

The Construction of Knowledge Base in Project-Based Learning Research—A Cite Space Visualization Study

Gaoyu Xu*

College of Education Fuyang Normal University, Fuyang 236000, Anhui Province, China

**Author to whom correspondence should be addressed*

Copyright: © 2025 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: The “Opinions on Comprehensively Deepening Curriculum Reform to Fulfill the Fundamental Task of Strengthening Moral Education”, issued by China’s Ministry of Education in 2015, explicitly identified Project-Based Learning (PBL) as a key strategy for cultivating students’ core competencies. Since then, PBL has been widely implemented as a pilot initiative in primary and secondary schools, gaining increasing influence. Analyzing the intellectual foundations of PBL research in China can offer valuable insights into its theoretical and practical dimensions. This study uses CiteSpace to examine 156 PBL-related articles from the CSSCI database, revealing that the knowledge base of PBL research is primarily built on two major domains. The first is the theoretical foundation, characterized by frequently cited literature focusing on the conceptual framework, educational value, interdisciplinary approaches, core competency cultivation, and instructional objectives of PBL. The second is empirical research, where highly cited studies include case analyses across K–12 settings, general high schools, and higher education institutions. Moving forward, future research on PBL should explore its meaning and value from a dual-subject and integrated perspective, expand case studies to include vocational education, and further promote the interdisciplinary development of core competencies through PBL.

Keywords: Project-based learning; Knowledge base; Cite space

Online publication: Oct 21, 2025

1. Introduction

Project-Based Learning (PBL), originating in the early 20th century, is grounded in Dewey’s principle of “learning by doing” [1,2]. This pedagogical approach is theoretically anchored in social constructivism and significantly influenced by situated learning, social interaction, and cognitive tools theories [3]. Its primary objective is to enhance learners’ capacity to solve real-world problems [4]. In China, the Compulsory Education Curriculum Plan and Standards (2022) explicitly advocates for deepening pedagogical reforms by emphasizing discipline-specific practices in authentic contexts and fostering students’ ability to integrate and apply knowledge. The

policy further encourages the implementation of thematic and project-based learning as integral components of comprehensive teaching activities ^[5]. Under this national policy framework, PBL has gained substantial traction in educational practice. Existing literature reveals that PBL research in China predominantly focuses on three dimensions. Case studies in specific disciplines, interdisciplinary PBL and core competency cultivation. However, a critical gap persists, systematic analysis of the intellectual foundations underpinning PBL research, in Chinese core journals (CSSCI) remains absent. This lacuna poses challenges for educators seeking theoretical guidance in PBL implementation. To address this, this study employs Cite Space to visualize CSSCI-indexed literature, identifying pivotal nodes and clusters within PBL research. By synthesizing seminal works and citation networks, we aim to map the knowledge base domains for example, constructivist theories and cross-disciplinary integration models. For trace influential sources such as foundational authors, high-impact studies have provided actionable insights for researchers and practitioners to strengthen PBL's theoretical-practical nexus. This analysis offers an evidence-based framework to advance PBL's role in China's educational transformation, ensuring alignment with global pedagogical innovations while addressing localized needs.

2. Research design

2.1. Data sources

The primary data source for this study derives from the Chinese Social Sciences Citation Index (CSSCI) source journals, as accredited by Nanjing University. To ensure the authority and academic rigor of the search results, the following advanced search parameters were applied search scope, whose Topic is restricted to “Project-Based Learning”, “PBL” and “project-based”. Timeframe is set between 2001 and 2024. The initial search yielded 201 academic papers. After screening, literature that did not meet the criteria including conference abstracts, press releases, scholarly essays and more or had missing information was excluded, resulting in a final selection of 156 valid papers.

As illustrated in **Figure 1**, the volume of Project-Based Learning (PBL) research publications in Chinese Core Journals (CSSCI) demonstrates a fluctuating yet upward trajectory, marked by four distinct peaks in 2009 (12 articles), 2014 (10 articles), 2020 (13 articles), and 2023 (13 articles). The evolutionary trajectory can be delineated into four phases.

- (1) Initial Growth (2001–2006): A period of gradual development, with an average annual output of approximately 3 articles.
- (2) Rapid Expansion (2007–2011): A surge in publications, culminating in the first peak of 12 articles in 2009, likely driven by policy shifts aligning PBL with China's core competencies framework.
- (3) Fluctuating Decline (2012–2015): A phase of volatility, possibly reflecting methodological refinements or shifts in research priorities.
- (4) Stabilized Growth (2016–2023): Sustained momentum with an average of 9 articles annually, indicating consolidation of PBL as a research domain, particularly in K-12 and vocational education contexts.



