Understanding the Drivers of Project-Based Learning Effectiveness and Implementation in Academic English: Self-Efficacy and Technology as Key Factors

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Abstract

This study aims to examine the factors influencing teachers' willingness to implement Project-Based Learning (PBL) in academic English courses. Specifically, it explores the impact of teachers' familiarity with PBL, their perceived benefits, and institutional support on their perceptions of PBL's effectiveness and their willingness to adopt it. The study also investigates the role of teachers' self-efficacy as a mediator and access to technology as a moderator in these relationships. A quantitative research design was employed, utilizing a survey questionnaire to collect data from academic English course teachers at T University in China. The sample consisted of 250 teachers, selected through purposive sampling. Structural Equation Modeling (SEM) with SmartPLS was used to analyze the data and test the proposed relationships between the variables. The findings revealed that teachers' familiarity with PBL, perceived benefits, and institutional support significantly influenced their perceptions of PBL's effectiveness and their willingness to implement it. Teachers' self-efficacy was found to mediate these relationships, while access to technology moderated the effect of self-efficacy on both perceived effectiveness and willingness to implement PBL. These results highlight the importance of teacher perceptions and institutional support in the successful adoption of PBL. This study contributes to the understanding of the factors that shape teachers' willingness to implement PBL, particularly in the context of academic English courses. By addressing the mediating and moderating roles of self-efficacy and technology, it provides valuable insights for educational institutions aiming to foster innovation in teaching practices.

Keywords: project-based learning, teachers' willingness, self-efficacy, institutional support, access to technology

1. Introduction

In recent years, the landscape of education has witnessed significant changes, particularly in how academic English courses are taught (Hrynyschyn & Dockweiler, 2021). Traditional teaching methods, which often focus on passive learning and teacher-centered approaches, are increasingly being replaced by more interactive and student-centered pedagogies (Lin et al., 2023). PBL emphasizes real-world problem solving, active learning, and critical thinking, making it popular. PBL substitutes passive learning with active, collaborative, and pragmatic learning (Cubric, 2020). Academic English students need strong language, analytical, and communication skills. PBL makes these goals possible. Encouragement to use language in real-world situations promotes learning and retention(Magfirah, 2022). Thus, PBL is an innovative academic English method that improves student engagement, language competency, and globalization preparation (Azmi & Festiyed, 2023). PBL is becoming more popular, although many English teachers struggle with it. PBL success depends on perceived benefits, instructors' familiarity, and institutional supports. These traits strongly influence instructors' PBL acceptance and implementation (Lyu et al., 2020). PBL familiarity may affect a teacher's readiness to implement it. PBL-savvy teachers believe it enhances student learning. If teachers are new with PBL, they may struggle to implement it (Setiyadi, 2023). PBL's benefits student involvement, critical thinking, and collaboration—may influence teachers. Research shows that instructors who understand PBL's benefits are more likely to use it. PBL execution is not determined by the instructor. Administrative approval, professional development, and resource availability are necessary for PBL (Lin et al., 2023). Without institutional support, PBL can be difficult to implement due to time restrictions, limited resources, and student or coworker reluctance.

Instructor self-efficacy the belief that they can teach and reach goals is essential to PBL's success (Jing & Yan, 2022). Self-efficacy inspires, innovates, and holds on teaching despite setbacks. High-self-efficacy teachers are more likely to implement PBL because they are aware that they can overcome setbacks (Brussoni et al., 2021). Nevertheless, low self-efficacy teachers might be cautious of PBL because it is complicated (Hrynyschyn & Dockweiler, 2021). PBL needs technology, particularly in academic English courses, to facilitate collaborative learning, research, and presentation. Technology improves information, collaboration, and communication through PBL. There are some teachers without technical skills (Khoiri et al., 2023). Teachers implement PBL technologies based on their technology and institutional resources. This study investigates how perceived advantages, institutional assistance, and previous PBL experience influence academic English teachers' PBL intentions. Instructor self-efficacy and access to technology influence these

dynamics. Earlier research suggests that teachers' knowledge of and perceptions of the value of PBL motivate them to adopt it, yet the combination is uncertain. Innovative learning depends upon self-efficacy, but more research is required to establish how it influences teachers' attitudes and use of PBL (Samsudin et al., 2020). This research bridges a research gap by investigating how access to technology influences the adoption of PBL. With the increased application of technology in education, knowledge about the effect of technology access on the implementation of PBL is vital in order to execute professional development programs and institutional policies (Achmad et al., 2024). The aims of the current study are to investigate and examine the determinants that affect teachers' intention to apply PBL in pedagogical English courses. Specifically, the study aims to:

1. Investigate the impact of teachers' familiarity with PBL on their perceptions of its effectiveness in academic English courses.
2. Examine how the perceived benefits of PBL influence teachers' intentions to adopt and implement this pedagogical approach in their teaching practices.
3. Assess the role of institutional support in shaping teachers' willingness and ability to implement PBL effectively in academic English courses.
4. Explore the mediating effect of teachers' self-efficacy on the relationship between teachers' familiarity with PBL, perceived benefits, and their willingness to implement PBL.
5. Analyze the moderating role of access to technology in influencing the relationship between teachers' self-efficacy and their perceptions of the effectiveness of PBL as well as their willingness to implement it.

