INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 15, Issue 01, (2025) E-ISSN: 2222-6990

A Review of Project-Based Learning and Design Education

Qin Zhang[1], Muhamad Firdaus Ramli[1*]

[1]Faculty of Art, Sustainability and Creative Industry, Sultan Idris Education University, Malaysia, [2]Department of Fine Arts and Process, Yuncheng University, China

Email: [1]zhangqin@ycu.edu.cn

Corresponding Author Email: firdaus.ramli@fskik.upsi.edu.my

To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v15-i1/24502 DOI:10.6007/IJARBSS/v15-i1/24502

Published Date: 26 January 2025

Abstract

This study examines the application and effectiveness of Project-Based Learning (PBL) in design education, addressing its role in bridging the gap between theoretical knowledge and industry demands. While China's design education system is highly centralised and integrates traditional cultural elements, it faces challenges in fostering creativity, interdisciplinary collaboration, and industry readiness. A review of recent studies highlights PBL's effectiveness in enhancing critical thinking, problem-solving, and teamwork, while also facilitating industry collaboration and technological integration. However, challenges such as scalability issues, lack of standardised assessment frameworks, and cultural adaptation persist. Findings suggest that structured PBL models, aligned with both traditional cultural values and global design trends, can improve pedagogical outcomes. Strengthening academia-industry collaboration and refining assessment criteria are crucial to maximising PBL's impact. Finally, PBL offers a transformative approach to design education, equipping students with the necessary skills for an evolving job market, but its successful implementation requires addressing structural and pedagogical challenges.

Keywords: Project-Based Learning, Design Education, Literature Review

Introduction

Design education plays a crucial role in preparing students to navigate the increasingly complex and dynamic demands of global industries. It is an essential area of study. As design professions evolve to encompass cultural, technological and economic, education must adapt to equip students with the necessary skills, creativity and cultural awareness. In China, this topic holds particular significance due to the nation's dual emphasis on preserving its rich cultural heritage and fostering innovation to compete in global markets. By exploring the integration of Project-Based Learning (PBL) into design education, this study seeks to address critical gaps in traditional teaching methodologies while enhancing students' readiness for interdisciplinary and real-world challenges. The findings will not only benefit educators and policymakers by offering insights into effective pedagogical strategies but also empower

students by cultivating their critical thinking, collaboration, and problem-solving skills. Finally, this study contributes to advancing both educational practices and professional competencies. It aligns them with China's broader goals of cultural preservation and global competitiveness.

In this review, China is selected as the context for design education. To begin, design education in China has undergone significant evolution under the influence of cultural, educational and industrial factors. It results in a curriculum structure that diverges considerably from global practices. A distinctive characteristic of Chinese design education is its highly centralised system. It is governed by the Ministry of Education. While this structure ensures uniformity and standardisation across institutions, it also limits flexibility in adapting to local industry needs or accommodating individual student interests (Liu et al., 2024). Another defining feature is the strong emphasis on integrating traditional cultural elements into the curriculum. Courses frequently incorporate studies on national costume culture and intangible cultural heritage, such as Ruichang paper-cutting. It aims to preserve and innovate traditional arts within contemporary fashion design (Zhang et al., 2021). While other countries also integrate cultural elements into design education, the Chinese approach places a stronger emphasis on the preservation of national heritage rather than solely focusing on contemporary global trends.

Despite these strengths, Chinese design education faces notable challenges in fostering collaboration between academic institutions and garment enterprises. Limited industry partnerships contribute to a gap between theoretical knowledge and practical application. These affect graduates' industry readiness. However, initiatives are underway to address these gaps through enhanced cooperation and experiential learning opportunities (Zhou, 2013). Recent reforms in Chinese design education have also emphasised entrepreneurship. They integrate business-oriented training into the fashion design curriculum. It seeks to align education with industry needs by combining design principles with entrepreneurial competencies. Thereby, it could better prepare students for an increasingly competitive job market (Yu et al., 2019). While similar initiatives exist internationally, the execution in China differs significantly in approach and integration.

In terms of pedagogy, design education in China is transitioning towards more innovative teaching methods to enhance creativity and aesthetic appreciation. Techniques such as heuristic learning, game-based teaching and experimental methodologies are being adopted to move beyond traditional rote-learning approaches (Lu, 2018). Additionally, the curriculum reflects a dual influence of local culture and globalisation. It strikes a balance between maintaining traditional Chinese elements and aligning with international fashion trends (Yang & Guerrini, 2020). This dual perspective enables students to appreciate their cultural roots while acquiring skills to compete in an increasingly globalised fashion industry.

Following that, project-based learning (henceforth, PBL) has emerged as an innovative teaching methodology in Chinese tertiary education. It offers substantial benefits in fostering essential skills and enhancing the overall educational experience. As China modernises its educational system to align more closely with global standards, PBL is increasingly being adopted to address the limitations of traditional teaching methods. However, its implementation in China faces unique cultural, technological and pedagogical challenges that

require thoughtful and strategic approaches for optimisation. PBL has proven highly effective in developing critical thinking, problem-solving, and teamwork skills among Chinese university students. By encouraging the application of theoretical knowledge to real-world challenges, PBL bridges the gap between academic learning and practical skills. Furthermore, it fosters interdisciplinary knowledge, enhances students' self-efficacy, and prepares them for complex professional environments (Shi & Li, 2024). The hands-on and interactive nature of PBL also significantly boosts student engagement and motivation. For example, a reformed project-based engineering course at a Chinese university demonstrated increased student satisfaction and participation, showcasing PBL's ability to create more dynamic and interactive learning environments (Ren et al., 2023).

Additionally, PBL promotes collaboration to cultivate social and communication skills essential for professional success. Group projects and shared problem-solving tasks encourage teamwork. Hence, PBL is valuable in technical and engineering disciplines (Shi & Li, 2024). Innovative assessment systems, such as the Comprehensive Ability Assessment Radar Map have also been introduced in some Chinese universities to evaluate a wide range of skills, including practical knowledge, motivation and teamwork. They offer a holistic view of student performance (Cao et al., 2022). However, the successful implementation of PBL in Chinese tertiary education depends heavily on effective instructional design. Many educators lack adequate training in PBL methodologies. It highlights the need for professional development programmes to equip teachers with the necessary skills (Chen et al., 2019).

