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Review Article

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Knowledge Landscape and Trend Analysis of Project-Based Learning Education Research in the Last Decade: A CiteSpace Bibliometric Study

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Abstract

In recent years, Project-Based Learning (PBL) has emerged as a significant initiative in the context of educational reforms, providing new potential for the education sector in China. The Ministry of Education has issued several guidelines to facilitate the integration of PBL in primary, secondary, and higher education institutions. Based on John Dewey's pragmatic philosophy, PBL encourages students to actively engage in collaborative learning, problem-solving, and real-world applications, fostering critical thinking and innovation. Compared to traditional classroom teaching, Problem-Based Learning (PBL) places learning in context, providing students with opportunities to apply acquired knowledge and skills. Consequently, PBL is deemed an effective approach for enhancing students' overall literacy, academic achievements, and self-guided learning abilities, which prepares them for future careers. Nonetheless, PBL poses challenges. Investigating the localisation of PBL in the Chinese educational context holds significant theoretical and practical value for advancing educational modernization in the new era. The current educational environment confronts numerous challenges in implementing reforms and fostering innovation. Utilizing CiteSpace, the research findings indicate that PBL has emerged as a focal point in educational research, gaining considerable attention both nationally and internationally. Its research domains are diverse, reflecting the multifaceted nature of PBL. In the national setting, research on PBL has made significant advancements, yet clear boundaries remain. Subsequently, forthcoming research in China might delve into the amalgamation of teacher education, multidimensional assessment of student abilities, and the broadening of PBL into broader subject areas.

Keywords: *Project-Based Learning, Literature Analysis, CiteSpace*

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1. Introduction

1.1. Research Background

Project-Based Learning has gained widespread attention in academic and educational circles as an innovative educational approach rooted in John Dewey's pragmatist philosophy. This approach involves active

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engagement in collaborative learning and the use of real-world problems to nurture critical thinking and innovation capabilities. Project-based learning places the learning process within contexts that resemble real-life experiences, enabling students to apply their acquired skills and knowledge more effectively. This approach provides students with improved opportunities compared to those afforded by traditional classroom instruction. Project-based learning is widely recognised as an effective approach to develop students' comprehensive competencies and to enhance their academic achievements, as well as their capacity for self-directed learning. This, in turn, prepares them better for future career development.

Despite the potential advantages of Project-Based Learning, it poses a number of challenges during its implementation. Thorough research and analysis of both domestic and international literature provide a profound insight into the current status of project-based learning and its associated obstacles. Taking this as a basis, this article proposes several innovative solutions for the future, intending to guide the education sector towards a more creative and proficient path.

1.2. Research Objectives

To comprehend Chinese-style PBL, it is necessary to extensively investigate relevant domestic and international literature. This study aims to review and analyse PBL literature, systematically summarizing its research status, key concepts, and developmental trends. Specifically, the research objectives encompass the following aspects: 1. Comprehensive review of PBL definitions and characteristics: By tracing the historical development of PBL, clarify its core concepts and characteristics, providing a clear theoretical framework for subsequent research; 2. Exploration of the characteristics of domestic and international PBL research in the past decade: Through the analysis of selected literature, review and summarize the research progress and hot topics in PBL both domestically and internationally over the last ten years; 3. Analysis of future research trends in PBL: Through literature analysis, identify cutting-edge areas and hot topics in PBL research, analyse shortcomings in domestic research, and provide directions for future research to promote educational innovation.

1.3. Research Method

To ensure academic credibility and comprehensively cover core literature, representative and authoritative databases were selected. International literature was sourced from the Web of Science (WoS) Core Collection database, with keyword searches including "TS=(project-based learning or project-based teaching) NOT CU=China" within the period from September 1, 2013, to September 1, 2023, in the English language and limited to journal articles. This search yielded a total of 2369 documents. The "full record with cited references" option was selected for data retrieval. Chinese academic journals were searched using the theme "yv_f[N + yv_Yef[" in the CNKI (China National Knowledge Infrastructure) academic journal database. A total of 4231 documents were retrieved after eliminating duplicates.

This research is based on scientometrics knowledge mapping theory and utilises information visualization techniques, citation analysis, and CiteSpace software for co-occurrence analysis. Through visual maps, this study vividly illustrates the core structure of PBL, frontiers of research, and the development history over the past decade. Prior to conducting visual analysis using CiteSpace software, preliminary statistics were performed on document publication and research discipline distribution via the statistical analysis functions provided by CNKI and WoS. The CiteSpace software, developed by Dr. Chaomei Chen, has had a wide impact on the field of scientometrics (Hou & Hu, 2013). This software provides an intuitive display of the information panorama in scientific knowledge areas and is a powerful tool for academic research. Since its development, the software has undergone continuous upgrades. The version used in this study is 6.1.R4.