This study investigates the difficult procedures of PBL acceptance and implementation in higher education, focusing on academic English courses. Global demand for innovative pedagogical methodologies, particularly PBL, has changed educational practices (Anggrella & Sudrajat, 2024). Educational attitudes, institutional support, and self-efficacy affect implementation. This study will analyze educators' PBL use, focusing on self-efficacy and technology, to fill gaps in the literature. Fostering supportive environments, managing resources better, and improving professional development programs can help schools implement new pedagogical methods like PBL. This study will help us understand how instructors' self-efficacy affects classroom use and PBL attitudes. This study examines how instructors' self-efficacy affects their PBL endorsement. Technology aids PBL and cooperation, thus it will be investigated (Magfirah, 2022). This study will examine how technology affects instructors' PBL skills, expanding knowledge of pedagogical innovation and technology in education. This research has philosophical and practical benefits. This study examines instructor familiarity, perceived benefits, institutional support, self-efficacy, and technology accessibility to improve PBL research. It will show how schools may help instructors use PBL to improve academic English courses. Education and teaching. Innovative instructional method research and policy in higher education may be affected by the findings.

2. Literature Review

PBL is being used more in academic English programs to improve language, critical thinking, and cooperation. Instructor familiarity greatly affects PBL effectiveness. Practical expertise in course-related initiative conception, implementation, and evaluation outperforms theoretical PBL knowledge (Hossein-Mohand et al., 2021). Since PBL principles are easier to understand, teachers are more likely to adapt activities to their students' requirements, improving educational outcomes. (Azmi & Festiyed, 2023) found that educators who understand PBL approaches can integrate language skills into project work and manage group dynamics, which are crucial in academic English environments. This familiarity gives educators confidence to try new methods. PBL uptake and use by teachers depend on perceived benefits and familiarity. Academic English courses improve conversational skills, while PBL boosts autonomy, motivation, and engagement (Ekanayake et al., 2024). Constructivist PBL supports language acquisition theories by emphasizing active learning through real-world problem solving and meaningful participation. Yuliansyah & Ayu, (2021) discovered that teachers who see their students' educational experience and language skills improve are more likely to employ PBL. Instructor institutional support often determines PBL success. Almulla, (2020) describe institutional support as administrative endorsement, instructional resources, and professional development. PBL in academic English programs may require more organization and resources. Professional development helps instructors create effective PBL activities, while resource allocation solves logistical issues. By creating a supportive environment for PBL, institutions improve its perceived effectiveness and foster a collaborative and imaginative culture among educators (Putro et al., 2024). Institutional policies and instructors' actions impact PBL effectiveness. Instructors' classroom experiences and results impact PBL assessments. Positive student engagement and achievement enhance instructors' confidence (Bi et al., 2021). Self-efficacy the idea that teachers can do their jobs well often impacts effectiveness. Self-efficacy helps instructors with PBL issues including time management and language learning goal alignment. Teacher perceptions and classroom outcomes must align for PBL success. Technology accessibility influences instructors' familiarity, perceived advantages, institutional support, and PBL efficacy. Online research, collaboration platforms, and multimedia presentations aid project planning and execution (Kissi et al., 2020).

H1: Teachers' familiarity with PBL has a positive impact on the perceived effectiveness of PBL in academic English courses.

H2: Perceived benefits of PBL mediate the relationship between institutional support and the perceived effectiveness of PBL.

H3: Access to technology moderates the relationship between teachers' familiarity with PBL and the perceived effectiveness of PBL, such that the relationship is stronger when access to technology is high.

