Visual Analysis of Project-based Learning Research Based on Citespace

Duo Haijian & Ishak Nor Asniza*

School of Educational Studies, Universiti Sains Malaysia,
11800 USM, Pulau Pinang, Malaysia

*Corresponding Author: asnizaishak@usm.my

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ABSTRACT

This study used Citespace 6.3. R1 visualization analysis software as the research instrument and Web of Science core collection as the data source to screen and visualize the relevant literature on project-based learning from 2019 to 2022. Research indicates that the number of articles on project-based learning published in 2022 is the most in 5 years. And then it shows a downward trend. China and the United States are the two countries with the most published literature on project-based learning. Computer science, engineering education, and virtual reality are disciplines closely related to project-based learning. Dependent variables as critical thinking, collaborative learning, team learning appeared more frequently in the articles.

Keywords: project-based learning, education, citepace, trend, bibliometric

INTRODUCTION

Project-based learning (PBL) is an active student-centered form which is characterized by students' autonomy, constructive investigations, goal-setting, collaboration, communication and reflection within real-world practices (Kokotsaki et al., 2016). It is different from traditional education in that it relies on project-based learning, or in other words, it carries out learning activities in the form of projects. The significance of learning knowledge lies not only in mastering it, but more importantly, in applying it to real life (Baskaran & Abdullah, 2022; Kiswanto, 2017). Project-based learning is an approach that combines knowledge with application.

In constructivist learning theory, learning is an active process in which the learner uses sensory input and constructs meaning out of it. Learning is not the passive acceptance of knowledge which exists "out there" but that learning involves the learner s engaging with the world (Harasim, 2018). Project-based learning is highly valued by educators due to its student-centered educational idea. The student is the focus of teaching and constitutes an important part of the learning process (Boudersa & Hamada, 2015).

How to connect students' education with their careers? Or what should education do to prepare students for their future careers? Some educators have already anticipated these issues and put them into practice in educational reform. Project-based learning is applied in STEM education (Hall & Miro, 2016), computer science (Pucher & Lehner, 2011), environmental education (Genc, 2015), engineering curriculum (Uziak, 2016),and so on. Career requirements for graduates evolve and demand changes to the educational approach used. Therefore, project-based learning is easy to promote in engineering and technology related majors.

Project-based learning is often applied to interdisciplinary fields, students' interdisciplinary collaboration, creativity, and communication skills are developed (Warr & West, 2020). The goal of

PBL is for the students to explain the importance of learning content and application. It will make students think about the relationship between knowledge, learning process, personal, career, and real life. PBL is one approach of deep learning (Virtue & Hinnant-Crawford, 2019) . Intellectual openness; inquisitiveness; analysis; reasoning, argumentation, and proof; interpretation; precision and accuracy; and problem solving (Bahari & Saleh, 2023; Conley, 2007) are key cognitive strategies related to college success .