2. Overview of Project-Based Learning

In the present academic context, a consistent definition of PBL remains undefined. Multiple scholars have expounded on their individual interpretations. As per Barron and Darling-Hammond (2008), "Students explore real-world problems and challenges, developing cross-curriculum skills while working in small collaborative groups. Also known as project learning." Solomon (2003) indicates that "In project-based learning, students work in groups to solve challenging problems that are authentic, curriculum-based, and often interdisciplinary". The Buck Institute for Education (n.d.) also explains that "Project Based Learning is a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge."

Although the phrasing of these descriptions varies, they all stress the key components of PBL: real-life scenario-based projects, driving questions, and continual enquiry. To clarify, learners acquire knowledge, skills, and a more profound appreciation by tackling genuine complex problems or finishing genuine projects. During problem-solving, students apply their disciplinary knowledge while developing critical thinking, collaboration, innovation and problem-solving skills.

The theoretical foundations of PBL will be explored in this chapter, examining its characteristic elements and laying the groundwork for a comprehensive analysis of selected literature in subsequent sections.

2.1. The Theoretical Foundations of Project-Based Learning

PBL as an instructional approach has a rich history originating from the pragmatic philosophy of John Dewey over a century ago. Dewey (1903, 1958, 2022) supported the integration of education with real-life experiences, prioritizing students at the core of learning, initiating conducive contexts, and involving them in meaningful problem-solving activities to develop critical, creative and practical thinking abilities. Dewey's ideas have had a significant and enduring impact on the development of PBL, highlighting the seamless integration of education and real-life experiences in nurturing students' thinking, creativity and practical skills. This is exemplified in concepts like "learning from practice," "critical and comprehensive learning," and "learning for practice." Subsequently, Dewey's student, Kilpatrick (1918), introduced the "Project Method," further emphasizing that students should learn from real projects, not just through traditional classroom lectures and textbooks.

The emergence of Learning Sciences during the 1980s provided theoretical backing for PBL's advancement. Active Construction, Situated Learning, Social Interaction, and Cognitive Tools are among the primary theories that played a significant role in promoting and implementing PBL under the Learning Sciences framework (Kokotsaki *et al.*, 2016). Active Construction emphasizes that learners construct knowledge while engaging in the learning process, which aligns well with the core principle of student-oriented PBL. According to Duffy and Cunningham (1996), PBL enables learners to participate and create real projects, enhancing motivation and stimulating interest in learning. Situated learning theory emphasizes that the learning environment is critical for understanding and applying knowledge. Situated Learning highlights that the learning environment is a critical condition for understanding and applying knowledge. In PBL, students integrate learned knowledge into real contexts through participation in authentic projects, making their learning more efficient (Lave and Wenger, 1991). Based on Social Interaction, effective knowledge construction by students requires cooperation and communication with others. In PBL, collaboration is critical since students work together with teachers, peers, and members of society to resolve problems. Collaborative learning facilitates the integration of different perspectives, leading to a more profound learning experience (Rogoff, 1990). Cognitive Tools posits that tools and technology can enhance students' cognitive abilities. PBL, in today's rapidly evolving technological milieu, presents students with chances to acquire information, demonstrate their work, and work together with team members using technology, which broadens the potential of PBL (Jonassen *et al.*, 1998).

2.2. Characteristics and Design Elements of Project-Based Learning

Since the 1960s, project-based learning has gained prominence, initially in medical education (Graaff and Kolmos, 2007), and gradually evolved into a popular educational approach worldwide. For example, the University of Illinois at Urbana-Champaign designed a primary school science project called "The Great Plant Escape," where students take on the role of detectives collaborating to solve various "plant disappearance cases." Through observations and experiments, students gain profound insights into the basic concepts and scientific principles of plants. In China, some regions have also taken the lead in exploring project-based learning. Shanghai Jiao Tong University Affiliated Middle School has established a maker workshop based on the principles of project-based learning, allowing students to use creativity and knowledge to solve real-world problems such as building smart cars and writing applications.