Next, technological integration, such as the use of e-learning platforms and computer-assisted teaching tools, enhances PBL but also presents challenges in terms of design and resource allocation. Selecting and optimising appropriate digital tools is crucial to supporting both teachers and students effectively (Meng et al., 2023). Moreover, feedback and assessment are critical for the success of PBL, yet ensuring timely, objective, and high-quality feedback remains a challenge. Developing standardised feedback systems could address these issues and improve learning outcomes (Cao et al., 2022). Cultural adaptation poses another significant challenge, as Chinese students often struggle with the self-directed and participatory nature of PBL due to traditional norms that emphasise passive learning. Group dynamics and communication styles further complicate its adoption, but supportive measures such as structured group work and clear communication strategies can help students adapt more effectively (Jiang et al., 2021).

In addition, PBL has been successfully applied in various disciplines in China. It demonstrates its versatility and effectiveness. For example, at Tianjin University of Technology and Education, PBL has been integrated into engineering education to align with industry demands, significantly enhancing students' practical problem-solving skills and bridging the gap between academia and industry (Li, 2015). In a college mechanics course, PBL has been used to integrate interdisciplinary knowledge, making the learning process more engaging and stimulating students' interest in science and technology (Guo & Tang, 2021). Similarly, in English language teacher training, PBL has been employed to develop intercultural communication skills and deepen students' understanding of home-country cultural knowledge, demonstrating its potential in language and cultural education (Zhang et al., 2024).

In short, the implementation of PBL in Chinese tertiary education has shown significant potential to enhance skill development, increase student engagement and improve the practical application of knowledge. Despite these advantages, its adoption faces challenges related to instructional design, technological integration, feedback quality, and cultural adaptation. Addressing these issues through targeted strategies will allow PBL to better meet the educational needs of Chinese university students and align with global educational standards, ultimately equipping graduates with the skills and competencies needed for modern professional environments. Thus, this study aims to answer research questions:

i) What are the key studies on PBL and design education conducted over the past five years?
ii) What is the research purpose?
iii) What insights can be drawn from existing research regarding the application and effectiveness of PBL in this context?

Literature Review

Social constructivism is a foundational component of contemporary educational learning theory. It posits that knowledge is constructed collaboratively through social interaction. It highlights the interplay between individual cognition and broader social processes. It asserts that understanding emerges within cultural, historical and social contexts. Grounded in the work of influential thinkers such as Vygotsky, Piaget and Bruner, social constructivism challenges traditional didactic teaching models by advocating for collaborative, interactive and student-centered methodologies (Palincsar, 1998). Although the theory has profoundly influenced pedagogical practices, it also presents notable limitations and critical challenges.

At its core, social constructivism emphasises that learning is inherently a social process. Vygotsky's concept of the Zone of Proximal Development (henceforth, ZPD) illustrates the importance of social interaction in advancing cognitive development. Through guided participation, students' progress from their current understanding to higher levels of competence, facilitated by peers, educators or cultural tools (Muniyappan & Sivakumar, 2018). Similarly, Bruner's notion of scaffolding highlights the role of structured support in helping students construct knowledge collaboratively (Lenkauskaitė et al., 2020). Communication serves as both a tool for cognitive development and a medium for social engagement, enabling the co-construction of knowledge.

Also, social constructivism has significantly influenced classroom dynamics by promoting active, student-centered learning environments. This theory emphasises collaborative problem-solving, dialogue and knowledge co-creation. They have been shown to enhance academic performance, critical thinking and interpersonal skills (Adams, 2006). Furthermore, social constructivism aligns with advancements in digital technologies and e-learning to enable students to engage in co-constructive practices across geographical and cultural boundaries. This has led to the emergence of e-social constructivism. It adapts traditional theories to virtual environments (Salmons, 2009).

Despite its contributions, social constructivism has faced criticisms. A key critique concerns its overemphasis on social contexts. Some argues undermine the role of individual agency and intrinsic motivation. Critics suggest that not all students thrive in collaborative

settings, with some feeling overshadowed in diverse or hierarchically structured groups (Hodson & Hodson, 1998). Moreover, implementing social constructivism often requires highly skilled facilitators and significant time investment. It could create barriers in resource-constrained settings. Additionally, the epistemological underpinnings of social constructivism have been contested because privileging socially constructed truths risks diluting objective knowledge standards (Young & Collin, 2004).

PBL and social constructivism share a synergistic relationship rooted in active, collaborative and contextualised learning experiences. Social constructivism posits that knowledge is co-constructed through social interaction and cultural mediation to form the theoretical foundation for PBL. PBL operationalises social constructivism by engaging students in real-world projects that require collaboration, problem-solving and critical thinking (Jumaat et al., 2017).

In addition, PBL reflects social constructivist principles by centering students in the educational process and fostering hands-on engagement. Vygotsky's ZPD aligns closely with PBL because students navigate scaffolded tasks beyond their current competencies through peer collaboration and teacher facilitation (Rahman et al., 2018). Furthermore, PBL encourages "learning by doing," a hallmark of social constructivism to require students to design, execute and present projects that address authentic challenges (Admawati et al., 2018). This approach enhances academic outcomes, critical thinking, and interdisciplinary knowledge application.

However, implementing PBL also presents challenges. Variability in group dynamics can lead to unequal participation, undermining collaboration (Miller et al., 2021). Additionally, PBL's success depends heavily on teacher preparation and support. It can be difficult in resource-constrained settings (Rahman et al., 2018). Another challenge is aligning PBL's contextualised learning outcomes with standardised assessments to creating tensions between experiential learning and traditional evaluation methods (Saleem et al., 2021).