Instructors' enthusiasm for PBL strongly impacts its effectiveness in schools. Teachers' PBL knowledge greatly impacts readiness. Academic and practical knowledge of PBL methodologies involves learning outcome assessment, classroom dynamics management, and project development (Zhong & Lyu, 2022). When educators understand these principles, they feel more confident using PBL strategies, which often require adaptability and innovation. Suhardi et al., (2023) found that familiarity reduces resistance to change and promotes PBL in education. PBL may be more accepted by educators who are confidence in their abilities to implement it, despite curricular inflexibility and time constraints. Instructors' perspectives on PBL's benefits impact their adoption. When they believe they can boost student learning, teachers use instructional strategies. Students learn critical thinking, cooperation, and practical problem-solving through PBL (X. Liu et al., 2020). Educators who appreciate these benefits are more inclined to use PBL when conventional methods fail to engage pupils. Teachers' enthusiasm for PBL is boosted by its alignment with educational goals, particularly interpersonal and communication skills. After successful pilot projects or seminars, educators' readiness to employ PBL increases (F. Liu et al., 2021). Institutional support is vital to teachers' PBL motivation. Educational institutions provide resources, professional growth, and administration encouragement (Pishghadam et al., 2023). When institutions motivate teachers, they are more willing to try new methods. PBL professional development can provide educators the skills and confidence to create great projects. Institutional policies that allocate time and resources for PBL activities show a commitment to innovative educational techniques, which prepares educators to implement them (Dalila et al., 2022). If PBL seems difficult without enough help, teachers may be less likely to use it. Teachers' knowledge, perceived benefits, institutional support, and drive to implement PBL are mediated by self-efficacy. Teachers' confidence in their PBL implementation skills is called self-efficacy (Pirchio et al., 2021). Self-efficacy helps teachers overcome challenges including aligning PBL with curricular standards and meeting various student needs. Studies show that instructors with high self-efficacy are more resilient and adaptable, which are essential for PBL. Previous PBL experience and training boost self-efficacy, underlining the importance of institutional support and familiarity in teacher confidence. Technology availability affects instructors' motivation to use PBL beyond familiarity, perceived benefits, and institutional support. Innovative project presentations, digital resources, and collaborative platforms are needed for PBL (Suhardi et al., 2023). Technologically adept teachers say PBL works. Talented and passionate teachers may struggle without enough technology. These traits motivate educators to implement PBL and improve institutions' technology infrastructure and training (Choi et al., 2024).

H4: Teachers' familiarity with PBL has a positive impact on their willingness to implement PBL.

H5: Perceived benefits of PBL mediate the relationship between institutional support and teachers' willingness to implement PBL.

H6: Access to technology moderates the relationship between institutional support and teachers' willingness to implement PBL, such that the relationship is stronger when access to technology is high.

Teacher self-efficacy in PBL affects academic English course success. Instructor self-efficacy is their confidence in creating, implementing, and managing problem-based learning activities (Shitu et al., 2021). Teachers' familiar with PBL concepts and procedures are more confident in their implementation. PBL skills such classroom administration, project design, and outcome evaluation boost teachers' confidence (Bell, 2010). High self-efficacy increases teachers' likelihood of recognizing PBL as a successful pedagogical technique, especially in academic English classes where collaborative and real-world activities can improve language abilities (Li et al., 2020), educators with high self-efficacy are more likely to use PBL effectively, improving student out. PBL's perceived benefits affect teachers' self-efficacy and efficacy. After learning about PBL's benefits to critical thinking, student engagement, and problem-solving, teachers are more motivated and skilled at implementing it (van Steen & Wilson, 2020). Their self-efficacy increases when they perceive incentives as boosting their PBL achievements. Additionally, educators with higher self-efficacy can better integrate PBL with language learning objectives and handle various student requirements, boosting PBL efficacy (Hrynyschyn & Dockweiler, 2021). In academic English courses, where language acquisition generally requires active and contextualized learning, PBL's perceived benefits and course objectives boost instructors' self-efficacy and effectiveness appraisal. PBL effectiveness and instructor self-efficacy depend on institutional support. Teachers gain confidence in PBL by receiving professional development, motivation, and resources from supportive institutions (Adov & Mäeots, 2021). PBL-focused professional development programs help educators obtain practical experience and overcome problems, boosting self-efficacy. Institutional policies that promote PBL and give resources show a commitment to new pedagogical approaches, motivating and enabling teachers to use it (Alshallaqi et al., 2022).

H7a: Teachers' self-efficacy in implementing PBL mediates the relationship between teachers' familiarity with PBL and the perceived effectiveness of PBL in academic English courses.

H7b: Teachers' self-efficacy in implementing PBL mediates the relationship between perceived benefits of PBL and the perceived effectiveness of PBL in academic English courses.

H7c: Teachers' self-efficacy in implementing PBL mediates the relationship between institutional support for PBL implementation and the perceived effectiveness of PBL in academic English courses.

Instructors' comprehension, perceived advantages, institutional support, and passion for this unique approach depend on self-efficacy. Teacher self-efficacy is PBL planning, coordination, and implementation confidence. This viewpoint requires instructors to study PBL. PBL teachers were more confident and engaged pupils by tying projects to curricular objectives (Odeh & Patanakul, 2024). Research supports this. Self-efficacy inspires PBL in instructors. Instructors' self-efficacy and PBL implementation depend on its advantages. PBL can raise instructors' confidence in delivering student learning objectives including motivation, teamwork, and critical thinking (Chu et al., 2017).