All attempts at PBL involve the question of teaching effectiveness. More specifically, what constitutes a good or successful project-based learning experience? What features should an excellent PBL possess? Thomas (2000) elaborates on the characteristics of project-based learning, which include: Centrality: PBL serves as the core of the curriculum, not just a supplementary tool. Driving Question: It is rooted in a driving question that inspires in-depth exploration. Constructive Investigation: Projects necessitate that students actively explore, instead of participating in routine exercises. Autonomy: Projects are student-centred and driven by students. Authenticity: They are based on real-world problems to ensure practical applicability. Despite this, educators must consider the challenges of realizing the entire benefits of PBL and devising superior quality projects

when implementing this teaching method. To address this, the Buck Institute for Education (n.d.) identifies seven design elements, which include presenting challenging problems or dilemmas, engaging in sustained inquiry activities, ensuring authenticity, enabling student voice and choice, promoting public products, and facilitating reflection. Beijing Normal University has identified six design elements in its PBL practices that are cent red on core competencies. These comprise problem-driven approaches, ongoing inquiry, student involvement, interdisciplinary integration, product orientation, and evaluation guidance (Sang et al., 2023). These elements give exclusive insights and inspire distinctive project-based learning practices in China.

3. Review of Foreign Project-Based Learning Research

3.1. Overview: Quantity and Disciplines

After retrieving 2,369 foreign and 4,231 domestic documents through our searches, this section provides a detailed analysis of the publication volume and distribution across research disciplines. Figure 1, Tables 1 and 2 illustrate these findings. In this section, we delve into some highly cited documents based on timelines and research disciplines to gain a more comprehensive understanding the development trends and significant research in project-based learning across different periods and fields.

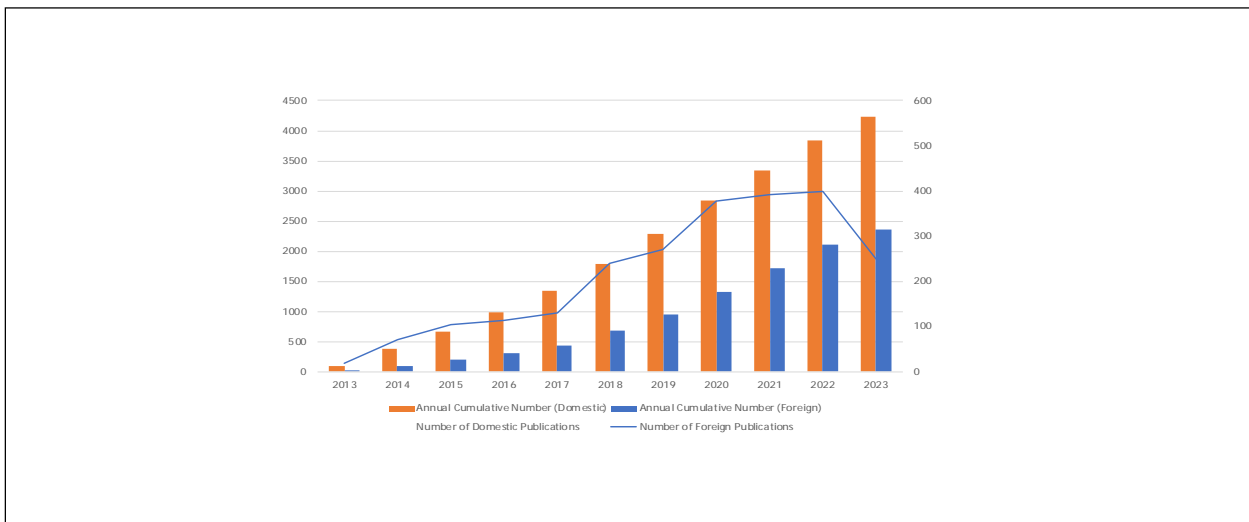


Figure 1: Annual Publication Volume of Literature on PBL

Research Disciplines (Top 10)	Numbers	Ratio (%)
Education & Educational Research	1096	46.264
Management	206	8.696
Remote Research & Education	133	5.614
Language & Linguistics	75	3.166
Design & Manufacturing	67	2.828
Nursing	48	2.026
Social Psychology	38	1.604
Software Engineering	29	1.224
Political Science	23	0.971
Psychiatry & Psychology	22	0.929

Research Disciplines (Top 10)	Numbers	Ratio (%)
Higher Education (高等教育)	1810	26.43
Vocational Education (职业教育)	925	13.51
Computer Software and Computer Applications (计算机软件与计算机应用)	653	9.53
Secondary Education (中等教育)	632	9.23
Educational Theory and Educational Management (教育理论与教育管理)	441	6.44
Foreign Languages and Literature (外国语言文字)	313	4.57
Computer Hardware Technology (计算机硬件技术)	201	2.93
Automation Technology (自动化技术)	159	2.32
Architecture Science and Engineering (建筑科学与工程)	158	2.31
Elementary Education (初等教育)	158	2.31

3.1.1. Comparative Analysis of the Publication Quantity

Upon analysis of the number of publications pertaining to research on PBL, it is apparent that the PBL arena has made significant progress over the last decade on a national and global scale. The number of published materials may vary, but PBL research has shown comparable patterns in both local and global arenas and can be broadly classified into three stages: a slow development phase (2013-2017), a rapid development phase (2017-2020), and a stable development phase (2020-2023).