Methodology

This study aimed to conduct a review of empirical studies on PBL and design education. To ensure the selection of relevant literature, a systematic search strategy was employed. Initially, broad keyword searches using "project-based learning" and "design education" were conducted on Google Scholar. It yielded approximately 15,600 publications. Given the impracticality of analysing such a vast number of studies, a refined search was performed. It limited the results to publications from 2021 onward. This adjustment reduced the number of studies to 6,990. It remained excessive for detailed analysis.

To enhance feasibility and ensure the inclusion of high-quality academic sources, the search was refined using the Scopus database. This yielded 58 publications. When restricted to studies published from 2021 onward, it was reduced to 55. Further refinement was applied by limiting the search to the social sciences subject area, article-type documents, English-language publications and studies explicitly containing "design education" and "project-based learning" as keywords. This final stage of filtering resulted in 12 highly relevant documents. The final Scopus search query was structured as follows: TITLE-ABS-KEY ("project-based learning" AND "design education") AND PUBYEAR > 2020 AND PUBYEAR < 2026 AND (LIMIT-

TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (EXACTKEYWORD , "Design Education") OR LIMIT-TO (EXACTKEYWORD , "Project Based Learning")) AND (LIMIT-TO (LANGUAGE , "English")). To provide a clear overview of the review methodology, a flowchart illustrating the selection process is included below.

Figure 1 Methodology Flowchart

Findings

The findings are presented in alignment with the three research questions in this study.

Research Question One

In order to present the findings, a table is attached below with elaboration.

Table 1
Relevant Past Studies

No	Author	Year	Title	Journal	Citation
1	McLain	2022	Towards a signature pedagogy for design and technology education: a literature review	International Journal of Technology and Design Education	21
2	Georgiev & Nanjappan	2023	Sustainability Considerations in Digital Fabrication Design Education	Sustainability (Switzerland)	9
3	Spruce	2021	Reflections on a project-based approach to work-related learning in spatial design	International Journal of Design Education	1
4	Kumar	2021	Educational chatbots for project-based learning: investigating learning	International Journal of Educational Technology in Higher Education	78

			outcomes for a team-based design course		
5	Indriati et al.	2024	Enhancing Authentic Assessment in Large-Class Design Education Through Authentic Project-Based Learning	International Journal of Learning, Teaching and Educational Research	0
6	Kuzmina K et al.	2023	Educating for complexity in Inclusive Design: From products to service systems	Art, Design and Communication in Higher Education	1
7	Kee & Lai	2024	Learning motivation and psychological empowerment of socioeconomically disadvantaged learners–an empirical study on inclusive project-based learning during Covid-19	International Journal of Inclusive Education	1
8	Lande	2024	Learning Through Product-Based Learning with Emphasis of People, Process, and Product Across Multi-Disciplinary Courses	International Journal of Engineering Education	0
9	Parmentier et al.	2021	A framework to design for meaning: insights on use, practicality and added value within a project-based learning context	International Journal of Technology and Design Education	7
10	Chan & Nagatomo	2022	Study of STEM for sustainability in design education: Framework for student learning and outcomes with design for a disaster project	Sustainability (Switzerland)	18
11	Liang	2021	Current State of Art Design Education in Colleges and a New Hybrid Learning Mode	International Journal of Emerging Technologies in Learning	3
12	Zhang et al.	2022	Correlation between the composition of personalities and project success in project-based learning among design students	International Journal of Technology and Design Education	7

The reviewed past studies indicate a growing research interest in PBL within design education across various disciplines, including technology, sustainability, engineering and inclusive education. Recent studies from 2024 continue to explore innovative applications of PBL, such as enhancing authentic assessment in large-class design education (Indriati et al., 2024) and integrating product-based learning across multidisciplinary courses (Lande, 2024).

The research on PBL in design education has focused on several key areas. Pedagogical development has been explored by McLain (2022), who examines the establishment of a signature pedagogy for design and technology education. Sustainability and digital fabrication have also been linked to PBL (Georgiev & Nanjappan, 2023; Chan & Nagatomo, 2022). They examine sustainability-driven approaches in design education. Work-related learning and authentic learning environments have been addressed (Spruce, 2021). It investigated spatial design education, while Indriati et al. (2024) emphasised the role of authentic PBL assessment. Technology integration in PBL has been examined by Kumar (2021). He investigated the use of educational chatbots in team-based design courses. Additionally, the influence of personality traits on learning success has been explored by Zhang et al. (2022). They analysed how students' personality compositions impact project success in PBL settings.

The impact of these studies varies in terms of citation rates, which range from 0 to 78 citations. Kumar (2021) has the highest citation count (78). It suggests significant influence due to its technological focus on chatbots in PBL. McLain (2022) and Chan and Nagatomo (2022) have also garnered substantial citations (21 and 18, respectively). It indicates their impact on pedagogical frameworks and sustainability-driven PBL. However, recent studies from 2024 have not yet accumulated citations, likely due to their recent publication.

Despite the increasing body of research, several challenges and gaps remain in PBL research for design education. Limited research on large-scale implementation is evident because most studies focus on specific case studies rather than the broader integration of PBL into curricula. Variability across disciplines also poses a challenge. While PBL research spans engineering, design, and sustainability, there is a noticeable gap in its application within fashion and fine arts education. Assessment and learning outcomes remain underdeveloped, despite efforts such as Indriati et al. (2024) exploring authentic assessment. Standardised frameworks for evaluating PBL effectiveness are still lacking. In conclusion, studies from 2021 to 2024 demonstrate an increasing integration of PBL with technology, sustainability, and interdisciplinary learning. However, research gaps persist in scaling PBL beyond small studies, developing standardised assessment frameworks, and expanding research into underrepresented design disciplines. These findings offer valuable insights into the evolution of PBL in design education and highlight areas for further research and curriculum innovation.

Research Question Two

In order to present the findings, a table is attached below with elaboration.