DATA SOURCE AND SEARCH PROCESS

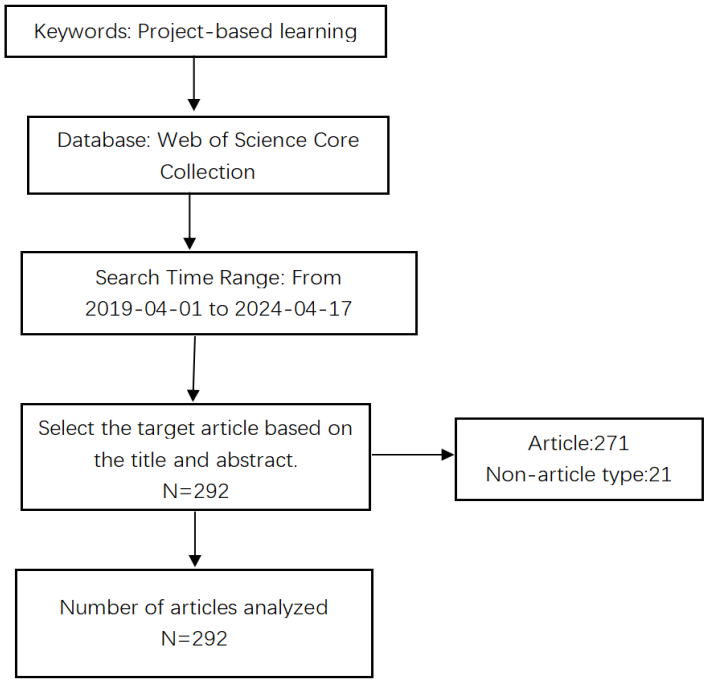
Data Source

The data for this study is sourced from the Web of Science Core Collection database. The Web of Science Core Collection has ten indexes containing information gathered from thousands of scholarly journals, books, book series, and conferences. It includes Science Citation Index Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index, Emerging Sources Citation Index, Conference Proceedings, Book Citation Index, and so on.

Search Process

Search in Web of Science Core Collection using “project-based learning” as a keyword. Set the time from April 2019 to April 2024. A total of 292 publications were screened. Articles:271; Review Articles or meeting paper or other types :21. Firstly, conduct a preliminary reading of the abstract, title of the literature, and then screen the obtained literature. To ensure consistency between the content of the article and the topic of this research, 292 articles are used as analysis resources in this study. Refer to Figure 1 for detailed information.

Figure 1: Data screening procedure



Research Instrument

Citespace is an internationally leading visualization application software developed by Dr. Chen Chaomei from the School of Information Science and Technology at Drexel University in the United States, suitable for multivariate, time-sharing, and dynamic complex network analysis (C. Chen, 2017). This study used the visualization analysis software Citespace (6.3. R1) to import all literature into the software, with a time span of 2019-04-01 to 2024-04-01 and a time slice of 1 year. A comprehensive and systematic visualization analysis was conducted on the keywords, authors, co cited literature, and national institutions of the literature.

Research Questions

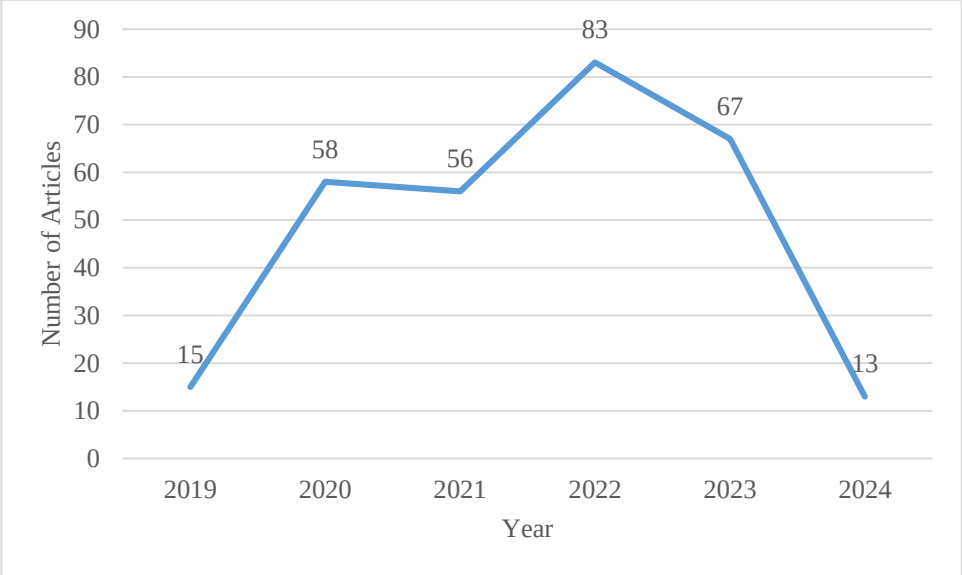
1. What is the research trend of project-based learning from 2019 to 2024? What is the distribution of research in the country? What is the distribution of research in institutions?
2. Which literature is frequently cited in the field of project-based learning?
3. What is the trend of research hotspots in the field of project-based learning?