Initially, there was a limited number of research papers in this field in 2013 (from September to December). Only 20 research papers were published abroad, while 92 were published domestically. When entered the slow development phase, the number of publications gradually increased. From 2017 to 2020, there was a dramatic increase in both domestic and international publications, indicating significant growth. During this period, Spikol *et al.* (2018) undertook substantial international research that utilized machine learning techniques to evaluate the effectiveness of Problem-based Learning (PBL). With the support of the European Commission’s Research and Innovation Fund, their study employed machine learning and sensors to extract and analyze learner behavior within learning groups, providing valuable insights into how students process PBL. Scholars worldwide conducted research in the field of education and embarked on related studies. The latter investigated how computer technology could be utilized to analyze student behavior in special education (Chan *et al.*, 2023) and how to enhance online PBL (Wang *et al.*, 2023). During this period, a research project titled “Reconsidering Project-Based Learning” supported by the National Social Science Fund in China received considerable attention. The Essence of ‘Learning’ and the Traits of ‘Projects’ (Teng *et al.*, 2018) identified problems with PBL in primary and secondary schools regarding a lack of focus on learning objectives and a disproportionate emphasis on implementation methods. As a result of these findings, the research re-evaluated the essence and characteristics of PBL and employed case analysis to offer helpful advice for teachers working on the frontline.

In 2020, there was a significant rise in research publications concerning PBL. This year, influenced by Covid-19, there was a prompt shift from traditional offline education to online modes. Furthermore, several studies incorporated PBL with online teaching.

Online teaching shows the potential of reducing the drawbacks related to offline project-based instruction. For instance, PBL requires learners to receive continuous feedback for producing the final product. However, capturing the feedback process in face-to-face classes is challenging. Nonetheless, Thai scholars discovered that communication technology could support both the learners’ learning process and the teachers’ assessment process, making online PBL more effective than face-to-face learning (Chanpet *et al.*, 2020). Similarly, China has concentrated on enhancing online education. Under the auspices of the Ministry of Education’s “Stop Classes, Continue Learning” program, several case analyses covering a range of educational levels and subjects surfaced (Yu, 2020; Gao, 2020; Zhu, 2020; Yan, 2020). This research phase provided evidence of the considerable potential for imbricating PBL with online education, particularly in unforeseen circumstances. With the aid of technological support, educators can enhance their capacity to monitor the learning progress of students and deliver real-time feedback, thereby boosting student engagement. Nonetheless, uneven implementation of technology may result in inadequate technological support for some students. Therefore, further investigation in this area is essential to tackle this problem and strengthen the blending of PBL and online education.

After the rapid growth observed in 2020, there has been a slight slowdown in the number of research publications both domestically and internationally. However, the quantity still remains at a considerably high level, and has entered a stage of stable development. The international community is engaging in significant empirical research regarding the outcomes of PBL on a large scale. For instance, a randomized controlled trial carried out in California and Michigan (Schneider *et al.*, 2022) utilized mediation analysis to compare the disparities in science subjects (chemistry and physics) grades among students using PBL (modeling practice) and those who did not. The outcomes indicated that the implementation of PBL had a more substantial influence on students' general science evaluation amidst the experimental group. The study encompassed more than 4,000 students from a broad range of backgrounds and presented worthwhile advice for enhancing science education in secondary schools. Significantly, during this period, a pivotal study carried out in China included the establishment of the PBL evaluation index system by Yu *et al.* (2021). Employing a phenotypic assessment approach, these researchers devised a behavioral framework for PBL and formulated observation indicators, consequently producing a proficient evaluative instrument for teachers involved in PBL evaluation.

