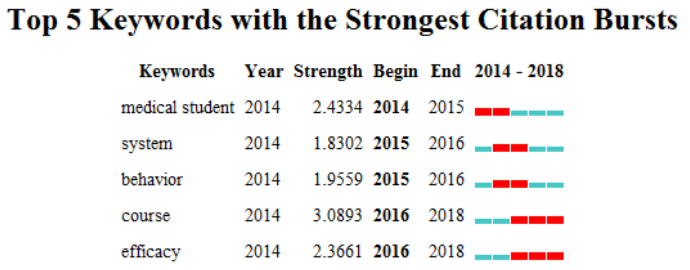

Figure 4: keyword burst in blended learning research literature

Figure 4 lists five words, which are arranged in chronological order, reflecting the changes in the frontier of international blended learning research in recent five years. "Medical student" appeared in 2014. Combined with the previous analysis of hot research fields, it can be seen that the application of blended learning mode in medical education has always been a research hot spot, and it has gradually shifted from the design of blended learning mode in medical courses to the learning motivation and autonomous learning ability of medical students. However, in 2015, the research frontier of blended learning turned to the analysis of "system" and "behavior". This frontier transformation not only meets the needs of new online learning methods such as massive open online course and micro-courses brought about by the development of educational technology, but also reflects that researchers begin to pay attention to students' behavior in the process of adapting to the new system.

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The application of intelligent learning technology, especially 4G and 5G techs, in mobile learning terminals brought about great changes in online learning methods, and courses such as smart classrooms began to be widely used in classroom teaching in many schools. How to apply blended learning mode in the new curriculum design has become a new research frontier, and how students self-regulate and learn independently in fragmented learning mode to improve learning efficiency has become the most concerned issue of blended learning researchers. Therefore, "course" and "effectiveness" appear in the keyword cluster of blended learning literature. This reflects that the impact of new technology on the learning environment and learners' self-efficacy have become the most cutting-edge research issues, and they have been important topics in blended learning research for a long time. Researchers can cut into the research field of blended learning from different aspects such as technology renewal and learner psychology, and find a new research breakthrough point.

4. Research Summary

Based on the above visual quantitative analysis of international blended learning research literature in recent five years, and comparing Cao Duo's Research on *Knowledge Map of International Blended Learning from 2005 to 2014* with the analysis of highly cited literature in the field of blended learning research published by Halverson & L.R. in 2014, we find that:

1） The main regions and research institutions of international blended learning research are still the United States, Britain, Australia and other countries, and the research institutions such as Brigham Young University and Sydney University still maintain a leading position in the number of articles published, but the interconnection between research institutions in countries and regions needs to be strengthened. In the past five years, scholars in China, including Taiwan and Hong Kong in China, have gradually become a new force in the study of blended learning.

2） In the case of co-citation, the papers published by traditional blended research scholars such as Professor Graham C. R. of Brigham Young University are in the forefront in terms of citation frequency and centrality. Lopez-Perez from Spain and Wu Renhe from Taiwan studied students' cognitive attitude towards blended learning mode by means of experiments or surveys. These empirical research works are cited frequently and become important core literature.

3） Through keyword clustering and quantitative analysis of mutation words, the application of blended learning methods, the construction of blended learning environment, the design of blended learning mode and the effectiveness of blended learning in medical education are still the hot spots of international blended learning research in recent five years. However, the focus of its application has shifted to the field of higher education, and with the application of new intelligent technology in education and teaching, blended learning environment and its impact on students' learning effect have become the most hot research field at present. Students' self-efficacy and mixed curriculum design will also become the main research frontiers in the future.

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