Research Findings

1. The Research Trend of Project-based Learning

A statistical analysis was conducted on the publication in project-based learning from 2019 to 2024. The analysis results are shown in the following figure.

Figure 2: Annual publication of project-based learning in WOS Core Collection (2019-2024)



From 2019 to 2022, the number of publications showed an upward trend. From 2022 to 2024, the number of publications has been decreasing year by year. It indicates that project-based learning has been extensively studied from 2021 to 2022.It takes several months or a year from research to publication of articles. So, the research time is a few months to a year before the publication date. The number of articles related to project-based learning reached its peak in 2022, with 83 articles annually. Project-based learning research has the highest popularity in 2022, and the research popularity decreases since then.

Table 1: The top 7 countries with the highest number of published articles

Citation Counts	Country
80	CHINA
63	USA
35	SPAIN
21	AUSTRALIA

Table 1 shows the top 4 countries with the highest number of citation counts, reflecting the research situation of different countries in the field of project-based learning. China has the highest number of publications, with 80 articles. Countries following closely behind are the United States, Spain, and Australia, with 63, 35, and 21 articles respectively.

1. Analysis of research institutions and collaborative networks

Figure 3: The distribution of project-based learning among institutions

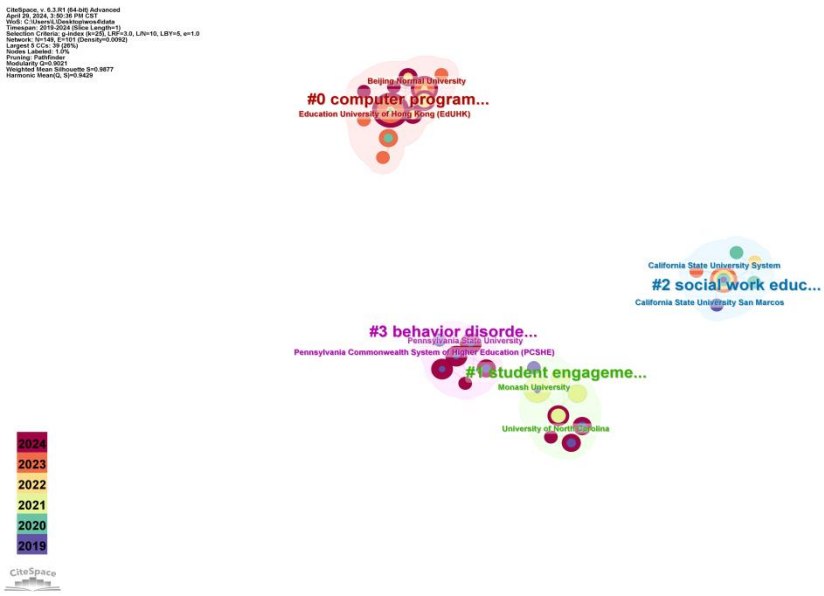


Figure 3 shows the distribution of research institutions in project-based learning, with a total of four clusters, as four research cooperation network blocks. There is a cooperative relationship between schools in Cluster 1 and Cluster 3. Research institutions such as Monash University have some research outputs in 2021. But by 2024, there will be more research results from universities such as the University of North Carolina， Pennsylvania State University - University Park and Pennsylvania Commonwealth System of Higher Education (PCSHE).

Table 2: Institutional citation counts

Citation Counts	Node Name
8	Education University of Hong Kong (EdUHK)
8	National Taiwan Normal University
6	Qatar University
5	Michigan State University

Data from table 2 indicates that Education University of Hong Kong (EdUHK) and National Taiwan Normal University have the highest citation counts among research institutions, both are 8. Citation counts of Qatar university is 6, while it is 6 in Michigan State University.