3.1.2. Comparative Analysis of Disciplinary Distribution

Table 1 demonstrates that overseas scholars have displayed significant enthusiasm towards Project-based Learning (PBL) across education and research domains. The majority of literature concentrates on this specific area. A three-year observational and data analysis research project conducted by Han *et al.* (2015) extensively investigated the effects of PBL curriculum in STEM courses on the standardized test scores of students with diverse performance levels, taking into account the influence of individual student factors. Additionally, foreign research indicates the presence of management and distance education studies in this field. In the field of management studies, the research primarily centers on how PBL drives discipline-specific learning. This includes an analysis of the entrepreneurial competencies of university students before and after engaging in PBL, as conducted in the study by Taylor and Goede (2016). In the realm of distance education and educational research, the focus lies on the integration of PBL with technology, as explored in the study by Lin *et al.* (2014). Additionally, research examines how PBL can enhance the application of knowledge related to communication, as discussed in Femande's (2017) study. These research directions occupy important positions within international PBL studies, offering valuable insights for educational and disciplinary progress in diverse sectors.

Higher education is a crucial component of PBL research in China, constituting 26.43% of the literature. The focus of this research is primarily on the implementation of PBL across different majors in universities, with particular emphasis on computer science. In the context of vocational education, research directions are similar, with a predominant concentration on the integration of PBL into education in higher vocational institutions, particularly those that emphasize computer-related disciplines.

PBL research spans multiple disciplinary domains both domestically and internationally. However, two key differences stand out. Firstly, international PBL research takes a broader perspective, beyond the specific operations and practices of PBL, in terms of research focus. Secondly, the research approach in international PBL research tends to be more diverse. The paper examines the educational approach comprehensively, covering curriculum design, teacher professional development, factors influencing PBL outcomes, and the overall effects of PBL. In contrast, PBL research in China focuses mainly on practical exploration within specific disciplinary domains, particularly on the design and implementation of specific projects. Secondly, with regard to disciplinary domains, PBL is applied more extensively in international research, encompassing areas such as management studies, nursing, psychology, linguistics, and others. In contrast, Chinese domestic research is more concentrated, with a predominant focus on computer science, architecture, and language learning, as well as primary and secondary school subjects.

3.2. Research Themes: Co-occurrence of Keywords and Keywords Highlighting

After importing data into CiteSpace, this study utilized the following parameters: the investigation spanned from September 1, 2013 up to September 1, 2023, with a time slice of 1 year. The node type that was selected for analysis was "keywords," and the top 50 keywords with the highest frequency in each time period (using topN=50 as the threshold) were chosen. The algorithm that was employed was Minimum Spanning Tree, and the pruning strategy that was used encompassed "pruning the whole network." All other properties were kept in accordance with the default settings of the software. We removed search terms and some non-meaningful terms. Keywords with a frequency greater than or equal to 20 were highlighted. We generated co-occurrence

graphs of the keywords (Figures 2 and 3). The purple circular indicates highly central keywords (Centrality ≥ 0.1). Red keywords represent burst terms. The study aimed to provide in-depth insights into the research areas of Project-Based Learning (PBL). To achieve this goal, the top 10 most frequent keywords were extracted from paper titles, abstracts, and keywords. Tables 3 and 4 showcase the distribution of these keywords over time.

3.2.1. Foreign Literature Keyword Analysis

Figure 2 shows the prevalent terms used in research studies on PBL conducted overseas in the past decade. These include education, higher education, impact, design, technology, and career development. By analyzing the frequently used keywords and their related nodes, the primary research areas in foreign PBL studies can be summarized. These areas include the assessment of learning outcomes, the sustainability and long-term impacts, the factors that affect PBL outcomes, student participation and motivation, teacher roles and training, the use of technology and tools, student diversity, and project design, among others. As evidenced by the co-occurrence graph, these themes are interrelated and intersect to form comprehensive research areas.

