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Exploring the AI-Enhanced Project-Based Learning for English Language Acquisition: A Systematic Review of the Key Elements and Emerging Technology Trends

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Abstract. Numerous studies substantiate the positive impact of integrating state-of-the-art technology into project-based learning (PBL) in English language acquisition. Technology like artificial intelligence (AI) within language learning contexts has shown that integrating emerging technology into English language learning effectively aids in language mastery. However, there is a lack of research that explicitly underscores the cutting-edge technology trends and fundamental components involved in the synergy of AI and PBL in English learning. Thus, this study aims to elucidate the disruptive technology trends and key elements contributing to the synergy of AI and PBL in English learning. Guided by the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) framework, this systematic review identified 12 articles published between 2020 and 2024 in journals and conferences from prominent databases, encompassing Eric, IEEE, Science Direct, Scopus, Web of Science and Google Scholar. This systematic review identifies seven critical elements facilitating the integration of AI and PBL in the English learning setting, including real-time feedback and objective assessment, personalized and adaptive learning, real-world context language learning, 24/7 AI-powered language assistant, scaffolding project design, collaborative learning, intelligent content generation and customization. Those findings reveal that the AI-enhanced PBL framework can foster language proficiency, learners' motivation and engagement and the cultivation of transferable skills.

Keywords: AI-Enhanced PBL; English language acquisition; key elements; technology trends, transferable skills

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1. Introduction

PBL has long been acknowledged as an effective teaching approach that motivates students to actively participate in real-world problem-solving activities (Almulla, 2020; Duke et al. 2021). Initially, PBL was leveraged to foster students' comprehension through active learning assignments, in contrast with rote memorization and passive learning (Heilala et al., 2023; Stefanou et al., 2013). Over the past decades, technology has served as a catalyst in enhancing PBL's impact across multifarious educational domains (Blumenfeld et al., 1991by providing the students with immediate access to online resources and platforms, and virtual simulation tools that facilitate immersive and interactive learning experiences (Al-Abdullatif & Gameil, 2021). With a focus on student-centered and authentic assignments, PBL has evolved to integrate state-of-art technology, encompassing virtual reality simulated learning and encompassing virtual reality (AI) assisted learning. Language learning has significantly benefited from the incorporation of technology into PBL in recent years. Historically, language acquisition relied heavily on exam-oriented teaching strategies, rather than exposure to authentic scenarios (Azamatova et al., 2023). Nevertheless, with the emergence of advanced technology, language learning began utilizing digital tools and online platforms to create a more dynamic and interactive learning environment (Garib, 2023). Those tools facilitated students' interactive language learning and authentic language application by offering them real-world related simulation tasks (Lai & Lee, 2024). In addition to rejuvenating language strategies, technology-enhanced PBL has also shed light on other domains like science, technology, engineering and mathematics, where PBL's impact on fostering collaboration and problem-solving has been reinforced by technology (Asfihana et al., 2022; Heilala et al., 2023).

The integration of AI into language learning has significantly rejuvenated teaching strategies by equipping students with customized learning experiences. AI-powered personalized learning systems allow students access to generated content that is tailored to their proficiency and preferences, thereby promoting motivation and retention (Jia et al., 2022). Moreover, the immersive and dynamic learning environment simulated by the chatbots and language virtual assistants allows students to rehearse real-world dialogues and get instant feedback, enhancing fluency and reducing anxiety (Du & Daniel, 2024; Ericsson & Johansson, 2023). By providing personalized learning experiences and private practice spaces, those AI tools are assumed to alleviate language-speaking anxiety and then enhance confidence and autonomy (Zou & Wang, 2024). Besides that, AI's thorough and detailed feedback systems leveraging speech recognition technology can facilitate students' oral English proficiency including pronunciation, sentence structure and fluency (Wang, 2024). Furthermore, AI-powered chatbots and virtual assistants that integrate human characteristics like humor and empathy can significantly improve learners' motivation and engagement by providing relatable and pleasurable learning experiences (Zhai et al., 2024).