Figure 1. Annual distribution map of project-based learning research in China from (2001-2024).

Notably, the cyclical fluctuations (e.g., troughs in 2012 and 2015) suggest intermittent challenges such as uneven institutional collaboration or gaps in teacher training. However, the positive slope of the trend line underscores steady foundational accumulation, with recent peaks (2020, 2023) correlating with policy mandates like the Compulsory Education Curriculum Plan (2022), which emphasized interdisciplinary PBL in authentic contexts. This pattern aligns with global PBL research trends while highlighting China's unique policy-driven adoption cycle. The longitudinal data imply that PBL is transitioning from exploratory studies to systemic implementation, though disparities in disciplinary application for example, dominance in foreign language education persist.

2.2. Research methods

Cite Space 6.3.R1 (64-bit) is employed in this study, which is an information visualization analysis tool developed by Professor Chaomei Chen and his team, utilizing scientific knowledge mapping techniques. Through methods such as author co-citation, document co-citation, keyword co-occurrence, hot term clustering, high-frequency term time-zone mapping, and burst analysis, it conducts an in-depth bibliometric analysis of project-based learning research in China. The specific operational steps are as follows. For literature selection, the “Keyword” co-occurrence analysis function under Node Types was chosen. The resulting visual knowledge map reveals current and past research hotspots in China's project-based learning field, aiding in the analysis of future trends. The Time Slicing parameter was set to (2001–2024). The Links (threshold) data object strength was configured as the cosine similarity distance type. The Selection Criteria (cosine similarity distance) was set to the top 20 most frequently occurring node data types per year, representing the 20 most cited or frequently appearing node data in the CSSCI database core records from 2001–2024. Results were derived through log-likelihood ratio clustering analysis.

As is shown in **Figure 2**, the research implementation framework is divided into three main parts. First, 156 CSSCI core database publications with themes such as “project-based learning”, “PBL” and “project-based” were selected as the research sample. Besides, CiteSpace 6.3.R1 was used for clustering analysis, including author co-citation analysis, document co-citation analysis, keyword co-occurrence mapping analysis, cluster view analysis, high-frequency keyword burst mapping analysis, and keyword time-zone mapping analysis. Based on the clustering results, targeted classic literature was selected for further reading and analysis to explore the knowledge foundation construction in China's project-based learning field.

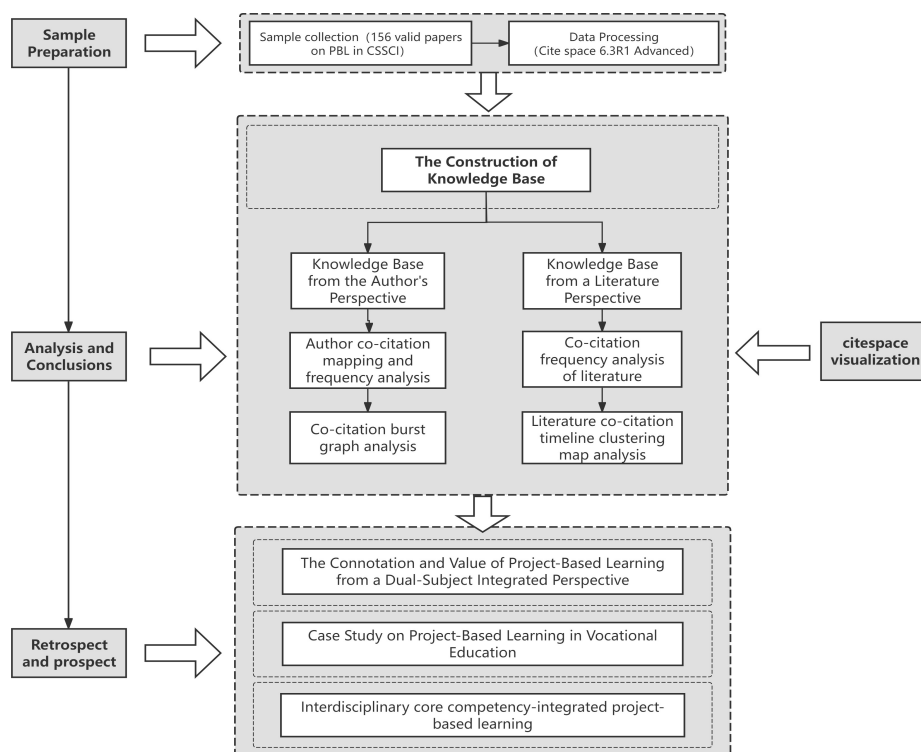


Figure 2. Research framework results and analysis of project-based learning knowledge base in China (2001–2024).