Table 2
Research Purpose

No	Author	Year	Research Purpose
1	McLain	2022	Reviewed literature exploring the concept of signature pedagogies
2	Georgiev & Nanjappan	2023	Refined the sustainability indicators in the context of digital fabrication design education and identified educational interventions for improving sustainability
3	Spruce	2021	Developed students' ability to transfer core design skills taught in their studio classes into diverse real-world scenarios
4	Kumar	2021	Investigated how integrating educational chatbots to facilitate team-based projects for a design course could influence learning outcomes.
5	Indriati et al.	2024	Examined how fusion of blended and authentic project-based learning by integrating online and face-to-face instruction can improve student engagement, critical thinking, creativity, and proposes an effective assessment system for large-class design education
6	Kuzmina K et al.	2023	Described how a Service Design workshop was introduced into an ongoing inclusive design project
7	Kee & Lai	2024	Examined the relationship between the learning outcomes of inclusive project-based learning and its impact on young learners' psychological empowerment, learning motivation and sense of alienation
8	Lande	2024	Described a concept of ''product''-based learning – learning experiences that focus on the deliberate design and making of tangible products with some engineering complexity as the learning goal of a course
9	Parmentier et al.	2021	Designed a framework to support the designer in explicitly considering affordances and applying product semantics during product design
10	Chan & Nagatomo	2022	Articulated the framework for design education by investigating problem-based and project-based learning and the double-diamond diagram for innovation
11	Liang	2021	Carried out a survey on the current state of art design education in colleges
12	Zhang et al.	2022	Student personalities were studied based on students' response to the personality assessments, Myers-Briggs Type Indicator and the four-type communication model

Research on PBL in design education has increasingly focused on theoretical advancements, real-world applications, technological integration, inclusivity, cognitive aspects and assessment models. Several studies emphasised conceptual and pedagogical developments in PBL. They explored signature pedagogies, problem-based learning frameworks and assessment models. McLain (2022) conducted a literature review on signature pedagogies to provide insights into structured PBL. Chan and Nagatomo (2022) proposed a framework for design education that integrates problem-based and PBL. They

incorporated the double-diamond diagram to enhance creativity. Similarly, Parmentier et al. (2021) developed a framework for designers to explicitly consider affordances and product semantics to contribute to cognitive aspects of design education.

Beyond theoretical frameworks, many studies examined the application of PBL to real-world design and problem-solving. Spruce (2021) investigated students' ability to transfer core design skills into professional practice. Indriati et al. (2024) explored blended and authentic PBL approaches to enhance student engagement, critical thinking and creativity. Lande (2024) introduced product-based learning. It emphasised hands-on and material-focused education as an alternative to conventional design instruction.

Next, technology integration in PBL has also been a key focus in recent research, with studies examining how digital tools can enhance learning outcomes. Kumar (2021) investigated the use of educational chatbots in facilitating team-based design projects, highlighting their potential to improve collaboration and efficiency. Georgiev and Nanjappan (2023) examined the role of sustainability and digital fabrication in design education. They showcased how emerging technologies can support environmentally conscious design practices.

In addition, inclusivity and student-centred learning approaches have also been explored within PBL frameworks. Kee and Lai (2024) studied inclusive PBL and its effects on psychological empowerment and learning motivation to emphasise the importance of equitable learning environments. Kuzmina et al. (2023) introduced Service Design workshops to promote inclusive project learning, demonstrating how structured PBL approaches can accommodate diverse learning needs.

Cognitive and behavioural aspects of PBL have also received scholarly attention, particularly in relation to student engagement and personality traits. Zhang et al. (2022) examined the influence of student personality types on learning engagement in PBL environments. They contributed to a deeper understanding of individual learning experiences and their impact on project success. Moreover, assessment of PBL in design education has been addressed at a macro level, with studies evaluating the broader implementation of PBL methodologies. Liang (2021) conducted a survey on the state of design education in colleges to assess how PBL is integrated into curricula and identifying areas for improvement. The studies reviewed from 2021 to 2024 indicate an increasing focus on pedagogical innovation, real-world applications, technological integration, inclusivity and cognitive research in PBL for design education. However, research gaps remain in scaling PBL models beyond small case studies, refining assessment frameworks and exploring interdisciplinary applications. Addressing these gaps will enable a more effective and inclusive integration of PBL methodologies in design education.

Research Question Three

In order to present the findings, a table is attached below with elaboration.

Table 3
Research Findings

No	Author	Year	Research Findings
1	McLain	2022	The conclusions propose a discursive framework for design and technology education in which the structures are tied together by the three fundamental activities of ideating, realising and critiquing; more commonly thought of as designing, making and evaluating. The deep structure being project-based learning, undergirded by the implicit values and attitudes associated with design thinking; including collaboration, creativity, empathy, iteration and problem solving.
2	Georgiev & Nanjappan	2023	The sustainability considerations in the prototyping process and outcomes in the design education context in FabLab are exemplified.
3	Spruce	2021	The key areas of learning resulting from the projects being; (1) dealing with ambiguity (2) transferring design skills across contexts, and (3) recognizing the needs of others.
4	Kumar	2021	Educational chatboxs were found to improve learning performance and teamwork with a practical impact. Moreover, it was found that educational chatboxs facilitated collaboration among team members that indirectly influenced their ability to perform as a team. Nevertheless, affective-motivational learning outcomes such as perception of learning, need for cognition, motivation, and creative self-efficacy were not influenced by educational chatboxs.
5	Indriati et al.	2024	the research indicates a notable impact of blended and authentic learning on assessment outcomes. The study, presented within the ANABLE (Assessment strategy iN Authentic Blended Learning Environment) framework, emphasizes the enhancements in assessment practices. These improvements enable educators to track learning progress, identify areas needing enhancement, and gauge proficiency levels.
6	Kuzmina K et al.	2023	The participants' self-reported experiences were captured throughout and results show the workshop's impact in five key aspects: re-framing the problem-solution space; encouraging a new design logic; challenging a heuristic approach to designing by systematizing the process; shifting views on disability from individual to structural and systemic levels; its effectiveness for student learning.
7	Kee & Lai	2024	Quantitative research results demonstrate that participatory PBL can contribute to inclusive education and empower the socioeconomic disadvantaged community in the process.
8	Lande	2024	develop and describe three dimensions for considering the pedagogical intent of such courses along axes of people-