PBL educators see time and preparation as implementation obstacles to sustain self-efficacy (Tolppanen et al., 2021). Teachers need resilience and self-efficacy for PBL. PBL advantages improve teachers' confidence in its implementation. Institutional support boosts teachers' PBL readiness and self-efficacy. According to Nazrul (2024), institutions support PBL with resources, professional growth, and inspiration. PBL-focused professional development helps instructors overcome problems and acquire confidence. Institutional policies that promote PBL, including time and resources for project design and execution, boost teachers' confidence (Park & Song, 2023). This institutional support boosts self-efficacy and shows a commitment to innovation, increasing the likelihood that instructors will use PBL. Teacher PBL preparation depends on self-efficacy and institutional support. Self-efficacy mediates internal outcomes like PBL preparation with external effects like familiarity, perceived benefits, and institutional support. PBL adoption is far more enthusiastic and confident in teachers with high self-efficacy (Hallford et al., 2022). The feedback loop of excellent execution from this preparedness boosts self-efficacy. This cycle emphasizes the importance of self-efficacy in PBL, as it is both an outcome and a catalyst for effective instructional practices. Addressing self-efficacy characteristics can help stakeholders create a PBL-ready environment for instructors, improving educational outcomes.

H8a: Teachers' self-efficacy in implementing PBL mediates the relationship between teachers' familiarity with PBL and their willingness to implement PBL.

H8b: Teachers' self-efficacy in implementing PBL mediates the relationship between perceived benefits of PBL and teachers' willingness to implement PBL.

H8c: Teachers' self-efficacy in implementing PBL mediates the relationship between institutional support for PBL implementation and teachers' willingness to implement PBL.

Technology accessibility affects English instructors' academic achievement, PBL self-efficacy, and readiness to utilize this approach. PBL is enabled by apps and platforms' resource accessibility, collaboration, and innovation (Lam et al., 2020). Technology helps confident educators create and administer PBL programs. Access to technology influences self-efficacy. Online collaborative tools, multimedia assets, and virtual learning environments help teachers comfortably use PBL (Abdallah et al., 2024). Self-efficacy may be difficult for even the finest instructors without technology. Technological access ties PBL to academic English course goals, improving its perceived value. Technology is used for real-time language practice, content generation, and online assessments in academic English (van Lier, 2004). Technology simplifies PBL, so instructors use it more. This access helps instructors engage students and produce appealing projects, improving PBL outcomes and teacher perspectives. Without enough technology, teachers may struggle to embrace PBL, lowering motivation and preparedness (Zhong & Lyu, 2022). Technology helps instructors manage complicated classroom dynamics and overcome obstacles, boosting their self-efficacy and PBL preparation. Self-efficacy helps PBL teachers use technology to improve student performance, cooperation, and communication (Mei et al., 2020). Technical support and training enhance confidence. Flexibility and accessibility enable educators integrate self-efficacy into successful teaching methods throughout PBL preparation. Lack of technological availability may lower instructors' confidence, causing a gap between their PBL expertise and willingness. This shows how technology helps introduce new teaching methods. A comprehensive education technology integration plan includes self-efficacy, perceived effectiveness, technical accessibility, and PBL. To use academic knowledge practically, technology is needed. Nwosu et al., (2024) found that educators with the tools and support for PBL are more likely to implement it. Success and PBL preparation follow. Technological help boosts self-efficacy and effectiveness. To fully exploit PBL's potential and encourage its widespread adoption, technological accessibility must be solved.

H9a: Access to technology moderates the relationship between teachers' self-efficacy in implementing PBL and the perceived effectiveness of PBL in academic English courses, such that the relationship is stronger when access to technology is high.

H9b: Access to technology moderates the relationship between teachers' self-efficacy in implementing PBL and teachers' willingness to implement PBL, such that the relationship is stronger when access to technology is high.

Thus, based on above literature, the following conceptual framework is developed which is shown in Figure 1.