The deployment of AI tools in PBL in promoting language learning symbolizes a groundbreaking innovation in educational technology and approaches,

combining AI's personalized competence with PBL's problem-solving essence. The AI-enhanced PBL facilitates language proficiency and enhances soft skills like problem-solving, collaboration, and critical thinking which are indispensable for future employment (Moundridou et al., 2024). The instructors can scaffold an active learning and real-world language application project design with the AI-enhanced PBL frameworks, hence promoting motivation and autonomy (Purnama et al., 2023). For instance, GPT-enhanced PBL assignments provide students with this real-world conversation simulation and substantial language application practices, facilitating their language proficiency and mitigating anxiety (Kumar, 2021). Moreover, research shows that their engagement and confidence are notably beneficial from AI-enhanced PBL projects that offer them instant and customized feedback (Al-Abdullatif & Gameil, 2021). This strategic combination of AI tools and PBL addresses the long-standing issues in the language acquisition domain, facilitating real-world relevant practices and tailoring them to individual preferences, thereby equipping students with both language proficiency and soft skills needed for the future workforce (Yefymenko et al., 2024; Azamatova et al., 2023).

This study sheds light on the key elements, technology trends, benefits and challenges of AI-enhanced PBL in English language acquisition, contributing to rejuvenating educational pedagogy and practice. As cutting-edge technology like AI is integrated into educational approaches, this study provides instructors and curriculum designers with critical discernment of how AI-enhanced PBL can exert great influence on fostering students' English proficiency, motivation and transferable skills. By synthesizing the findings from a wide range of high-quality literature, this study offers insight into the strategic combination and implementation of PBL and AI in language learning.

However, this study also reveals details about the potential challenges like over-reliance on AI, and insufficient student-teacher interaction (Kot & Nykyporets, 2024; Belda-Medina & Goddard, 2024). Addressing these issues enables the integration of AI into PBL to be effective, and sustainable. Consequently, the significance of this systematic review is to pave the way for future research, reshape educational policies and establish a robust foundation for strategic integration of PBL and AI that can revolutionize language learning. The research objectives for this paper areas follows:

1. What are the key elements of AI-enhanced PBL that most effectively foster English language learning?
2. What emerging AI-related trends and technologies are being utilized in PBL to foster English language learning?
3. What are the reported benefits and challenges of integrating AI into PBL for English language learners?

2. Systematic review method

A systematic review, serving as the cornerstone of contemporary research, provides robust and comprehensive summaries of evidence in specific fields and then facilitates the informed decisions of policymakers and all stakeholders

(Calderon Martinez et al., 2023). This study employs the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) 2020 checklist, encompassing 27 essential items that authors should include when reporting a systematic review or meta-analysis (Salameh et al., 2020; Page et al., 2021). By adhering to this checklist, this study can provide precise, exhaustive and reproducible accounts of their review processes and findings, thereby enhancing the transparency, completeness and reliability of the evidence presented. As shown in Figure 1, the four steps utilized by the researchers are identification, screening, eligibility and inclusion.