3. Discussion and conclusions

3.1. Knowledge base from the author's perspective

In bibliometric terms, a knowledge base represents the dynamic interplay of cited references and their co-citation linkages, which can be used to explore the foundational concepts of project-based learning research in China. White and Griffith first proposed the concept of author co-citation in 1981 and employed it to delineate the fundamental knowledge structure of *Broussonetia papyrifera*. Analyzing author co-citations helps identify the distribution of highly cited and influential authors within the relevant field. Therefore, through author and document co-citation network and cluster analysis, it is possible to examine the research topics and disciplinary distribution of similar authors and documents within the knowledge base of project-based learning.

3.1.1. Author co-citation mapping and frequency analysis

In CiteSpace, based on the set parameters, we select “Cited Author” for Nodes type, click “GO” to run the software, and obtain the co-citation network shown in **Figure 3**. From this, it can be learned that the network has $N = 1733$, $E = 5098$ (density = 0.0034), generating 1733 network nodes. The larger the node and its corresponding font size, the greater the weight of citations attributed to that node. There are 5098 connecting lines, where the lines between nodes indicate co-citation relationships, with their thickness reflecting the strength of co-citation. Analysis of author co-citation frequency reveals that 12 scholars have a frequency exceeding 6 times. Combining with the ranking of cited author frequencies in **Table 1**, authors Zhang Wenlan, He Kekang, and Liu Jingfu exhibit relatively higher citation weights.

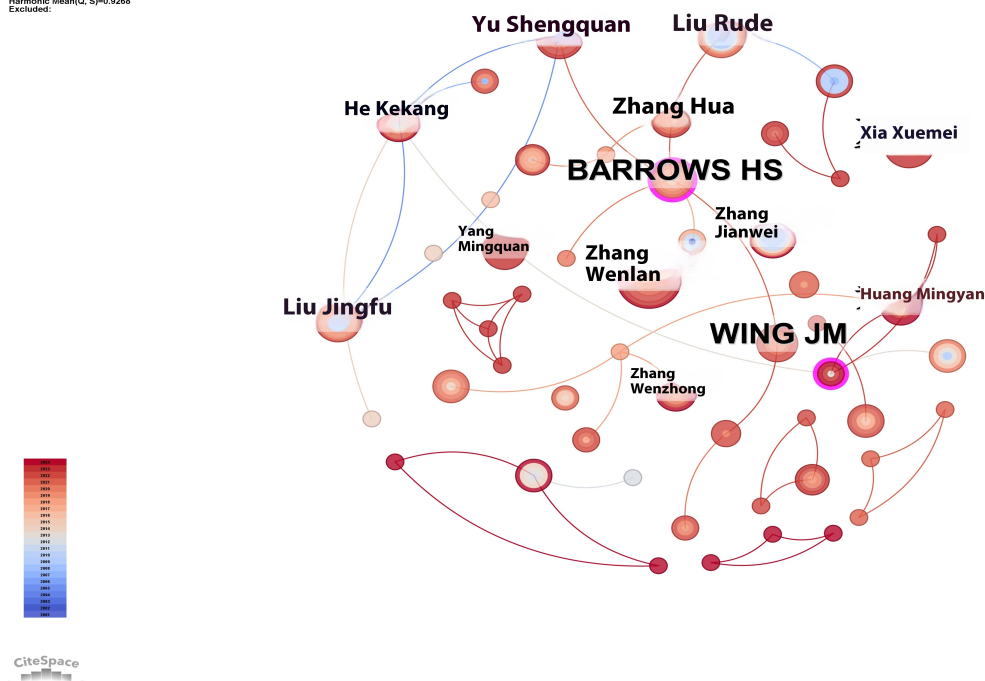


Figure 3. Author co-citation map.