			focused, product-focused, and process-focused in their efforts to give students practice as engineers and engage in industry and partner projects.
9	Parmentier et al.	2021	Both the results of the design projects and the results of the survey suggest that it is feasible and valuable to use a framework to design for meaning. The results also suggest the value to integrate these theories in education programs, especially when a framework is offered that makes it directly usable in project-based learning. The framework invites the students to consider affordances more in depth and offers pathways to alter them when needed. It is a framework because it offers triggers, insights and potential pathways without imposing a method, still leaving flexibility to the designer to decide what is interesting, relevant or mandatory
10	Chan & Nagatomo	2022	Moreover, the study found that evaluation is one of the most critical phases of the design to manifest dynamic interaction between divergence and convergence. Subsequently, this study investigated how the Framework for Innovation could enhance students' design-thinking feedback loops in their design process. The questionnaire results and comparison with other classes suggest positive feedback of students' performance after employing framework to the Innovation Design (I) of the Department of Design, NTNU.
11	Liang	2021	The results show that, the proposed learning mode can effectively enhance teaching quality, and improve the core literacy and professional ability of students.
12	Zhang et al.	2022	Results also show that group compositions that have members with leadership qualities (the Rational temperament and the Director communication style) are more likely achieve success.

First of all, recent studies highlighted structured pedagogical approaches in PBL for design education. They emphasised the role of creativity, iterative design thinking and structured evaluation. McLain (2022) identified **ideating, realising and critiquing** as fundamental activities underpinning PBL. It advocated for creativity and iterative design processes. Parmentier et al. (2021) proposed a framework for **meaning-making** They highlighted the flexibility of affordance considerations in design education. Chan and Nagatomo (2022) underscored **evaluation** as a critical design phase. They reinforced the necessity of structured feedback loops within PBL methodologies.

Beyond theoretical advancements, PBL has been widely applied in real-world and inclusive learning contexts. It could enhance practical skill acquisition and foster social responsibility. Spruce (2021) demonstrated that PBL strengthens students' abilities to **handle ambiguity and recognise user needs**. It prepared them for dynamic professional environments. Indriati et al. (2024) introduced the **ANABLE framework**. It proved that blended learning models improve student engagement and enhance assessment quality. Kee and Lai (2024) showed that **participatory PBL empowers disadvantaged communities**. It aligned design education with broader social responsibility principles.

Additionally, technological integration within PBL has shown both benefits and limitations. Kumar (2021) explored the use of **educational chatbots**. He found that while they enhance teamwork, they fail to significantly improve intrinsic motivation. Georgiev and Nanjappan (2023) integrated **sustainability in digital fabrication** to demonstrate how PBL can foster environmental consciousness in design education.

Moreover, PBL also plays a critical role in shaping personal and cognitive development in leadership, teamwork and cognitive flexibility. Zhang et al. (2022) emphasised the **importance of leadership traits** in successful group collaboration. Kuzmina et al. (2023) highlighted that PBL enhances **systematic design thinking**. It could provide students with structured approaches to complex problem-solving. Lande (2024) categorised **PBL experiences into people-focused, product-focused and process-focused dimensions**. They offered a nuanced understanding of how different PBL approaches influence learning outcomes.

In addition, the effectiveness of PBL in improving **industry readiness and technical competence** has also been a key focus in recent research. Liang (2021) confirmed that PBL significantly enhances **professional literacy**. It equiped students with essential workplace skills. Lande (2024) argued for **stronger industry-academic collaborations** to ensure that PBL methodologies aligned with market demands and professional expectations.

Despite these advancements, several challenges remain in the implementation and optimisation of PBL. **Scalability issues** persist. While blended models improve scalability, personalised learning in large classes remains difficult to achieve. **Technology over-reliance** poses another concern. AI tools improve logistical aspects of education but fail to fully engage students on an emotional level. **Industry alignment** remains a critical gap. Hence, it requires further research to bridge the divide between academic PBL models and real-world industry expectations. **Team dynamics** studies have highlighted the importance of leadership. However, optimal role distribution within PBL projects remains underexplored. Additionally, **assessment frameworks** for PBL remain inconsistent with no widely adopted standard for evaluating its effectiveness.

In conclusion, the reviewed studies collectively support PBL's efficacy in fostering **creativity, collaboration, inclusivity and industry preparedness** in design education. However, further research is required to refine **scalability, industry relevance and assessment strategies**. Addressing these gaps will ensure that PBL continues to evolve as a robust and effective approach to design education, equipping students with the skills and competencies needed for modern professional environments.

Discussion

The adoption PBL in design education has garnered increasing research interest. Recent studies advocated structured pedagogical approaches that emphasise creativity, iterative design thinking and evaluation (McLain, 2022; Parmentier et al., 2021). PBL has been widely recognised for its ability to bridge theoretical knowledge with practical applications. It equips students with problem-solving skills, adaptability and professional competencies. However, its effectiveness is contingent upon pedagogical structuring, integration with industry and technological mediation.

One of the primary advantages of PBL is its experiential and inquiry-based approach. It fosters student engagement and enhances real-world problem-solving capabilities. Studies have highlighted its role in developing creativity (McLain, 2022) and meaning-making in design processes (Parmentier et al., 2021). Additionally, Indriati et al. (2024) emphasised that PBL improves student engagement and assessment quality in blended learning environments. This aligns with broader educational trends that advocate for active and student-centred learning (Fields et al., 2021).

Furthermore, PBL promotes inclusive and socially responsible education. Research by Kee and Lai (2024) underscored its role in empowering disadvantaged communities. It aligned with socioeconomic inclusivity goals. This supports findings by Spruce (2021) suggested that PBL strengthens students' ability to navigate ambiguity and address user needs in dynamic professional settings. However, while PBL enhances practical skill acquisition, its effectiveness depends on curricular alignment and institutional support (Sukackė et al., 2022).