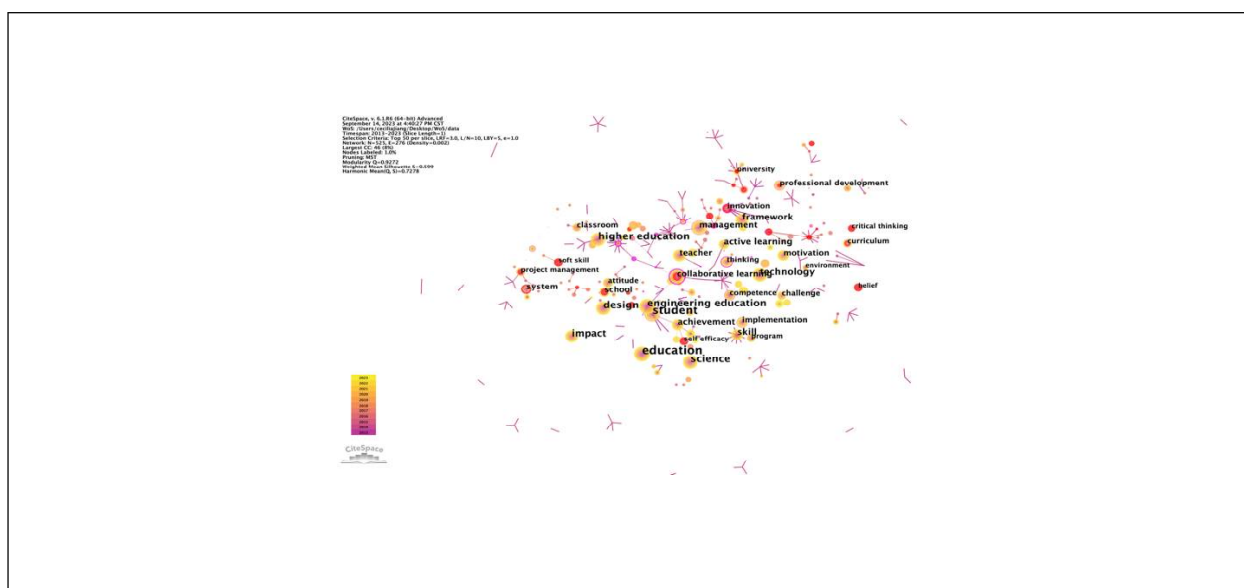


Figure 2: Co-occurrence Network of Keywords in Foreign PBL Research

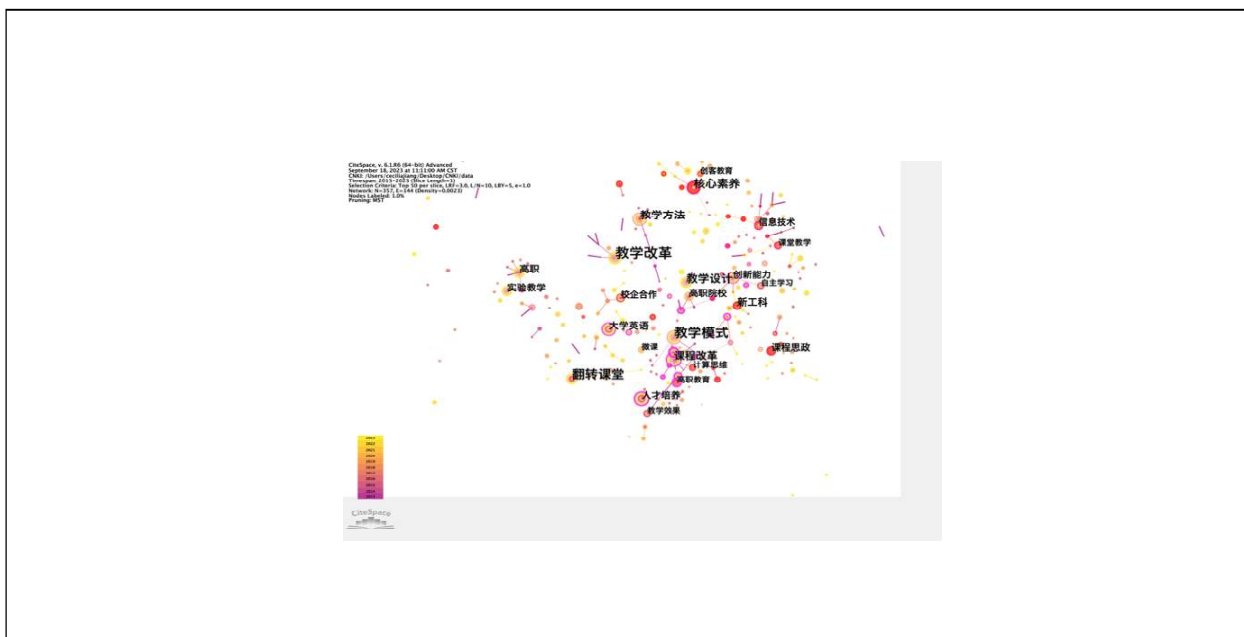


Figure 3: Co-occurrence Network of Keywords in Domestic PBL Research

Table 3: Burt Keywords in Foreign PBL Research

Top 10 Keywords with the Strongest Citation Bursts					
Keywords	Year	Strength	Begin	End	2013 - 2023
upper-division undergraduate	2014	4.99	2015	2018	
instruction	2014	4.98	2015	2018	
laboratory instruction	2016	5.78	2016	2018	
school	2016	4.62	2017	2020	
innovation	2013	7.03	2018	2020	
belief	2018	6.98	2018	2020	
outcm	2018	4.55	2018	2020	
university	2014	5.03	2019	2020	
critical thinking	2014	6.63	2021	2023	
soft skill	2017	4.62	2021	2023	