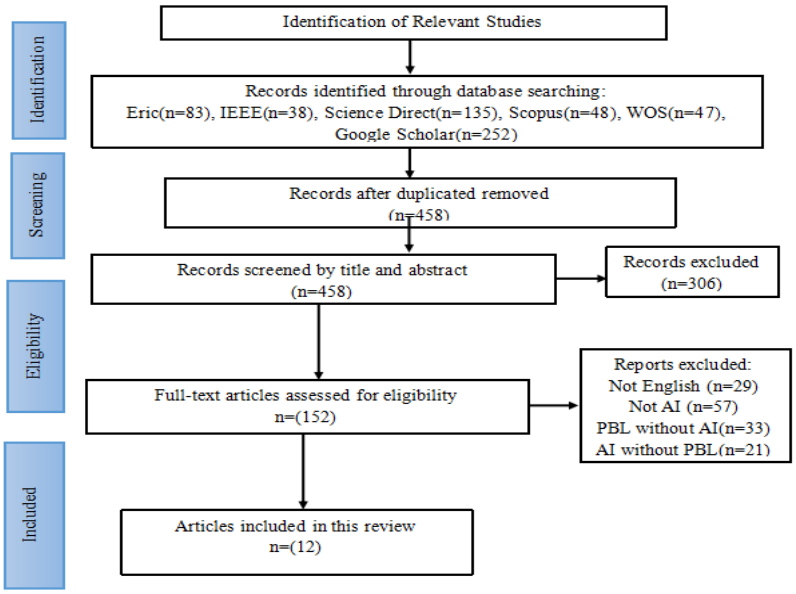

Figure 1: PRISMA Flow Chart for Selecting Process of Articles

2.1. Systematic Review Method

The study used manual data collection, primarily through an Excel spreadsheet, to gather information on the authors, year, research focus, research design, participants, emerging technology integration trends and key elements of PBL and AI integration.

Phase I: Identifying Phase

In this phase, relevant papers collected from six prominent databases are utilized to identify current research materials involving the topic. Six major databases encompassing Eric, IEEE, Science Direct, Scopus, Web of Science and Google Scholar were utilized for the review process. Those databases were selected aligning with their significance in the education field (e.g., Eric and Science Direct) and AI (e.g., IEEE), seeking to ensure the reliability, and comprehensiveness of the review.

The first step of the search is conducted with the Boolean operators as shown in Table 1. Table 1 showcases the Boolean operators used to search relevant papers:

Table 1: Database and Boolean Operators Employed to Search Relevant Articles

Database	Relevant papers in Phase I	Boolean Operators
Eric	83	("Artificial Intelligence" OR "AI" OR "AIALL" OR "Large Language Models" OR "Intelligent Tutoring Systems" OR "Machine Learning" OR "Technology-Enhanced") AND ("Project-Based Learning" OR "PBL") AND ("ESP" OR "EFL" OR "English" OR "Language")
IEEE	38	("Artificial Intelligence" OR "AI" OR "AIALL" OR "Large Language Models" OR "Intelligent Tutoring Systems" OR "Machine Learning" OR "Technology-enhanced") AND ("Project-Based Learning" OR "PBL") AND ("English for Specific Purposes" OR "ESP" OR "English as a Foreign Language" OR "EFL" OR "English" OR "Language")
Science Direct	135	("Artificial Intelligence" OR "Technology-enhanced") AND ("Project-Based Learning" OR "PBL") AND ("ESP" OR "EFL" OR "English" OR "Language")
Scopus	48	("Artificial Intelligence" OR "Technology") AND ("Project-Based Learning" OR "PBL") AND ("English for Specific Purposes" OR "English as a Foreign Language" OR "English" OR "Language")
Web of Science	47	("Artificial Intelligence" OR "Technology-enhanced") AND ("Project-Based Learning" OR "PBL) AND ("ESP" OR "EFL" OR "English" OR "Language")
Google Scholar	252	AI-enhanced Project-based learning in English language acquisition

Phase II: Screening Phase

After 603 papers were gathered and 145 duplicates were eliminated, the authors examined 458 articles that had been searched through the databases mentioned above. Those 458 articles were filtered based on their titles and abstracts, and 306 deemed ineligible were eliminated.

Phase III: Eligibility Phase

After that, the authors independently reviewed the full text of the remaining papers to ensure that they satisfied the inclusion requirements as indicated in Table 2. Among those articles, 29 are in other domains, rather than English language acquisition, 57 integrate other technology into PBL, 33 focus only on PBL without AI-enhanced, and 21 solely concentrate on AI without PBL integrated. As a result, 140 were eliminated from the remaining 152 items after their eligibility was examined.