Technological integration in PBL presents both advantages and limitations. Kumar (2021) explored educational chatbots as facilitative tools in PBL. It demonstrated that while they enhance teamwork, they do not significantly impact intrinsic motivation. This aligns with findings from Georgiev and Nanjappan (2023) who integrated sustainability-driven digital fabrication into PBL models. Although technology can enhance engagement, it cannot fully replace the human-centred interactions essential to PBL's collaborative nature (Borthwick et al., 2022). Moreover, over-reliance on technology without appropriate pedagogical scaffolding can hinder deeper cognitive engagement (Al-khresheh, 2024).

Another major advantage of PBL is its role in cognitive development, leadership and teamwork. Zhang et al. (2022) highlighted the importance of leadership-oriented group compositions. They demonstrated how team dynamics influence project success. Similarly, Kuzmina et al. (2023) argued that PBL enhances systematic design thinking. They allowed students to approach complex problems with structured methodologies. Lande (2024) further categorised PBL experiences into people-focused, product-focused and process-focused dimensions. They offered a nuanced understanding of its impact on learning outcomes. These findings are corroborated by Wang et al. (2024). He asserted that collaborative PBL models stimulate metacognitive growth.

Despite these benefits, several challenges remain. Scalability is a persistent issue. While blended models improve accessibility, personalised learning in large-class PBL settings remains difficult (Indriati et al., 2024). Additionally, standardised assessment frameworks are lacking. It is difficult to quantify PBL's effectiveness across different institutions and disciplines (Maros et al., 2023). Furthermore, while PBL aligns well with engineering and sustainability education, its integration into fashion and fine arts education remains underexplored. Finally, industry alignment remains inconsistent, with a disconnect between academic PBL models and professional expectations (Lande, 2024). This highlights the need for stronger academia-industry collaborations to ensure that PBL methodologies remain relevant and applicable to real-world contexts.

While the literature overwhelmingly supports PBL as an effective pedagogical tool, its success heavily depends on institutional support, industry relevance and adaptable

frameworks. PBL offers a more engaging and skill-oriented learning experience compared to traditional lecture-based instruction. Yet, its implementation is often fragmented. Many institutions struggle with scalability and assessment standardisation. It hinders its widespread adoption.

Moreover, technological advancements, while beneficial, should be supplementary rather than central to PBL. Studies show that human interaction, peer collaboration and reflective learning remain core to PBL's efficacy (Hussein, 2021). Future research should focus on refining PBL assessment methods, optimising team compositions and exploring interdisciplinary applications beyond STEM disciplines. In conclusion, PBL remains a highly valuable but complex pedagogical approach. While it fosters creativity, collaboration, and industry readiness, challenges related to institutional implementation, assessment inconsistencies and scalability concerns must be addressed. Future research should bridge these gaps, ensuring that PBL continues to evolve as a sustainable and adaptable model in design education.

Conclusion

This review has critically examined the application and effectiveness of PBL in design education. The findings indicated that PBL has gained increasing recognition as an effective pedagogical approach. It fosters creativity, interdisciplinary learning and industry alignment. Studies highlight its potential to bridge the gap between theoretical knowledge and practical skills. Also, it enhances student engagement, problem-solving abilities and professional competencies. However, despite these advantages, challenges related to scalability, technological integration and the absence of standardised assessment frameworks persist.

Next, pedagogical advancements in PBL have been widely explored, with McLain (2022) emphasising structured creativity through iterative design thinking and Parmentier et al. (2021) advocating flexible affordance considerations. These frameworks contribute to a structured approach to design education to enable students to engage with complex problem-solving processes more effectively. PBL's real-world applications have also been extensively studied. It demonstrates its impact on both practical skill acquisition and inclusive education. Spruce (2021) found that PBL strengthens students' ability to navigate ambiguity and address user needs, while Kee and Lai (2024) highlighted how participatory PBL can empower socioeconomically disadvantaged communities. These findings reinforce the argument that PBL enhances both technical and social competencies, making it an equitable and skill-driven educational approach.

Moreover, technological integration in PBL presents both opportunities and challenges. While educational chatbots (Kumar, 2021) and sustainability-focused digital fabrication (Georgiev & Nanjappan, 2023) have demonstrated potential benefits. An over-reliance on technology without structured human interaction remains a limitation. These studies suggest that technology should supplement rather than replace human-centered learning experiences. Additionally, PBL plays a critical role in shaping leadership, teamwork and cognitive flexibility. Research by Zhang et al. (2022) underscored the importance of leadership traits in group dynamics, while Kuzmina et al. (2023) found that PBL enhances systematic design thinking, equipping students with structured problem-solving methodologies. Lande (2024) further categorised PBL experiences into people-focused,

product-focused and process-focused dimensions. It offered a nuanced understanding of how PBL influences learning outcomes.

Subsequently, PBL's role in industry readiness has also been widely recognised. Liang (2021) confirmed that PBL significantly enhances professional literacy. It prepared students for real-world work environments. However, Lande (2024) argued for stronger academia-industry collaborations to highlight inconsistencies between academic PBL models and professional market demands. These findings reinforce the need for greater industry integration to ensure PBL graduates possess relevant professional skills. The findings of this review hold significant implications for design education. To ensure PBL aligns with national policies while maintaining flexibility for industry-driven learning, universities, industries and policymakers must collaborate to create scalable PBL models that balance theoretical knowledge and real-world experience.

Furthermore, the increasing integration of technology in PBL requires careful implementation. While digital tools can enhance learning efficiency, they should not replace essential elements of collaborative and hands-on learning. A balanced approach, combining digital tools with human interaction, will be crucial for PBL's long-term success. Finally, the lack of standardised assessment frameworks remains a major challenge in PBL implementation. Current evaluation methods vary across institutions. Thus, it is difficult to measure learning outcomes consistently. Future efforts should focus on developing holistic assessment criteria that reflect both technical competencies and cognitive skills to ensure PBL remains an effective and scalable educational model.

Despite significant advancements in PBL research, several gaps remain. Future studies should focus on scaling PBL for large-class instruction because current research primarily examines small-scale implementations. There are limiting insights into how PBL can be adapted for large university settings. Bridging the academia-industry gap is another priority because stronger partnerships between universities and industries are needed to ensure that PBL curricula align with real-world professional demands. Additionally, while PBL has been extensively studied in engineering and sustainability education, its application in fashion design and fine arts remains underexplored. Refining assessment frameworks is also necessary because the lack of standardised evaluation methods remains a significant barrier to measuring PBL effectiveness. Furthermore, while short-term benefits of PBL have been demonstrated, more longitudinal studies are needed to understand its impact on career success and lifelong learning.