1. Cited references analysis

Table 3: Co-cited literature of Projected-based learning

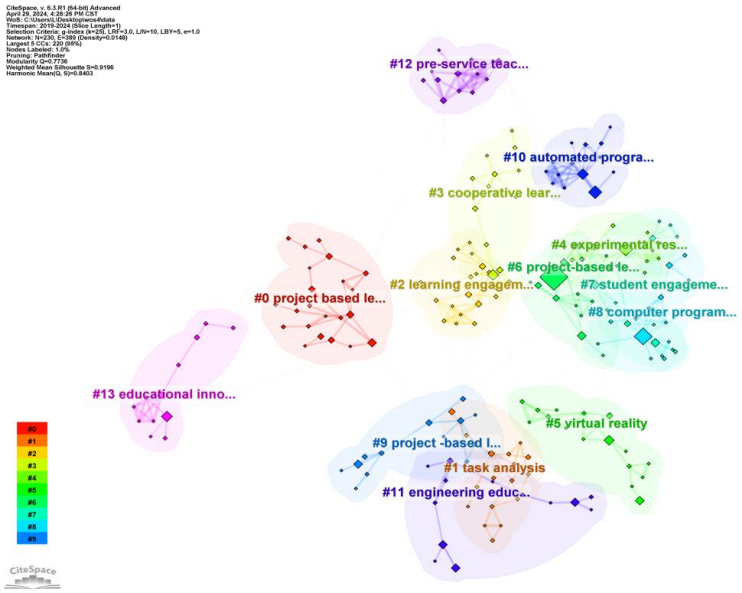
Citation Counts	Centrality	Year	Authors	Title
24	0.18	2019	Cheng Huan Chen, Yong Cih Yang	Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators
17	0.07	2020	Peng yue Guo, Nadira Saab, Lysanne S. Post, Wilfried Admiraal	A review of project-based learning in higher education: Student outcomes and measures
11	0.08	2016	Dimitra Kokotsaki, Victoria Menzies, Andy Wiggins	Project-based learning: A review of the literature

Table 3 shows the information of the three articles with the highest citation counts. The article with the highest citation rate is" Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators". The publication year of the article is 2019, and its centrality is 0.18. The article with the second highest citation rate is "A review of project-based learning in higher education: Student outcomes and measures". The article with the third highest citation rate is" Project-based learning: A review of the literature". The citation counts of an article is its authoritative indicator in the research field. The higher the citation counts, the more authoritative the article is.

1. Keyword analysis

Keyword clustering, co-occurrence analysis and emergent analysis can present the research hotspots and development trends in the current field. The ribbon sets the node type to Keyword, and other parameter functions default as above in citepace software.

Figure 4: Keyword clustering analysis for project-based learning



The clustering graph uses keywords as clustering labels. A node in the figure represents a keyword, and the larger the node, the more frequently the word is cited. The connections between nodes represent co-occurrence (citation) relationships, and the thickness of the connections represents the strength of co-occurrence (citation) (Y. Chen et al., 2014).

There are 13 clusters in the figure 2. Clusters related to disciplinary information include:" #5 virtual reality"," #8 computer programme", "#10 automated programme" and "#11 engineering education". Researchers have conducted research on project-based learning in these disciplines. Cluster as" #1 task analysis"," #3 cooperative learning" and" #7 student engagement" reflect the research content related to project-based learning.

From the keyword clustering information in the figure 2, computers are a popular discipline combined with project-based learning. The keywords related to Cluster # 8 include "critical thinking", "team-based learning"," interdisciplinary", "social robots". This can reflect the research content related to project-based learning in the field of computer science.