Table 2: Inclusion and Exclusion Criteria

Category	Inclusion	Exclusion
Relevance to Topic	1. Studies that specifically discuss the integration of AI technology and PBL. 2. Studies that specifically discuss the integration of AI technology and PBL in English learning	1. Studies that do not focus on the integration of AI technology and PBL. 2. Studies that discuss technology or PBL in general without specific reference to English learning
Type of Studies	Peer-reviewed journal articles, conference papers, book chapters, systematic reviews, meta-analyses, and empirical studies, pre-print	Opinion pieces, editorials, letters to the editor
Language	Publications in English	Publications not in English
Publication Date	Studies published between 2020 and 2024	Studies published before 2020
Accessibility	Full-text articles	Abstracts without full-text availability

Phase IV: Inclusion Phase

After assessing the article eligibility, 140 articles were removed because they showed at least one exclusion criterion. Those articles were ineligible because they only focussed on AI technology or PBL or did not address English learning. After examining the exclusion criterion, only 12 articles met the inclusion criterion. Opinion pieces, editorials, letters to the editor and non-peer-reviewed articles were removed according to the exclusion criterion. In addition, studies published before 2020 were excluded. This research primarily placed emphasis on the key elements of AI-enhanced project-based learning in English language acquisition, with all studies focussing on AI-enhanced PBL in English.

4.2 Quality Assessment

In this systematic review, we evaluated the quality of included studies on AI-enhanced PBL in English language acquisition leveraging the PRISMA guidelines to ensure the robustness of the methodology. Each included study was assessed for clear objectives, extensive literature review, reliable data collection and thorough result reporting. Two independent reviewers evaluated the studies to reduce bias, settling disagreements by discussion. The results revealed that the majority of studies aligned with key PRISMA standards, showing robust research objectives and explicit methodologies. However, insufficient participant descriptions and small sample sizes were frequently encountered. While a substantial number of the studies were rated as moderate to high-quality, potential biases in data analysis were noted. Although the current evidence supports AI-enhanced PBL in English language acquisition, this review highlights that more robust methodologies should be leveraged to strengthen the validity and reliability in this emerging field.

5. Results

Concerning the systematic review, there were 12 articles focusing on the AI-enhanced PBL in English language learning from 2020 to 2024. Among them, six studies adopted mixed methods (Belda-Medina & Goddard, 2024; Herget, 2020; Kim, 2024; Kot & Nykyporets, 2024; Song et al., 2022; Wu & Wan, 2022), three studies adopted the qualitative method (Adikhanova et al., 2023, Baskara 2023; Beckett & Pae, 2024), while the remaining three studies utilized quantitative method (Adipat, 2023; Lu, 2021; Mahmoud, 2022). All articles about AI-enhanced PBL were selected for further analysis. In this part, the article contents were extensively analyzed to determine the extent to which they aligned with the three research questions.

Table 3: Research Methodology

1. Adikhanova et al., 2023	Qualitative
2. Adipat, 2023	Quasi-experimental research design/ quantitative
3.Baskara 2023	Argumentative review strategy/ qualitative
4. Beckett & Pae, 2024	Explore theoretical aspects / qualitative
5. Herget, 2020	Case study/ mixed methods
6. Kim, 2024	Questionnaire/ mixed methods
7. Kot & Nykyporets, 2024	Mix methods
8. Lu, 2021	ADDIE/ quantitative
9. Belda-Medina & Goddard, 2024	Mixed methods
10. Mahmoud, 2022	A questionnaire and a pre-test and a post-test/ quantitative
11. Song et al. , 2022	Develop model and questionnaire/ mixed methods
12.Wu & Wan, 2022	Mixed method

5.1 Identification of Research on the Elements of AI-Enhanced PBL in EFL

As for the first research question, seven major key components of AI-enhanced PBL in English language learning are included after reviewing the articles. The results are demonstrated in Table 4, focusing on real-time feedback and objective assessment (n=10), personalized and adaptive learning (n=8), real-world context language learning (n=5), 7/24 AI-powered language assistant (n=4), scaffolding project design (n=4), collaborative learning (n=2), intelligent content generation and customization (n=2).