Overall, PBL represents a transformative approach to design education. It offers a dynamic, interdisciplinary and student-centered learning experience. It has demonstrated significant potential in fostering creativity, collaboration and industry readiness. However, challenges related to scalability, technological balance and assessment frameworks must be addressed. Moving forward, continued research and policy-driven innovations will be essential to ensuring PBL remains a robust and adaptable model in contemporary design education. By refining teaching methodologies, fostering industry collaborations and developing standardised assessment strategies, PBL can continue to equip students with the critical skills needed to navigate the evolving demands of the design industry.

References

Adams, P. (2006). Exploring social constructivism: Theories and practicalities. *Education 3-13*, *34*(3), 243-257. https://doi.org/10.1080/03004270600898893

Admawati, H., Jumadi, J., & Nursyahidah, F. (2018). The effect of STEM project-based learning on students' scientific attitude based on social constructivism theory. *Proceedings of the Mathematics, Informatics, Science, and Education International Conference (MISEIC 2018)*. https://doi.org/10.2991/miseic-18.2018.65

Al-khresheh, M. H. (2024). Bridging technology and pedagogy from a global lens: Teachers' perspectives on integrating ChatGPT in English language teaching. *Computers and Education: Artificial Intelligence*, *6*, 100218. https://doi.org/10.1016/j.caeai.2024.100218

Borthwick, M., Tomitsch, M., & Gaughwin, M. (2022). From human-centred to life-centred design: Considering environmental and ethical concerns in the design of interactive products. *Journal of Responsible Technology*, *10*, 100032. https://doi.org/10.1016/j.jrt.2022.100032

Cao, Y., Case, J., Wu, J., & Liang, B. (2022). Investigating student and faculty perceptions of a new assessment system for project-based learning. *2022 ASEE Annual Conference & Exposition Proceedings*. https://doi.org/10.18260/1-2--41072

Chan, M., & Nagatomo, D. (2022). Study of STEM for sustainability in design education: Framework for student learning and outcomes with design for a disaster project. *Sustainability*, *14*(1), 312. https://doi.org/10.3390/su14010312

Chen, J., Kolmos, A., Guerra, A., & Zhou, C. (2019). Aalborg UNESCO Certificate: Staff Development and Challenges in PBL Training Programme. *Journal of Engineering Education Transformations*, *33*(1), 13-21.

Fields, L., Trostian, B., Moroney, T., & Dean, B. A. (2021). Active learning pedagogy transformation: A whole-of-school approach to person-centred teaching and nursing graduates. *Nurse Education in Practice*, *53*, 103051. https://doi.org/10.1016/j.nepr.2021.103051

Georgiev, G. V., & Nanjappan, V. (2023). Sustainability considerations in digital fabrication design education. *Sustainability*, *15*(2), 1519. https://doi.org/10.3390/su15021519

Guo, C., & Tang, Y. (2021). A case study of thoroughly integrated STEM PBL course of mechanics. *Journal of Physics: Conference Series*, *1732*(1), 012142. https://doi.org/10.1088/1742-6596/1732/1/012142

Hodson, D., & Hodson, J. (1998). From constructivism to social constructivism: A Vygotskian perspective on teaching and learning science. *School science review*, *79*(289), 33-41.

Hussein, B. (2021). Addressing collaboration challenges in project-based learning: The student's perspective. *Education Sciences*, *11*(8), 434. https://doi.org/10.3390/educsci11080434

Indriati, L., Mai, N., & Tan, H. Y. (2024). Enhancing authentic assessment in large-class design education through authentic project-based learning. *International Journal of Learning, Teaching and Educational Research*, *23*(9), 432-452. https://doi.org/10.26803/ijlter.23.9.22

Jiang, D., Dahl, B., & Bøgelund, P. (2021). Adaptability to Problem-based Learning at Aalborg University: Experience from four first-year Chinese engineering graduate students. In *Educate for the future: PBL, Sustainability and Digitalisation 2021* (pp. 131-140). Aalborg Universitetsforlag.

Jumaat, N. F., Tasir, Z., Halim, N. D., & Ashari, Z. M. (2017). Project-based learning from constructivism point of view. *Advanced Science Letters*, *23*(8), 7904-7906. https://doi.org/10.1166/asl.2017.9605

Kee, T., & Lai, A. (2024). Learning motivation and psychological empowerment of socioeconomically disadvantaged learners – an empirical study on inclusive project-based learning during COVID-19. *International Journal of Inclusive Education*, *28*(11), 2438-2457. https://doi.org/10.1080/13603116.2022.2112771

Kumar, J. A. (2021). Educational chatbots for project-based learning: Investigating learning outcomes for a team-based design course. *International Journal of Educational Technology in Higher Education*, *18*(1), 65. https://doi.org/10.1186/s41239-021-00302-w

Kuzmina, K., Branco, R. M., Trigueiros, P., & Burrows, A. (2023). Educating for complexity in inclusive design: From products to service systems. *Art, Design & Communication in Higher Education*, *22*(2), 241-261. https://doi.org/10.1386/adch_00076_1

Lande, M. (2024). Learning through product-based learning with emphasis of people, process, and product across multi-disciplinary courses. International Journal of Engineering Education, 40(6), 1499–1506.

Lenkauskaitė, J., Colomer, J., & Bubnys, R. (2020). Students' social construction of knowledge through cooperative learning. *Sustainability*, *12*(22), 9606. https://doi.org/10.3390/su12229606

Li, L. (2015). Project-based learning in electronic technology: A case study. *European Journal of Engineering Education*, *40*(5), 499-505.