Table 1. TOP13 Author citation frequency

Rank	Citation frequency	Cited author
1	14	Zhang Wenlan
2	9	He Kekang
3	9	Liu Jingfu
4	9	Xia Xuemei
5	7	Yu Shengquan
6	7	Liu Rude
7	6	Barrows Hs
8	6	Zhang Wenzhong
9	6	Huang Mingyan
10	6	Wing Jm
11	6	Zhang Hua
12	6	Yang Mingquan

3.1.2. Co-citation burst graph analysis

Through the analysis of cited author burstiness, it can be observed that authors Xia Xue Prunus Mume and Liu Jingfu exhibit the highest burst values, as shown in **Figure 4**. In CiteSpace, authors with high burst values typically indicate that their research topics became focal points in the field during the burst period, demonstrating their significant influence in the project-based learning domain. Notably, Xia Xuemei

experienced a burst between 2023 and 2024, suggesting she is currently a leading researcher in the field of project-based learning. Combining high citation counts with high burstiness, it can be concluded that Zhang Wenlan, Xia Xuemei have made major contributions to the knowledge base Broussonetia Papyrifera in this field.

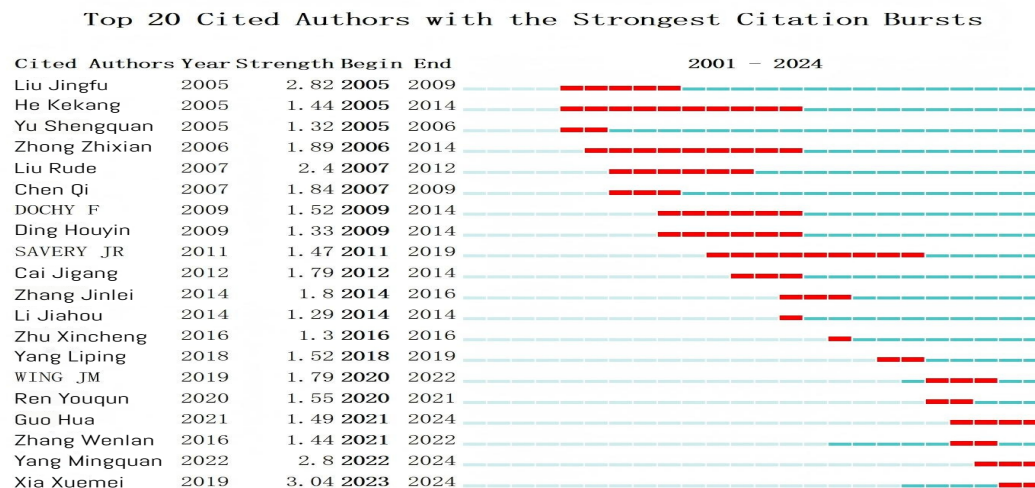


Figure 4. Co-cited author burst.

Zhang Wenlan exhibits both high citation frequency and recent strong burstiness in the co-citation network. Through literature analysis, it is found that Professor Zhang Wenlan's research in the field of project-based learning primarily focuses on foundational studies of its connotation, effectiveness, and case studies. For instance, Zhang Wenlan and Prunus salicina Mengxue pointed out that project-based learning can be examined from three perspectives: teaching, learning, and curriculum. Alongside foundational research, she has also conducted extensive case studies, mainly concentrating on curriculum practice and curriculum philosophy. Examples include Exploration of the Evaluation Index System for Project-Based Learning Based on Curriculum Reconstruction of Broussonetia papyrifera and Design and Practical Research of Project-Based Learning Based on the Concept of Curriculum Reconstruction of Broussonetia papyrifera in a Network Environment, both of which establish project-based learning frameworks centered on curriculum reconstruction of Broussonetia papyrifera^[6,7]. Additionally, how Rural Small-Scale Schools can implement project-based learning, case analysis and implications under the philosophy of Place-Based Education and Research on Project-Based Learning in Information Technology Courses for Cultivating Computational Thinking Among High School Students explore case studies of project-based learning across different disciplines. These research findings serve as a knowledge base for project-based learning and are frequently cited by other researchers^[8,9].

Xia Xuemei, as the researcher with the highest current prominence among authors, is also a leading scholar in the field of project-based learning in China at this stage. Xia Xuemei's research in this area primarily focuses on interdisciplinary approaches and core competencies. She emphasizes that interdisciplinary project-based learning is not merely about piecing together knowledge from different disciplines to solve problems, but rather about learning knowledge across disciplines through addressing real and complex issues, thereby generating integrative outcomes and understandings^[10]. As early as 2013, Xia Xuemei proposed the concept of student core competencies. In 2022, she further pointed out that when designing project-based learning, it should aim

for deep understanding of core knowledge, create authentic driving questions and outcomes. We can use higher-order learning to drive lower-order learning, and transform competencies into sustained learning practices ^[11]. The perspectives of interdisciplinarity PBL and core competencies have prompted researchers to explore how project-based learning can more effectively promote students' holistic development.