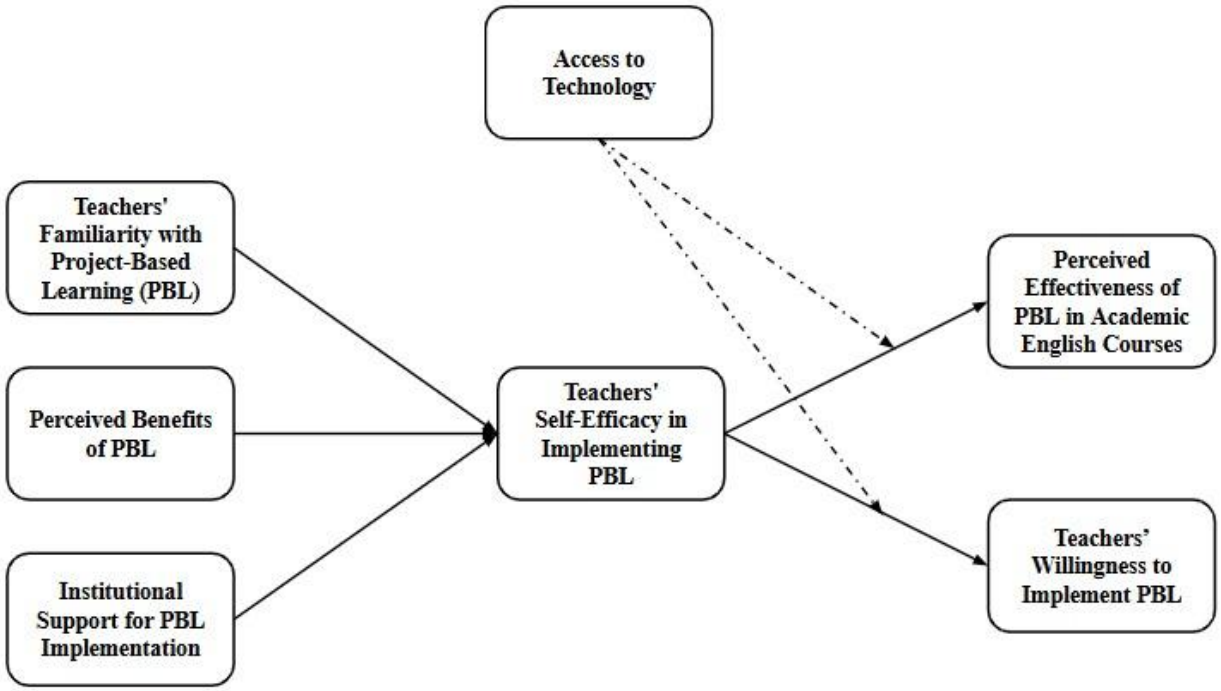

Figure 1. Conceptual Framework

3. Methodology

This cross-sectional survey and quantitative method of research investigated how many variables influence teachers to implement PBL in academic English classes. Cross-sectional designs worked optimally to study variable relationships at one point in time. The study investigated how teachers' self-efficacy, perceived benefits, institutional support, and access to technology influence the effectiveness and implementation of PBL. The T University cohort of instructors of academic English reading courses was surveyed with a standardized survey to quantify each attribute. The research tested numerous hypotheses regarding the ways factors mediate and moderate PBL adoption in academic English settings. T University instructors who taught academic English reading courses in China formed the population of the study. T University was selected based on its dedication to PBL and creative English language instruction pedagogy. This cohort's instructors primarily taught English literacy classes, which enhance language ability and academic proficiency in higher education. The group has varying technological, pedagogical, and PBL skills. Instructors who taught academic English reading courses were investigated to see how PBL influences language acquisition. This cohort of instructors was appropriate to analyze the influence of self-efficacy, institutional support, and PBL familiarity on PBL efficacy and implementation in an academic English course. Depending on the complexity of the model and the guidelines for structural equation modeling, 150 participants were needed. 180 T University English instructors were studied, a large sample. SmartPLS, the data software that was taken up, was created specifically for medium-sized survey samples. Thus, this sample size was sufficient. The study gathered data from 180 teachers to make sure the findings proportionally represented T University's teaching faculty and provided generalizable answers regarding PBL in academic English classes. Convenience sampling was employed to enlist volunteers who were available. Instructors were invited to participate in the study through email and faculty meeting announcements. This non-random sample method was utilized owing to practical considerations and the necessity to target academic English instructors. The information was gathered from all chosen participants through an online questionnaire completed by them. Perceived benefits of PBL, teacher familiarity, institutional support, self-efficacy to implement PBL, perceived PBL effectiveness in academic English courses, and likelihood to implement PBL were measured through the questionnaire. We modified tools of academic English instruction to construct the questionnaire. The 35-item questionnaire measured teachers' concepts, sentiments, and beliefs on a scale of 1 (strongly disagree) to 5 (strongly agree). The survey included demographic inquiries about the participant's years of teaching experience, skills in PBL, and accessibility to technology. The questionnaire was pilot tested with a few educators for reliability and understandability before handing it out. Upon pilot testing, the final survey was sent out electronically. The two months of data collection were adequate to generate a high response rate for teachers who filled up the survey and received follow-up reminders. All the answers were anonymous for privacy, and it was voluntary. The results of the survey were processed via SmartPLS, which is a PLS-SEM tool. SmartPLS was utilized as it could work with formative and reflective constructs, and this was vital in measuring the complex variable interactions of this study. The validity and reliability of the measuring model were tested early in the research. This entailed composite reliability (CR) and average variance extracted (AVE) calculations to measure construct internal consistency and convergent validity (Fornell and Larcker, 1981). The structural model measured independent, mediator, moderator, and dependent variable relationships. The model identified whether teachers' PBL knowledge, perceived advantages, support at institutions, and availability of technology influenced their self-efficacy

and motivation to implement PBL. Path coefficients' statistical significance was validated using bootstrapping at 0.05. It was explored in the study whether instructors' self-efficacy moderated predictor-outcome relations and whether technology suppressed them. A PLS-SEM study ascertained what encourages teachers to use PBL and how effective it is in educational English courses.