Liang, J. (2021). Current state of art design education in colleges and a new hybrid learning mode. *International Journal of Emerging Technologies in Learning (iJET)*, *16*(17), 120-133. https://doi.org/10.3991/ijet.v16i17.25651

Liu, C., Asipova, N., Lu, B., & Wu, W. (2024). Comparative study on curriculum design of art education between China and Kyrgyzstan. *Scientific Herald of Uzhhorod University Series Physics*, (55), 2969-2977. https://doi.org/10.54919/physics/55.2024.296ks9

Lu, B. J. (2018). Analysis of effect of fashion design teaching method reform from a modern aesthetic perspective. *Kuram ve Uygulamada Egitim Bilimleri*, *18*(5), 1584-1590. https://doi.org/10.12738/estp.2018.5.056

Maros, M., Korenkova, M., Fila, M., Levicky, M., & Schoberova, M. (2023). Project-based learning and its effectiveness: Evidence from Slovakia. *Interactive Learning Environments*, *31*(7), 4147-4155. https://doi.org/10.1080/10494820.2021.1954036

McLain, M. (2022). Towards a signature pedagogy for design and technology education: A literature review. *International Journal of Technology and Design Education*, *32*(3), 1629-1648. https://doi.org/10.1007/s10798-021-09667-5

Meng, N., Dong, Y., Roehrs, D., & Luan, L. (2023). Tackle implementation challenges in project-based learning: A survey study of PBL E-lEarning platforms. *Educational technology research and development*, *71*(3), 1179-1207. https://doi.org/10.1007/s11423-023-10202-7

Miller, E. C., Severance, S., & Krajcik, J. (2021). Motivating teaching, sustaining change in practice: Design principles for teacher learning in project-based learning contexts. *Journal of Science Teacher Education*, *32*(7), 757-779. https://doi.org/10.1080/1046560x.2020.1864099

Muniyappan, D., & Sivakumar, P. (2018). Social constructivism perspectives on teaching learning process. *Paripex-Indian Journal of Research*, *7*(2).

Palincsar, A. S. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology*, *49*(1), 345-375. https://doi.org/10.1146/annurev.psych.49.1.345

Parmentier, D. D., Van Acker, B. B., Saldien, J., & Detand, J. (2021). A framework to design for meaning: Insights on use, practicality and added value within a project-based learning context. *International Journal of Technology and Design Education*, *31*(4), 815-838. https://doi.org/10.1007/s10798-020-09575-0

Rahman, A. A., Mohd Zaid, N., Abdullah, Z., Mohamed, H., & Aris, B. (2018). Social constructivism learning through project based learning with scaffolding in flipped classroom. *2018 International Conference on Learning and Teaching in Computing and Engineering (LaTICE)*, 50-56. https://doi.org/10.1109/latice.2018.00017

Ren, Y., Jiang, Y., & Tang, X. (2023). What drives undergraduate engineering students to engage in project based learning: A case of curriculum reform in a Chinese University. *2023 IEEE Frontiers in Education Conference (FIE)*, 1-5. https://doi.org/10.1109/fie58773.2023.10342911

Salmons, J. (2009). E-social constructivism and collaborative E-learning. *Handbook of Research on Electronic Collaboration and Organizational Synergy*, 280-294. https://doi.org/10.4018/978-1-60566-106-3.ch019

Shi, Y., & Li, W. (2024). Empowering education: Unraveling the factors and paths to enhance project-based learning among Chinese college students. *Sage Open*, *14*(3). https://doi.org/10.1177/21582440241276600

Spruce, J. (2021). Reflections on a project-based approach to work-related learning in spatial design. *The International Journal of Design Education*, *15*(1), 101-117. https://doi.org/10.18848/2325-128x/cgp/v15i01/101-117

Sukackė, V., Guerra, A. O., Ellinger, D., Carlos, V., Petronienė, S., Gaižiūnienė, L., Blanch, S., Marbà-Tallada, A., & Brose, A. (2022). Towards active evidence-based learning in engineering education: A systematic literature review of PBL, PjBL, and CBL. *Sustainability*, *14*(21), 13955. https://doi.org/10.3390/su142113955

Wang, C., Gao, B., & Chen, S. (2023). The effects of metacognitive scaffolding of project-based learning environments on students' metacognitive ability and computational thinking. *Education and Information Technologies*, *29*(5), 5485-5508. https://doi.org/10.1007/s10639-023-12022-x

Yang, Y., & Guerrini, L. (2020). Environmental (Art) design VS interior and spatial design: A dialogue between Chinese and Italian design disciplines. *E3S Web of Conferences*, *179*, 01008. https://doi.org/10.1051/e3sconf/202017901008

Young, R. A., & Collin, A. (2004). Introduction: Constructivism and social constructionism in the career field. *Journal of Vocational Behavior*, *64*(3), 373-388. https://doi.org/10.1016/j.jvb.2003.12.005

Yu, S., Yuizono, T., & Kim, E. (2019). Integrating entrepreneurship education into design education: Toward an Embeddedness model based on design thinking. *DS 95: Proceedings of the 21st International Conference on Engineering and Product Design Education (E&PDE 2019), University of Strathclyde, Glasgow. 12th -13th September 2019*. https://doi.org/10.35199/epde2019.63

Zhang, C., Hu, X., & Shi, M. (2021). Innovation in teaching model based on university museum resources: Taking the course of study on Chinese ethnic costume decoration as an example. In *International Conference on Human-Computer Interaction* (pp. 148-159). Springer International Publishing.

Zhang, D., Wu, J. G., & Fu, Z. (2024). Improving pre-service English teachers' native cultural knowledge and English language knowledge of native culture in a PBL classroom. *Innovation in Language Learning and Teaching*, 1-15. https://doi.org/10.1080/17501229.2024.2318568

Zhang, W., Yang, A. C., Huang, L., Leung, D. Y., & Lau, N. (2022). Correlation between the composition of personalities and project success in project-based learning among design students. *International Journal of Technology and Design Education*, *32*(5), 2873-2895. https://doi.org/10.1007/s10798-021-09716-z

Zhou, H. (2013). Teaching reform of dress designing. *Lecture Notes in Electrical Engineering*, 699-707. https://doi.org/10.1007/978-1-4471-4811-1_89