Table 4: Key Elements of AI-Enhanced PBL in English Language Learning

No.	Key Elements	Authors & Year
	Real-time feedback and objective assessment	Adilkhanova et al. 2023; Adipat, 2023; Baskara 2023; Herget, 2020; Kim, 2024; Kot & Nykyporets, 2024; Lu, 2021; Belda-Medina & Goddard, 2024; Mahmoud, 2022; Song et al. , 2022
	Personalized and adaptive learning	Baskara, 2023; Kim, 2024; Kot & Nykyporets, 2024; Lu, 2021; Belda-Medina & Goddard, 2024; Mahmoud, 2022; Song et al., 2022; Wu & Wan, 2022
	Real-world context language learning	Adipat, 2023; Beckett & Pae, 2024; Herget, 2020; Song et al., 2022; Wu & Wan, 2022
	24/7 AI-powered language assistant	Baskara, 2023; Kim, 2024; Kot & Nykyporets, 2024; Mahmoud, 2022
	Scaffolding project design	Baskara, 2023; Beckett &Pae, 2024; Herget, 2020; Wu & Wan, 2022
	Collaborative learning	Baskara, 2023; Song et al., 2022
	Intelligent content generation and customization	Baskara, 2023; Belda-Medina & Goddard, 2024

5.2 Identification of Emerging Trends and AI Technology Are Being Utilized in PBL to Foster English Language Learning

Concerning the second research question, this study is estimated to identify the emerging AI technology being utilized in PBL to foster English language learning. Table 5 shows the results, with natural language processing (n=6), machine learning algorithm (n=4), AI-driven tools (n=4), and generative AI (n=2) respectively. From analyzing the AI technology being utilized in PBL of all the articles, it can be concluded that AI is constantly evolving and iterative, from early-stage AI technology to advanced generative AI. On top of that, state-of-art AI technology is instantly being integrated into PBL. With the release of more advanced versions of generative AI like ChatGPT, AI's role in fostering language learning will be amplified and pivotal.

Table 5. AI Technology Utilized in AI-enhanced PBL

No	AI technology	Authors&Year
1	NLP	Adilkhanova et al., 2023; Kim, 2024; Kot & Nykyporets, 2024; Lu, 2021; Mahmoud, 2022; Song et al. , 2022
2	ML	Adilkhanova et al., 2023; Herget, 2020; Kim, 2024; Mahmoud, 2022
3	AI-driven tools	Adipat, 2023; Beckett &Pae, 2024; Kot & Nykyporets, 2024; Belda-Medina & Goddard, 2024
4	Generative AI	Baskara, 2023; Kim, 2024

5.3 Identification of Benefits and Challenges of Integrating AI into PBL for English

As for the third research question, this study identified the benefits and challenges of integrating AI into PBL for English language acquisition. As shown in Table 6, three major benefits including language proficiency (n=11), transferable skills acquisition (n=9), motivation and engagement (n=7), positive attitude and AI literacy (n=5), scalability and accessibility (n=1), pedagogy innovation (n=1), were substantiated by all the reviewed articles.