4. Results

Measurement Model Assessment

Table 1 and Figure 2 assess the study's constructs' reliability and validity. Cronbach's Alpha and Composite dependability (CR) are the main build dependability measurements. Good reliability and internal consistency are shown by Cronbach's Alpha (α) of 0.866 and Composite Reliability (CR) of 0.903 for the variable "access to technology" (AT), exceeding the widely accepted threshold of 0.7. Access to technology has an AVE of 0.651, exceeding the 0.5 threshold. The items examine the intended idea with sufficient convergent validity. These findings corroborate the accuracy and legitimacy of the "access to technology" assessment instruments for further investigation. An acceptable internal consistency and a Cronbach's Alpha of 0.801 and Composite dependability (CR) of 0.869 indicate high dependability for "institutional support for PBL" (ISPBL). An AVE of 0.623 shows institutional PBL support's convergent validity. The outer loadings for each item in this construct range from 0.765 to 0.832, all exceeding the 0.7 threshold, proving unidimensional. This shows that "institutional support for PBL" parts match the basic theoretical premise. Cronbach's Alphas of 0.835 and 0.872, respectively, and CR values of 0.889 and 0.907 indicate high internal consistency for "perceived benefits of PBL" (PBPBL) and "perceived effectiveness of PBL" (PE). These constructs have AVEs of 0.668 and 0.661, demonstrating the measuring model's appropriateness and excellent convergent validity. The construct "teachers' familiarity with PBL" (TFPBL) has the highest Cronbach's Alpha of 0.883 and Composite Reliability (CR) of 0.919. Scores that exceed acceptable levels show the items' robust internal consistency. Teachers' PBL knowledge AVE is 0.739, much over the 0.5 threshold, showing that the questions accurately represent the idea. Similarly, "teachers' self-efficacy in implementing PBL" (TSEIPBL) and "teachers' willingness to implement PBL" (TWIPBL) are reliable and valid. Cronbach's Alpha of 0.852, Composite Reliability (CR) of 0.898, and Average Variance Extracted (AVE) of 0.688 indicate strong internal consistency and convergent validity in TSEIPBL. The Average Variance Extracted (AVE) of 0.606 is slightly lower than other constructs, however TWIPBL's Cronbach's Alpha of 0.833 and Composite Reliability (CR) of 0.883 indicate solid reliability.

Table 1. Construct Reliability and Validity

	Items	Outer Loading	Cronbach Alpha	CR	AVE
Access to Technology	AT1	0.809	0.866	0.903	0.651
	AT2	0.820			
	AT3	0.797			
	AT4	0.787			
	AT5	0.820			
Institutional Support for PBL	ISPBL1	0.832	0.801	0.869	0.623
	ISPBL2	0.779			
	ISPBL3	0.781			
	ISPBL4	0.765			
Perceived Benefits of PBL	PBPBL1	0.851	0.835	0.889	0.668
	PBPBL2	0.812			
	PBPBL3	0.807			
	PBPBL4	0.798			
Perceived Effectiveness of PBL	PE1	0.831	0.872	0.907	0.661
	PE2	0.838			
	PE3	0.823			
	PE4	0.793			
	PE5	0.777			
Teachers' Familiarity with PBL	TFPBL1	0.834	0.883	0.919	0.739
	TFPBL2	0.868			
	TFPBL3	0.857			
	TFPBL4	0.879			
Teachers' Self-Efficacy in Implementing PBL	TSEIPBL1	0.792	0.852	0.898	0.688
	TSEIPBL2	0.830			
	TSEIPBL3	0.849			
	TSEIPBL4	0.847			
Teachers' Willingness to Implement PBL	TWIPBL1	0.820	0.833	0.883	0.606
	TWIPBL2	0.766			
	TWIPBL3	0.845			
	TWIPBL4	0.597			
	TWIPBL5	0.836			