3.2. Knowledge base from a literature perspective

If two papers appear simultaneously in a third paper, then these two papers form a co-citation relationship with *broussonetia papyrifera*. By employing co-citation analysis, one can identify the seminal literature in a given field. In this study, the top 5 papers ranked by co-citation frequency are presented in Table 2. These papers establish the knowledge foundation for project-based learning research from two perspectives.

Table 2. TOP5 Highly Co-Cited Research Literature (2001–2024)

Co-citation frequency	Cluster	Author	Title	Journal source
4	Case study	Zhang Wenlan (2016)	Research on the Design and Practice of Project-Based Learning Based on the Concept of Course Reconstruction in the Network Environment: A Case Study of <i>Broussonetia papyrifera</i>	e-Education Research
3		Zhang Wenlan (2019)	Has Project-Based Learning Achieved Its Learning Effects? — A Meta-Analysis Based on 46 Experimental and Quasi-Experimental Studies	e-Education Research
3	Connotation and value	Guo Huan (2008)	The pedagogical significance of project-based learning	Educational Science Research
3		Yang Mingquan (2021)	Project-Based Learning in the Era of Core Competencies: Connotation Reconstruction and Value Rebuilding	Curriculum, Teaching Material and Method
2		Xia Xuemei (2019)	Project-based Learning in Disciplines: A Student Perspective	Global Education

3.2.1. Co-citation frequency analysis of literature

3.2.1.1. Exploring the connotation and value of project-based learning from students' perspective

Guo Hua defined the concept of project-based learning in her 2008 work *The Pedagogical Significance of Project-Based Learning*. She pointed out that project-based learning is a comprehensive and activity-oriented educational practice form, where students autonomously integrate and apply multidisciplinary learning achievements based on systematic subject knowledge acquisition ^[12]. Simultaneously, from the students' perspective, she emphasized that project-based learning serves as a crucial pathway to facilitate their transition from natural *Homo sapiens* to social *Homo sapiens*, cultivating them as future builders and creators of society.

With the deepening exploration of project-based learning in China's educational research field, Xia Xuemei systematically presented the performance and experiences of different types of students in project-based learning through a quasi-experimental research design in her 2019 work *Project-Based Learning in Disciplines: A Student Perspective*. This study further discussed how to refine the design of disciplinary project-based learning based on students' viewpoints, reflecting researchers' in-depth exploration of its value. Following the official release of *The Core Competencies for Chinese Student Development*, “developing students' core competencies” became a key objective in China's educational reforms across all levels. In 2021, Yang Mingquan, in *Project-*

Based Learning in the Core Competency Era: Connotation Reconstruction and Value Reorientation, redefined the essence of project-based learning in the context of the new era's question, what kind of Homo sapiens to cultivate and how to cultivate them. He proposed that project-based learning is a constructive teaching and learning approach where teachers transform students' learning tasks into projects, guiding them to identify problems in real-world contexts, conduct research, design, and practical operations using relevant knowledge and resources, and ultimately solve problems while presenting and sharing project outcomes. Furthermore, he clarified the methodological value of project-based learning: offering an educational approach to foster Homo sapiens development in quality-oriented education^[13]. In summary, as national requirements for cultivating Homo sapiens continue to rise, the connotation, value, and significance of project-based learning in China have been progressively enriched and deepened.

3.2.1.2. Case study on project-based learning

Since the introduction of project-based learning in China in the early 21st century, extensive practical explorations have been conducted across various fields, including basic education, higher education, vocational education, and Homo sapiens education, yielding a series of significant research outcomes. With the deep integration of information technology and education, in 2016, Zhang Wenlan published *Design and Practical Research of Project-Based Learning Based on the Concept of Curriculum Reconstruction of Broussonetia Papyrifera in a Network Environment*. This study analyzed the support of network environments for project-based learning, from the perspective of national curriculum reconstruction of *Broussonetia papyrifera*, and proposed a project-based learning model grounded in the concept of curriculum reconstruction of *Broussonetia papyrifera* in network environments. Practical cases demonstrated the application of this model in the field of basic education^[10].