Table 6. Benefits and Challenges of AI-enhanced PBL in English

No.	Benefits	Challenges
1.	Language proficiency (Adilkhanova et al., 2023; Adipat, 2023; Baskara, 2023; Beckett & Pae, 2024; Herget, 2020; Kim, 2024; Kot & Nykyporets, 2024; Lu, 2021; Mahmoud, 2022; Song et al., 2022; Wu & Wan, 2022)	Imbalance AI and PBL integration design (Adipat, 2023; Baskara, 2023; Beckett & Pae, 2024; Belda-Medina & Goddard, 2024; Kim, 2024; Kot & Nykyporets, 2024; Lu, 2021; Mahmoud, 2022; Song et al., 2022; Wu & Wan, 2022)
2.	Transferable skills acquisition (Adilkhanova et al., 2023; Adipat, 2023; Baskara, 2023; Beckett & Pae, 2024; Herget, 2020; Belda-Medina & Goddard, 2024; Mahmoud, 2022; Song et al., 2022; Wu & Wan, 2022)	Participants' limited familiarity with and training on AI tools (Baskara, 2023; Beckett & Pae, 2024; Belda-Medina & Goddard, 2024; Herget, 2020; Kim, 2024; Kot & Nykyporets, 2024; Lu, 2021; Mahmoud, 2022)
3.	Motivation and engagement (Adilkhanova et al., 2023; Adipat, 2023; Baskara, 2023; Kim, 2024; Kot & Nykyporets, 2024; Lu, 2021; Mahmoud, 2022)	Overreliance on AI (Adilkhanova et al., 2023; Baskara, 2023; Belda-Medina & Goddard, 2024; Kim, 2024; Lu, 2021; Mahmoud, 2022)
4.	Positive attitude and AI literacy (Baskara, 2023; Beckett & Pae, 2024; Kim, 2024; Belda-Medina & Goddard, 2024; Mahmoud, 2022)	Inadequate student-teacher interaction (Baskara, 2023; Lu, 2021; 9. Belda-Medina & Goddard, 2024; Song et al., 2022; Wu & Wan, 2022)
5.	Scalability and accessibility (Kot & Nykyporets, 2024)	AI's limitations and bias (Baskara, 2023; Beckett & Pae, 2024; Belda-Medina & Goddard, 2024; Kot & Nykyporets, 2024; Mahmoud, 2022)
6.	Pedagogy innovation (Baskara, 2023)	Access and affordability of AI. (Belda-Medina & Goddard, 2024; Kim, 2024; Kot & Nykyporets, 2024; Song et al., 2022; Wu & Wan, 2022)
7.		Limitations of generalizability (Adilkhanova et al., 2023; Adipat, 2023; Herget, 2020)

In addition, this study also explored the potential challenges. From Table 6, seven major challenges like imbalance in AI and PBL integration design (n=10),

participants' limited familiarity with and training in the use of AI tools (n=8), overreliance on AI (n=6), inadequate student-teacher interaction (n=5), AI's limitations and bias (n=5), access and affordability of AI (n=5), limitations of generalizability (n=3), were identified in all the reviewed articles.

6. Discussion

The finding of this study sheds light on the integration of AI-enhanced PBL in fostering English language acquisition. Addressing the three research questions provides valuable insights into the key elements of AI-enhanced PBL, the emerging technology trends, and the use of AI technology and the identification of benefits and challenges. All articles selected for this review were comprehensively interpreted and analyzed in line with the three research questions.

6.1 Key Elements

Table 1 shows that there are seven key elements of AI-enhanced PBL in English language acquisition. Those elements ranked from the significance are as follows: real-time feedback and objective assessment, personalized and adaptive learning, real-world context language learning, 24/7 AI-powered language assistant, scaffolding project design, collaborative learning, intelligent content generation and customization.

Among these, real-time feedback and objective assessment emerge as the most significant components, rendering learners prompt corrective feedback to modify and refine their language application (Mahmoud, 2022). Personalized and adaptive learning serves as the second key element, improving motivation and engagement by tailoring to individual's preferences and levels (Kim, 2024; Kot & Nykyporets, 2024). Another vital element is real-world context language learning, where AI-enhanced PBL provides learners with opportunities to practice English with real-world scenarios and contextual prompts (Herget, 2020; Lu, 2021). In addition, the 24/7 AI-powered language assistant overhauls traditional language learning by offering learners continuous support and linguistic practice without time and space limits (Song et al., 2022). As another core element, scaffolding project design supports educators wisely designing the project, wisely and allows students access to substantial resources relevant to the project, thereby refining the project as a whole (Beckett & Pae, 2024). Through projects, AI-enhanced PBL also facilitates collaborative learning by promoting interactive and immersive assignments (Kim, 2024). Lastly, intelligent content generation provides customized learning materials catering for different preferences and levels, ensuring adaptive learning to satisfy learners' personalized learning needs (Wu & Wan, 2022; Mahmoud, 2022).