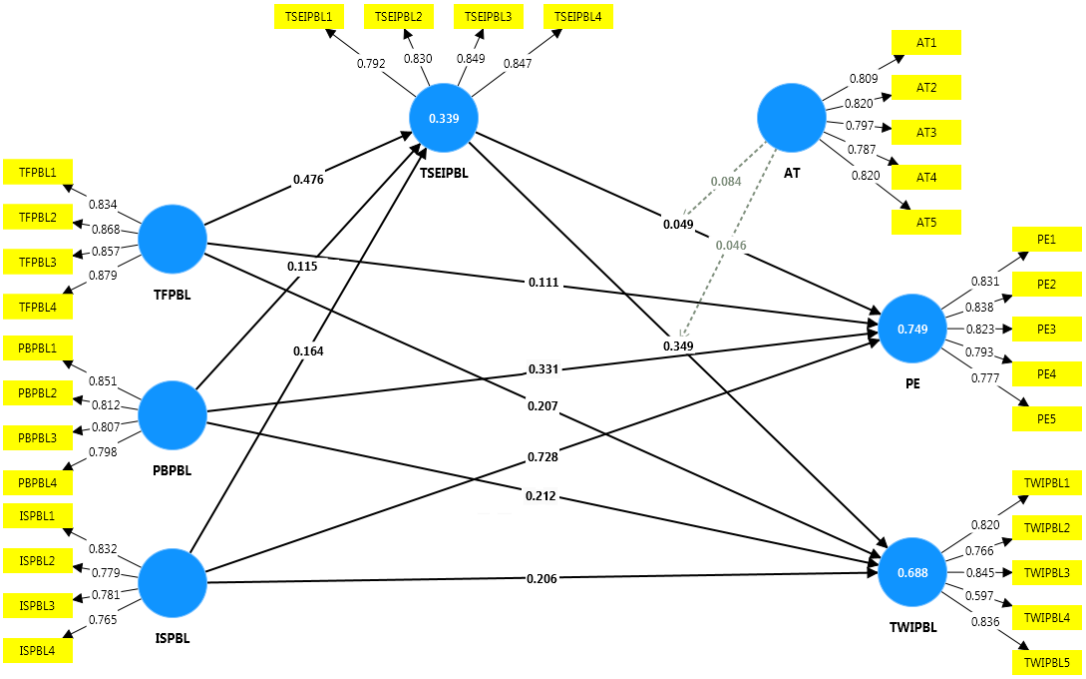

Figure 2. Measurement Model

Discriminant Validity

The Heterotrait-Monotrait ratio (HTMT) is a key metric for evaluating model construct uniqueness, and Table 2 shows component discriminant validity. Compare construct correlation coefficients to HTMT values to assess discriminant validity. "Institutional support for PBL" (ISPBL) and "access to technology" (AT) had HTMT scores of 0.637, below 0.85. This implies sufficient construct distinction. The data for "access to technology" (AT), "perceived effectiveness of PBL" (PE) (0.624), and "teachers' familiarity with PBL" (TFPBL) (0.618) indicate that these categories are not conceptually similar. Small HTMT values indicate that the constructs are conceptually distinct, proving the measurement model's discriminant validity. A detailed analysis of Table 2 shows that the HTMT values for "perceived benefits of PBL" (PBPBL) and "teachers' self-efficacy in implementing PBL" (TSEIPBL) (0.531) and "teachers' willingness to implement PBL" (TWIPBL) and "TSEIPBL" (0.849) are both within the acceptable threshold. The maximum HTMT value between "teachers' self-efficacy in implementing PBL" (TSEIPBL) and "teachers' willingness to implement PBL" is 0.849, as shown in the table. It remains below 0.85, indicating that these constructs are still distinct. In addition, "institutional support for PBL" (ISPBL) and "perceived effectiveness of PBL" (PE) (0.979) had values over the threshold, suggesting conceptual overlap. Most pairs show enough distinction in the HTMT analysis, supporting component discriminant validity. Several pairs show little overlap, requiring more study.

Table 2. Discriminant Validity (HTMT)

	AT	ISPBL	PBPBL	PE	TFPBL	TSEIPBL	TWIPBL
AT							
ISPBL	0.637						
PBPBL	0.626	0.811					
PE	0.624	0.979	0.707				
TFPBL	0.618	0.700	0.917	0.669			
TSEIPBL	0.849	0.488	0.531	0.542	0.626		
TWIPBL	0.829	0.665	0.716	0.720	0.766	0.849	

Coefficient of Determination and Q2

Table 3 shows the coefficient of determination (R^2) and predictive relevance (Q^2) for each core construct, demonstrating the model's explanatory and predictive power. The "perceived effectiveness of PBL" model explains 74.9% of variance (R^2=0.749). In academic English classes, the model's predictors—teacher familiarity with PBL, institutional support, and perceived benefits of PBL—significantly affect PBL's perceived efficacy. The model's Q^2 score for PBL's perceived efficacy is 0.714, beyond the 0.35 threshold, indicating strong predictive validity. Results show the model accurately depicts PBL's perceived efficacy. The model explains 33.9% of "teachers' self-efficacy in implementing PBL," with a R^2 value of 0.339. Despite its moderate explanatory power, the model may not account for additional characteristics that affect instructors' PBL self-efficacy. The Q^2 score of this construct is 0.425, above the 0.35 criterion, showing predictive relevance, but less than perceived efficacy. The model effectively explains 68.8% of instructors' PBL usage (R^2 = 0.688). The model has good predictive power for this construct, with a Q^2 score of 0.691. The model's predictive and explanatory power is strong, notably for PBL's perceived usefulness and instructors' motivation to adopt it.