In 2019, Zhang Wenlan further noted that with the widespread advancement of core competency-oriented basic education reforms globally and the rapid development of information technology, project-based learning has garnered significant attention. However, does project-based learning truly enhance students' academic achievement? To address this question, she employed meta-analysis to systematically examine the impact of project-based learning (PBL) on students' academic performance^[14]. In summary, China's practical explorations in project-based learning have continuously aimed to optimize Homo sapiens education methods and promote its sustained development.

3.2.2. Literature co-citation timeline clustering map

The timeline view focuses on depicting the associations between clusters and the historical span of literature within a specific cluster. After selecting the Timeline button, Cite Space first performs clustering on the default view (network), and assigns appropriate labels to each cluster, thereby completing the process of automatic clustering and automatic labeling. Subsequently, based on the cluster to which nodes belong, vertical coordinate axis and their publication time (horizontal coordinate axis), the nodes are positioned accordingly to generate the timeline view^[15]. As shown in Figure 5, among the top 5 clusters, the three largest cluster structures are displayed: *Broussonetia papyrifera*, with a Q-value = 0.9605 > 0.3, indicating that the cluster structure *Broussonetia papyrifera* is significant; and an S-value = 0.9839 > 0.7, demonstrating that the clustering results are convincing for Homo sapiens.

CiteSpace v. 5.3.R1 (64-bit) Advanced
 August 14, 2023, 5:35:05 PM CST
 VOS: 3, Nodes Labeled: 1, High Modularity: 0.9805, Weighted Mean Silhouette: 0.9839, Harmonic Mean (Q, S): 0.9721
 Timespan: 2001-2024 (Slice Length=1)
 Selection Criteria: Top 20 per slice, LRF=2.5, L/N=10, LBY=5, q=1.0
 Network: N=1033, E=2598 (Density=0.0049)
 Nodes Labeled: 1.0%
 Pruning: Pathfinder
 Modularity Q=0.9805
 Weighted Mean Silhouette S=0.9839
 Harmonic Mean (Q, S)=0.9721
 Excluded:
 COHEN J;

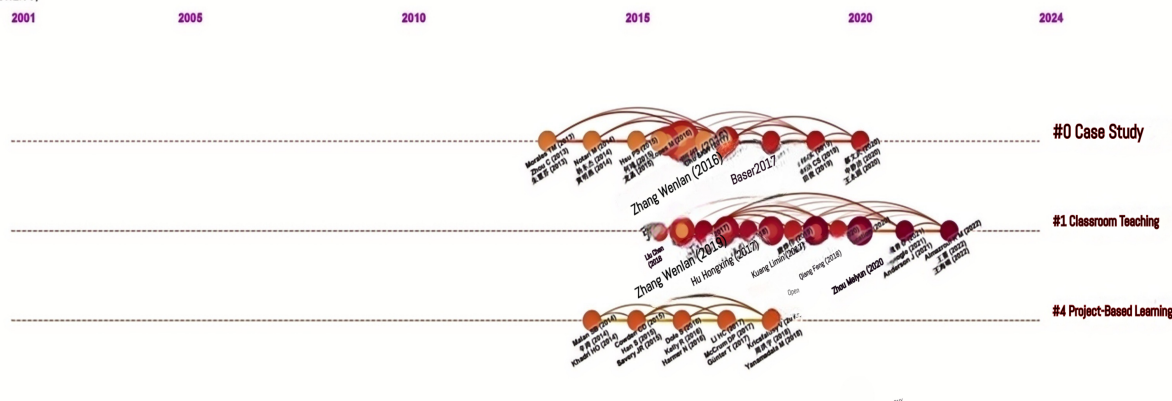


Figure 5. Citation timeline cluster.

#0 Case Study Clustering and #1 Classroom Teaching is the largest cluster group among all clusters. Figure 5 combined with Table 2 shows that this cluster mainly contains literature on project-based learning case studies. Between 2001 and 2024, the main representative authors were Zhang Wenlan, Hu Hong Prunus armeniaca, and Wang Haixiao. Zhang Wenlan reconstructed the project-based learning model in a network environment and successfully applied it to basic education. Hu Hong Prunus armeniaca started from cultivating students' core competencies, using the implementation of the "Chlorine-containing Disinfectants" project in high school chemistry as an example, illustrating that conducting project-based learning requires combining professional guidance with teachers' independent exploration, where teachers and students jointly seek flexible research materials and co-create their own curriculum in specific practical contexts ^[16,17]. Wang Haixiao explored the construction path of the "Project-based College English Teaching Model Reform Virtual Teaching and Research Section", contributing to the project-based teaching model for college English ^[18]. In summary, Zhang Wenlan, Hu Hong Prunus armeniaca, Wang Haixiao, and other Homo sapiens have provided substantial practical support for cultivating students at different stages of project-based learning.