Figure 5: Keyword Timeline Map

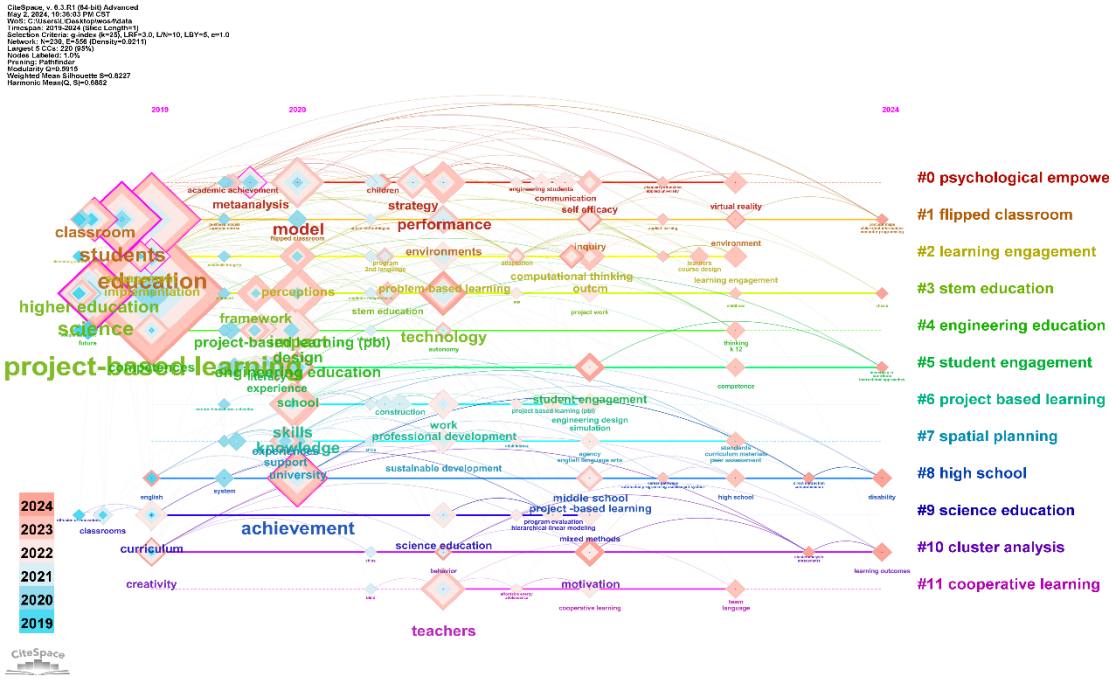


Figure 5 reflects the development of relevant words in project-based learning research from 2019 to 2024. The larger the node, the more times the word appears. This indicates the development dynamics of some words closely related to project-based learning over time. The appearance time of a word represents the time when relevant research was conducted, and the size of the node indicates its frequency of occurrence. The larger the node, the more times the word appears.

Several words with higher frequency of occurrence have basic forms around 2019, such as project-based learning, science. The number of related words appearing has decreased since 2019. It is possible that there has been a decrease in research in this field, which is in line with the trend of changes in figure 2.

CONCLUSION

This study analyzed the research trends of project-based learning from 2019 to 2024 using Citespace 6.3. R1. Research has found that: 1) According to the statistical analysis of the annual publications, the highest number of publications was in 2022, with 83 articles. Afterwards, the publications showed a downward trend. The keyword timeline also confirms this, as project-based learning had a higher number of citations of related words in 2019. Over time, the number of related words declined, and the number of citations also decreased. 2) From a geographical distribution perspective, China and the United States have the highest citation rate in project-based learning articles, followed by Spain and Australia. 3) According to institutional classification, the citation rate of the Education University of Hong Kong is relatively high. 4) From the article, "Reviewing the effects of project-based learning on students' academic achievement: A meta-analysis investing modelers" has the highest citation rate, with citation count of 24 and centrality of 0.18. 5) Keyword analysis shows that the research areas of project-based learning are concentrated in disciplines such as computer science, engineering education, virtual reality, etc. The research content includes critical thinking, collaborative learning, team learning, interdisciplinary, and other aspects.