6.2 AI Technologies

AI technologies catalyze transforming PBL frameworks by creating personalized, interactive and immersive language learning environments. Derived from students' data, machine-learning algorithms are leveraged to generate customized content and provide prompt feedback, thereby proactive interventions can be achieved (Kot & Nykyporets, 2024; Song et al., 2022). AI-assisted tools like chatbots and virtual assistants are integrated into the PBL

framework to render real-world simulation dialogues and generate customized language learning materials, which are tailored to diverse learning needs and adapted to individual levels (Kim, 2024; Mahmoud, 2022). Based on contextual feedback, NLP provides guidance and reflection on vocabulary, sentence structure, grammar, and pronunciation, promoting interactive language practice and objective assessment (Adipat, 2023; Herget, 2020). By analyzing sophisticated language patterns, deep learning algorithms are incorporated into the PBL framework to provide personalized feedback and fuel advanced speech recognition (Lu, 2021; Wu & Wan, 2022). The fusion of neural networks assists in generating content, structuring sentences and enhancing pronunciation, facilitating full-spectrum understanding (Lu, 2021). Lastly, ChatGPT features as a virtual assistant in language, offering prompt feedback and generating customized linguistic materials, hence fostering communicative competence in the context of the PBL framework (Kim, 2024).

6.3 Benefits and Challenges

In the context of language acquisition, AI-enhanced PBL provides multifarious benefits, including improved language proficiency, enhanced transferable skills, increased learner engagement and motivation, and technology literacy. AI-enhanced PBL projects provide learners with personalized learning experiences, real-life relevant language practice and prompt feedback, which effectively foster language proficiency (Adipat, 2023). By engaging participants in real-world scenarios, AI-enhanced PBL fostered transferable skills like problem-solving, critical thinking, collaborative learning, and creativity (Belda-Medina & Goddard, 2024). In addition, learners' motivation and engagement are enhanced by actively participating in the interactive AI-enhanced PBL projects (Baskara, 2023). Lastly, learners develop their technology literacy in alignment with the frequently leveraging AI tools to accomplish the assignments (Beckett & Pae, 2024).

In addition, several challenges posed by the AI-enhanced PBL framework, particularly relevant to the imbalance of AI in PBL integration design may hinder effectively integrated AI technologies into the PBL framework to foster language acquisition (Mahmoud, 2022). Furthermore, students and instructors may need to be trained to effectively utilize emerging technology like AI to improve language proficiency (Baskara, 2023; Herget, 2020). Additionally, AI tools integrated into PBL may result in insufficient interaction between students and teachers as students rely more on AI tools (Lu, 2021). Furthermore, AI's limitation in generating inaccurate content and cultural bias, in accordance with restricted access and affordability of AI in underdeveloped areas, may negatively impact AI-enhanced PBL in language learning (Kim, 2024; Kot & Nykyporets, 2024; Song et al., 2022). Lastly, this review is confined to the linguistic domain, potentially restricting the generalizability of AI and PBL integration across broader educational contexts (Adilkhanova et al., 2023; Adipat, 2023; Herget, 2020).

6.4 Comparison of Traditional PBL and AI-enhanced PBL in English Language Acquisition

PBL is recognized as an effective teaching approach to foster problem-solving skills, critical thinking and students' engagement by providing real-world projects. However, AI-enhanced PBL has evolved to addressed the limitations of traditional PBL, while latter one has consistently acknowledged technology as a catalyst for fostering engagement and soft skills (Blumenfeld et al., 1991; Zainuddin, 2023). This study delves into the key differences between the two approaches on seven key elements: real-time feedback and objective assessment, personalized and adaptive learning, real-world context language learning, 24/7 AI-powered language assistant, scaffolding project design, collaborative learning, intelligent content generation and customization.