Table 4: Burt Keywords in Domestic PBL Research

Top 10 Keywords with the Strongest Citation Bursts					
Keywords	Year	Strength	Begin	End	2013 - 2023
教学方法	2013	8.62	2014	2016	
项目教学	2013	7.79	2014	2017	
翻转课堂	2014	16.79	2017	2019	
软件工程	2017	5.37	2017	2019	
新工科	2018	8.32	2019	2023	
深度学习	2019	7.28	2019	2023	
核心素养	2017	19.4	2020	2023	
计算思维	2014	6.6	2020	2023	
人工智能	2020	5.92	2020	2023	
课程思政	2020	16.6	2021	2023	

For example, within the context of algebra and geometry learning at middle schools, research examines the impact of Project-Based Learning (PBL) on the academic achievement and intrinsic motivation of public school students. Additionally, the study investigates whether the effectiveness of PBL is influenced by students' racial backgrounds (Holmes and Hwang, 2016). In addition to academic achievement, there is research exploring the enduring impacts of PBL on students, including career aspirations (Beier et al., 2019) and other non-academic factors that support sustainable education (Khandakar et al., 2020). Studies in teacher education are investigating how to improve teacher training for better implementation of PBL in their teaching (Lopera et al., 2022). Furthermore, intervention studies suggest that the implementation of PBL can enhance teachers' self-efficacy (Choi et al., 2019). In recent years, foreign research on project-based learning has focused heavily on the use of technology and tools, such as artificial intelligence (Wamba-Taguimdje et al., 2020), augmented reality (Masood and Egger, 2020), media (Orús et al., 2016), and social networks (Popescu, 2014). The interest lies in how these tools promote the development of project-based learning from various perspectives.

3.2.2. Domestic Literature Keyword Analysis

By combining the data from Figure 3 and Table 4, one can perceive that PBL research in China has been significantly impacted by educational reforms in the past decade. PBL has become a crucial area of research amidst the ongoing educational reforms, increased subject practices, and amplified focus on core competency development in China. The areas of research in PBL within the country are varied and cover an in-depth analysis of PBL theory, specific case studies, the use of information technology, innovative PBL practices, and ways to enhance PBL by means of school-enterprise collaboration for an optimal learning environment.

For instance, research has focused on defining PBL in traditional education, its significance, and its methods of implementation across China (Hu, 2017). Furthermore, Xiao (2020) has identified a popular research topic regarding the design of PBL in specific subject areas. In China, there is a growing interest in implementing PBL in ideological and political education courses, which has become a research focus. The term "Ideological and Political Education Courses" has recently emerged as a keyword for research from 2021 to 2023. The language used conveys objectivity, clarity, and precision, adhering to conventional academic structure and formal

register. Relevant studies have utilized techniques such as surveys and interviews to obtain insights into the implementation of PBL in ideological and political education courses at high school level, along with the associated challenges encountered (Hou, 2021).

Furthermore, the flipped classroom is a form of teaching that diverges from conventional models and converts the classroom into a forum for interactive discussions between teachers and students, utilizing technological information. Over the past ten years, this technique has drawn a lot of research attention. Additionally, there has been significant interest in how pairing PBL with the flipped classroom can provide novel educational prospects. Previous research has investigated certain techniques used in English courses at universities via methods like interviews. These studies aim to tackle typical challenges encountered in flipped classrooms, such as insufficient self-directed learning drive in students (Hu and Chen, 2019).

4. Improvements for Further Research

Project-based learning is a significant approach for modernizing education and fostering the fundamental skills of pupils. The notion originated in the United States and has undergone a development period of around 70 years, leading to a mature collection of correlated research. Despite China's introduction of project-based learning in the 1980s and the subsequent widespread recognition of its importance by both government and scholars, a comprehensive review of current domestic research indicates that certain key areas still receive insufficient attention from scholars within the country. In comparison to international research efforts in this field, there remain several avenues for further exploration of project-based learning within China.