DISCUSSION

Project-based learning is highly anticipated in the education field. Educators expect it to play a role in improving teaching efficiency and enhancing students' learning abilities (Almulla, 2020). The research distribution of project-based teaching in different countries indicates its development in the field of education in different countries. Research institutions with high citation counts have made significant progress in the research path of project-based teaching. The authors of articles with high citation rates have high authority in the field of project-based teaching. The annual publication statistics of project-based teaching show the development trend of this field. Information extracted from keyword cluster figure and timeline figure indicates that the development of research content related to project-based teaching over time. Based on multiple research indicators, the research popularity of project-based learning has shown a downward trend in recent years.

REFERENCES

Almulla, M. A. (2020). The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning. *SAGE Open*, *10*(3). https://doi.org/10.1177/2158244020938702

Bahari, F. A. Z., & Saleh, S. (2023). Content Validation Procedure: Development of Problem-solving Skills Test (PSST): Prosedur Pengesahan Kandungan: Pembangunan Ujian Kemahiran Penyelesaian Masalah (PSST). *Jurnal Pendidikan Sains Dan Matematik Malaysia*, *13*(1), 1–9.

Baskaran, V. L., & Abdullah, N. (2022). Authentic Learning Approach in Science Education. *Jurnal Pendidikan Sains Dan Matematik Malaysia*, *12*(1), 54–64.

Boudersa, N., & Hamada, H. (2015). Student-Centered Teaching Practices: Focus on The Project-Based Model to Teaching in the Algerian High-School Contexts. *Arab World English Journal*, *August*, 84–91.

Chen, C. (2017). Science Mapping: A Systematic Review of the Literature. *Journal of Data and Information Science*, *2*(2), 1–40. https://doi.org/10.1515/jdis-2017-0006

Chen, Y., Chen, C., Hu, Z., & Wang, X. (2014). *Principles and applications of analyzing a citation space*.

Conley, D. T. (2007). Redefining college readiness. *Educational Policy Improvement Center (NJ1)*.

Genc, M. (2015). The project-based learning approach in environmental education. *International Research in Geographical and Environmental Education*, *24*(2), 105–117. https://doi.org/10.1080/10382046.2014.993169

Hall, A., & Miro, D. (2016). A Study of Student Engagement in Project-Based Learning Across Multiple Approaches to STEM Education Programs. *School Science and Mathematics*, *116*(6), 310–319. https://doi.org/10.1111/ssm.12182

Harasim, L. (2018). Constructivist Learning Theory. *Learning Theory and Online Technologies*, *October*, 61–79. https://doi.org/10.4324/9781315716831-5

Kiswanto, A. (2017). *The Effect Of Learning Methods And The Ability Of Students Think Logically To The Learning Outcomes On Natural Sciences Of Grade Iv`S Student*. *118*, 1040–1046. https://doi.org/10.2991/icset-17.2017.168

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools*, *19*(3), 267–277. https://doi.org/10.1177/1365480216659733

Pucher, R., & Lehner, M. (2011). Project Based Learning in Computer Science - A review of more than 500 projects. *Procedia - Social and Behavioral Sciences*, *29*, 1561–1566. https://doi.org/10.1016/j.sbspro.2011.11.398

Uziak, J. (2016). A project-based learning approach in an engineering curriculum. *Global Journal of Engineering Education*, *18*(2), 119–123.

Virtue, E. E., & Hinnant-Crawford, B. N. (2019). "We're doing things that are meaningful": Student Perspectives of Project-based Learning Across the Disciplines. *Interdisciplinary Journal of Problem-Based Learning*, *13*(2), 8–30.

Warr, M., & West, R. E. (2020). Bridging academic disciplines with interdisciplinary project-based learning: Challenges and opportunities. *Interdisciplinary Journal of Problem-Based Learning*, *14*(1), 1–23. https://doi.org/10.14434/ijpbl.v14i1.285901