First, feedback in traditional PBL activities is often delayed, reliant heavily on the teachers' availability, and subject to human bias (Aldabbus, 2018; Somani & Rizvi, 2018). Teachers are unable to provide real-time feedback for each student in traditional PBL, while AI-enhanced PBL leverages the natural language processing and data analysis to render instant feedback, catering for students' individual needs (Baskara, 2023; Kim, 2024). Second, traditional PBL fails to provide personalized and adaptive learning due to instructors' inability to catering to all students' individual needs simultaneously (Arqam & Asrifan, 2024), while AI-enhanced PBL can identify individual's deficiency in pronunciation, grammar and sentence structure accordingly by using speech recognition analysis and NLP-based grammar checker, and tailor the resources aligning with individual's preferences (Belda-Medina & Goddard, 2024; Lu, 2021). Third, the lack of authenticity of the immersive language learning environment provided by traditional PBL also hinders students' language acquisition in realistic scenarios (Somani & Rizvi, 2018), while AI-enhanced PBL can generate authentic conversation and real-time scenarios to bridge the gap (Belda-Medina & Goddard, 2024). Fourth, traditional PBL is limited to the physical classroom, restricting students' access to language practice and support outside the classroom (Arqam & Asrifan, 2024). In contrast, AI-enhanced PBL narrows the divide by offering a 7/24 language virtual assistant, assuring linguistic practice and support without time and space limits by (Kot & Nykyporets, 2024). Fifth, another challenge encountered by traditional PBL is that instructors struggle to provide appropriate project design catering to students' level (Belmekki & Koumachi, 2024), frequently resulting in students being assigned to either too simplistic or excessively complicated project (Aldabbus, 2018). By breaking down the project and providing step-by-step guidance, AI-enhanced PBL offers dynamic project design and personalizes scaffolding to align with an individual's levels and preferences (Herget, 2020; Wu & Wan, 2022). Sixth, collaboration of traditional PBL is often confined due to unequal participation and limited peer interaction (Hamidah & Pinkan, 2022), while AI-enhanced PBL can foster effective and equitable collaboration by monitoring each member's contribution and participation (Song et al., 2022). Lastly, traditional PBL is constrained to ensure students' access to customized ad intelligent content generation tools, limiting the scope of their projects (Zainuddin, 2023), while AI-enhanced PBL offers intelligent content generation, encompassing customized vocabulary lists and scenario prompts tailored to

project requirements, which not only saves time but also enriches the learning experience (Baskara, 2023; Belda-Medina & Goddard, 2024).

To put in a nutshell, traditional PBL has also acknowledged the significant role of technology, highlighting that technology-enhanced PBL can facilitate engagement, collaboration, and real-world application of knowledge (Blumenfeld et al., 1991). With the advent of advanced AI tools, AI-enhanced PBL closes the divide in traditional PBL lack by addressing its limitations through real-time feedback, personalized learning and intelligent content generation. By adhering to traditional PBL principles, AI-enhanced PBL exerts great influence on fostering language proficiency and essential 21st-century skills.

As integrating cutting-edge technology like AI into PBL is becoming essential and a trending topic in the education field, instructors and curriculum designers should undergo sufficient training to effectively incorporate AI into PBL (Baskara, 2023; Herget, 2020) while maintaining the balance between the technology and student-teacher interaction (Lu, 2021; Wu& Wan, 2022). In addition, curriculum designers should prioritize strategies to ensure AI is leveraged as a supportive tool rather than a replacement (Lu, 2021), fostering authentic collaboration and critical thinking.

7. Conclusion

In light of the PRISMA guideline, this research encompassed a thorough analysis of the existing literature, assuring the inclusion of all relevant studies. This approach contributed to a comprehensive perspective on the issues and minimized the risks of bias. In conclusion, AI-enhanced PBL has the potential to significantly transform English language learning by fostering personalized, interactive and collaborative experiences. The key elements including real-time feedback and objective assessment, personalized and adaptive learning, real-world context language learning, 24/7 AI-powered language assistant, scaffolding project design, collaborative learning, intelligent content generation and customization play pivotal roles in supporting language acquisition and transferable skills cultivation. Emerging technologies such as machine learning algorithms, AI tools, natural language processing, deep-learning algorithms, neural network algorithms and generative AI are further enhancing the learning experience. The benefits of AI-enhanced PBL like language proficiency, transferable skills acquisition and motivation have been identified. However, challenges such as AI and PBL integration design, and overreliance on AI need to be addressed to ensure equitable and effective language learning outcomes. Overall, the integration of AI into PBL presents both opportunities and challenges, with careful implementation needed to maximize its benefits for English language learners. This systematic review concentrates solely on the teaching of English, while other domains need to be explored in future research. Finally, more empirical studies pertaining to the effective integration of PBL and AI, and objective assessment of it should be explored in the future.

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