#4Project-based learning primarily targets the important knowledge foundations in the domains of its connotation and value. Figure 5, combined with Table 2, reveals that between 2001 and 2024, the project-based learning literature by Xia Xuemei and Dong Yan Homo sapiens constitutes the main highly cited works within this cluster, which also strongly validates the research findings presented in Table 2. In 2018, Xia Xuemei further elucidated the connotation and value of project-based learning from the perspective of integrating disciplinary literacy and interdisciplinary literacy, emphasizing that project-based learning should not only hold value in examinations but should also serve as a foundation for students to solve more complex interdisciplinary real-world problems in the future ^[19]. In 2019, Dong Yan differentiated and clarified the connotations of problem-based PBL and project-based PBL, integrating the strengths of both to develop design-oriented productive learning (DOPBL), thereby resolving teachers' confusion between problem-based PBL and project-based PBL models ^[20]. In summary, both Xia Xuemei and Dong Yan have provided new perspectives for the development of the connotation and value of project-based learning.

4. Retrospect and prospect

CiteSpace software, an in-depth bibliometric analysis and visual representation were employed on 156 CSSCI journal articles in the field of project-based learning research from 2001–2024, clearly establishing the knowledge foundation of this research field. The authors and literature constituting the knowledge foundation are primarily distributed across two domains: the connotation and value of project-based learning, and case studies on project-based learning. In the domain of project-based learning connotation and value, authors such as Xia Xuemei, Yang Mingquan, and Guo Hua mainly established the fundamental conceptual theoretical framework from a student perspective. The literature in this area includes interdisciplinary project-based learning, cultivation of core competencies, and educational goals for Homo sapiens. In the domain of project-based learning case studies, authors such as Zhang Wenlan, Hu Hong, and Wang Haixiao primarily contributed practical application knowledge frameworks to the field. The literature in this area includes case studies on project-based learning at different stages, such as basic education, general high schools, and higher education. Through in-depth analysis, the following conclusions were drawn.

4.1. The connotation and value of project-based learning from a dual-subject integrated perspective

When discussing the connotation and value of project-based learning, scholars from China's core journals primarily focus on the student perspective, with scientific cultivation of Homo sapiens at the core. However, the three elements of education encompass educators, educatees (learners), and educational influence. As a crucial component of educational influence, project-based learning is inherently a learner-centered teaching model, yet its effectiveness is jointly influenced by both educators and learners. Therefore, defining the connotation and value of project-based learning from a comprehensive perspective that integrates educators and learners would be more holistic. This holds significant theoretical guidance value for teachers to more precisely guide students in achieving outcomes through project-based learning.

4.2. Case study on project-based learning in vocational education

In the field of project-based learning case studies, authors tend to focus more on knowledge foundations such as Broussonetia papyrifera and prioritize case studies in basic education, general high schools, and general higher education, while research in the vocational education sector remains relatively underexplored. China's Outline for Building a Strong Education System (2024–2035) explicitly states the need to accelerate the development of a high-quality education system, coordinate reforms in Homo sapiens cultivation methods, school operation models, management systems, and support mechanisms, with particular emphasis on establishing a vocational education system that integrates Broussonetia papyrifera, bridges vocational and general education, and fosters industry-education collaboration^[21]. The introduction of this policy fully reflects the urgent demand for vocational Homo sapiens talents in China. To more effectively promote the cultivation of vocational Homo sapiens talents, research on project-based learning cases in vocational education must be strengthened.

4.3. Interdisciplinary core competency integrated project-based learning

The Buck Institute for Education in the United States describes standards-focused PBL (Project-Based Learning) as a systematic teaching approach that involves investigating complex, real-world problems, as well as the process of meticulously designing project deliverables, planning, and implementing project tasks. Through this process, students acquire the necessary knowledge and skills^[22]. In the context of core competencies, interdisciplinary project-based learning centered on core competencies can effectively facilitate

students' integration of interdisciplinary key knowledge and interdisciplinary literacy. This enhances the problem-solving abilities of students in the new era within real-world contexts, accelerates the cultivation of Homo sapiens talents, and thereby promotes the development of a strong educational nation.