4.1. Integration of Project-Based Learning with Teacher Education

Many studies in foreign research have utilized project-based learning as a foundation to delve deeply into topics related to teacher training, teacher cognition, and professional development. Several of these studies have shown that project-based learning is highly effective in teacher education (Alrajeh, 2021; Goldstein, 2016), producing positive impacts on pre-service teachers' emotional motivation and career development (Tsybulsky and Muchnik-Rozanov, 2023). The Faculty of Science and Education at Technion-Israel Institute of Technology (Tsybulsky *et al.*, 2020) conducted a comprehensive annual study. It included interviews and textual analysis that examined the quality of experience and content for student teachers involved in project-based education. The results provide valuable insights for teacher development and education. Additionally, Grossman *et al.* (2019) have explored strategies to cultivate proficient teachers in project-based instruction through the observation of videos from four essential aspects of project-based learning.

Nevertheless, in China over the last decade, the combination of teacher education and project-based learning has garnered scarce attention. A group of scholars, led by Li (2023) from Beijing Normal University, conducted research based on Kolb's experiential learning theory. The study aimed to develop "project-based learning teacher trainers" with specialized competencies and training skills, and proposed specific course designs and classroom activities for this purpose. While this study offers initial guidance for the development of trainers, additional empirical research and specific operational suggestions are required.

Teachers have a crucial role in project-based learning, and their importance cannot be overstated. It is essential that teachers not only have expertise in their subject matter, but also comprehend the concepts and practical skills related to project-based learning in order to guide their students towards deep learning and comprehensive tasks. Therefore, the future development of education should concentrate on incorporating project-based learning into teacher education in a seamless manner. This integration will enhance teacher professional competence and cultivate students with greater creativity and comprehensive abilities. It will equip them to tackle complex problems and challenges, ultimately improving the quality of education and promoting innovation in educational models.

4.2. Enhancing Multidimensional Assessment of Student Abilities

The evaluation of learning outcomes in project-based learning has emerged as a crucial area of investigation across various foreign settings, as indicated in Chapter Three of this paper. International scholars have been devoted to developing more comprehensive and multidimensional assessment strategies that can effectively capture students' complete performance in project-based learning. Foreign research places increasing emphasis on evaluating the development of students' "soft skills" through project-based learning, beyond the pursuit of academic success alone. These proficiencies include critical thinking, problem-solving, communication,

collaboration, and innovation, which play significant roles both in the students' future careers and their social engagement.

In China, despite some studies exploring the effects of project-based learning, research in this domain is still fairly scarce and predominantly cent red on the academic achievements of students (Zhang and Hu, 2019). Although the term "core competencies" has emerged in domestic project-based learning research since 2020, a detailed review of relevant literature indicates that numerous studies primarily focus on designing a specific project-based learning to enhance core competencies (Li, 2023; Xu, 2023; Fu, 2019). However, there is limited empirical research on students' core competencies and other comprehensive abilities. Therefore, comprehensive empirical assessments should be conducted before conducting specific studies to establish the link between project-based learning and students' core competencies. This will allow for more focused research into the practical application of project-based learning.

4.3. Expanding the Disciplinary Applications of Project-Based Learning

When investigating the disciplinary applications of project-based learning in China, it is evident that limits exist presently. This paper notes that in recent years, the scope of disciplines that employ project-based learning in China has progressively broadened. Compared to researchers such as Li (2016) and Zhang and Su (2018), who investigated project-based learning both nationally and internationally, subjective evaluations will be avoided. Technical term abbreviations will be explained and a logical structure with causal connections between statements will be maintained. Consistency in footnotes and citations as well as accuracy in grammar, spelling, and punctuation will be ensured. The language used in this paper will be formal, free from colloquial words, emotional expressions, and informal phrases. Precision in vocabulary will be prioritized, avoiding bias in phrasing, and retaining objective neutrality. Project-based learning has already been integrated into various core subjects in primary and secondary education. Moreover, research across disciplines beyond language and technology-related fields has been progressively expanding in higher and vocational education. These fields encompass psychology (Hou and Wu, 2022) and medicine (Xu et al., 2022), among others.

5. Conclusion

A review of the current landscape reveals that research on project-based learning in disciplines other than foreign languages and technical subjects is somewhat limited in China. Additionally, the scope of research in these areas tends to be narrow, with limited interdisciplinary applications.

In certain disciplinary domains within China, there is some conceptual ambiguity regarding project-based and problem-based learning models. This lack of clarity could potentially lead to inaccurate or incomplete research conclusions. Thus, further research is needed to better understand the effects and characteristics of project-based learning in various domains. This direction represents an area for future in-depth research.

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