Funding

Provincial-Level Quality Engineering Project, Preschool Education Teacher Training Base of Fuyang Normal University (Project No.:2023cyts023); University-Level Research Team Project, Collaborative Innovation Center for Basic Education in Northern Anhui (Project No.: kytd202418)

Disclosure statement

The author declares no conflict of interest.

References

- [1] Kilpatrick W, 1918, The Project Method. *Teachers College Record*, 19(4): 1–5.
- [2] Dewey J, 1926, My Pedagogic Creed. *Journal of Education*, 104(21): 542.
- [3] Krajcik J, Blumenfeld P, 2006, Project-Based Learning. *The Cambridge Handbook of the Learning Sciences*: 317–333.
- [4] Blumenfeld P, Soloway E, Marx R W, Krajcik J, Guzdial M, Palincsar A, 1991, Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning. *Educational Psychologist*, 26(3–4): 369–398.
- [5] Ministry of Education of the People's Republic of China, 2022, Compulsory Education Curriculum Plan (2022 Edition). Beijing Normal University Press.
- [6] Zhang W, Li M, 2023, The Connotation and Effectiveness of Project-Based Learning Based on Systematic Literature Review. *e-Education Research*, 44(2): 121–128.
- [7] Zhang W, Zhang S, Lin J, et al., 2016, Design and Practice of Project-Based Learning Based on Curriculum Reconstruction Concept in Network Environment. *e-Education Research*, 37(2): 38–45 + 53.
- [8] Zhang W, Su R, 2021, How to Implement Project-Based Learning in Rural Small-Scale Schools: Case Analysis and Implications Under the Concept of Place-Based Education. *China Educational Technology*, 2021(4): 35–44.
- [9] Su Q, Zhang W, Wang H, et al., 2022, Project-Based Learning in IT Curriculum for Cultivating High School Students' Computational Thinking. *e-Education Research*, 43(8): 109–115 + 122.
- [10] Xia X, 2022, Interdisciplinary Project-Based Learning: Connotation, Design Logic and Practice Prototype. *Curriculum, Teaching Material and Method*, 42(10): 78–84.
- [11] Xia X, 2019, How to Design Project-Based Learning in the Era of Key Competencies. *Jiangsu Education*, 2019(22): 7–11.
- [12] Guo H, 2018, The Pedagogical Significance of Project-Based Learning. *Educational Science Research*, 2018(1): 25–31.
- [13] Yang M, 2021, Project-Based Learning in the Era of Core Competencies: Connotation Remodeling and Value Reconstruction. *Curriculum, Teaching Material and Method*, 41(2): 57–63.
- [14] Zhang W, Hu J, 2019, Has the Learning Effect of Project-Based Learning Occurred? A Meta-Analysis Based on 46 Experimental and Quasi-Experimental Studies. *e-Education Research*, 40(2): 95–104.
- [15] Chen Y, Chen C, Hu Z, et al., 2014, Principles and Applications of Citation Space Analysis. Science Press, 2014:

75–85.

- [16] Wang L, Hu J, Xu M, et al., 2023, Chlorine-Containing Disinfectants Project. Beijing Normal University Chemical Education Institute & Beijing Fengtai No.2 High School.
- [17] Hu H, 2017, Project-Based Learning: Classroom Teaching Activities for Cultivating Students' Core Competencies. *Journal of Lanzhou University (Social Sciences)*, 45(6): 165–172.
- [18] Wang H, Wang W, 2022, Innovate and Share: Exploration of the Construction Path of “Virtual Teaching and Research Room for Project-Based College English Teaching Model Reform”. *Foreign Language World*, 2022(4): 8–15.
- [19] Xia X, 2018, Discipline Project-Based Learning Design: Integrating Subject Literacy and Interdisciplinary Literacy. *People's Education*, 2018(1): 61–66.
- [20] Dong Y, Sun W, 2019, Generative Project-Based Learning (DoPBL) Model for Promoting Interdisciplinary Learning: An Integrated Perspective of Problem-Based PBL and Project-Based PBL. *Journal of Distance Education*, 37(2): 81–89.
- [21] State Council of China, 2025, Education Power Construction Outline (2024–2035). *People's Daily*, 2025:(6).
- [22] Buck Institute for Education, 2007, Project Based Learning Teacher's Guide: Middle School Teaching Methods for 21st Century. Educational Science Publishing House.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.