Table 3. Coefficient of Determination and Q2

Constructs	R2	Q2
Perceived Effectiveness of PBL	0.749	0.714
Teachers' Self-Efficacy in Implementing PBL	0.339	0.425
Teachers' Willingness to Implement PBL	0.688	0.691

Structural Equation Model

Table 4 and Figure 3 show the path coefficients, t-values, and p-values for each association from direct path analysis for the hypotheses. Hypothesis H1 examines "perceived effectiveness of PBL" (PE) and "teachers' familiarity with PBL" (TFPBL) with a path coefficient of 0.111, t-value of 2.194, and p-value of 0.014. Instructors' familiarity with PBL and their assessment of its efficacy are positively correlated since the p-value is below 0.05. This suggests that instructors' PBL effectiveness assessments improve with experience. Hypothesis H2 examines how "perceived benefits of PBL" (PBPBL) affect efficacy. The path coefficient, t-value, and p-value are 0.331, 8.181, and 0.000, suggesting a strong positive correlation. This shows that instructors' PBL efficacy assessments are heavily impacted by their benefits beliefs. Hypothesis H3 explores how "institutional support for PBL" (ISPBL) affects PBL effectiveness and finds a strong path coefficient of 0.728, a t-value of 12.417, and a p-value of 0.000. These findings show that institutional support drives perceived performance.

Analyzing hypotheses about instructors' PBL readiness shows construct linkages. H4 examines the statistically significant positive connection between teachers' familiarity with project-based learning (TFPBL) and their preparedness to apply TWIPBL, with a path coefficient of 0.207, a t-value of 2.344, and a p-value of 0.010. This suggests that PBL-savvy teachers are more likely to use it. Hypothesis H5, which examines how perceived PBL benefits (PBPBL) affect instructors' preparedness to embrace PBL, has a path coefficient of 0.212, a t-value of 2.091, and a p-value of 0.003. This study shows that educators who see greater PBL benefits are more inclined to use it. Hypothesis H6 examines how institutional support for project-based learning (ISPBL) affects instructors' PBL preparation. A significant positive influence is indicated by the route coefficient of 0.206, t-value of 2.697, and p-value of 0.004. The direct path analysis shows that institutional support affects teachers' perceived efficacy and motivation to adopt PBL, as well as robust and statistically significant correlations between components.

Table 4. Direct Path Analysis

Hypotheses	Relation	Path coefficient	t Value	P value
H1	TFPBL -> PE	0.111	2.194	0.014
H2	PBPBL -> PE	0.331	8.181	0.000
H3	ISPBL -> PE	0.728	12.417	0.000
H4	TFPBL -> TWIPBL	0.207	2.344	0.010
H5	PBPBL -> TWIPBL	0.212	2.091	0.003
H6	ISPBL -> TWIPBL	0.206	2.697	0.004

N0te: *p< 0.05

Mediation Assessment

The mediation study, shown in Table 5, examines how numerous factors indirectly affect "PBL effectiveness " (PE) and "teachers' willingness to implement PBL" (TWIPBL) through "teachers' self-efficacy in implementing PBL". The mediating effects show how self-efficacy turns other variables into results. With a path coefficient of 0.000 and a t-value of 3.89 (p-value = 0.000), "perceived benefits of PBL" (PBPBL) indirectly affects teachers' self-efficacy (TSEIPBL). This suggests that self-efficacy strongly influences the relationship between PBL benefits and efficacy. A path coefficient of 0.023 and a t-value of 2.97 (p-value = 0.003) show that "teachers' familiarity with PBL" (TFPBL) indirectly affects PBL effectiveness through instructors' self-efficacy (TSEIPBL). The relationship between PBL familiarity and PBL effectiveness is somewhat mediated by self-efficacy. A path coefficient of 0.008 and a t-value of 3.45 (p-value = 0.001) indicate that "institutional support for PBL" (ISPBL) mediates PBL's perceived efficacy. This suggests that institutional support boosts instructors' self-efficacy, boosting PBL's perceived success.

The mediation study found significant indirect impacts on "teachers' willingness to implement project-based learning" (TWIPBL). The "perceived benefits of PBL" (PBPBL) via teachers' self-efficacy (TSEIPBL) strongly motivate instructors to utilize PBL, as shown by a route coefficient of 0.002 and a t-value of 4.12 (p-value = 0.000 Self-efficacy strongly influences instructors' PBL preparation and perceived advantages. The link between "Teachers' familiarity with PBL" (TFPBL) and instructors' PBL self-efficacy had a significant path coefficient and t-value. PBL-experienced instructors need self-efficacy to succeed. A path coefficient of 0.057 and a t-value of 3.68 (p-value = 0.000) show that "institutional support for PBL" (ISPBL) significantly affects teacher self-efficacy. This shows that institutional support boosts teacher self-efficacy and PBL adoption. These findings suggest that self-efficacy reduces predictors' effects on PBL efficacy and adoption.

Table 5. Mediation Analysis

Hypotheses	Relation	Path coefficient	t Value	P value
H7a	PBPBL -> TSEIPBL -> PE	0.000	3.89	0.000
H7b	TFPBL -> TSEIPBL -> PE	0.023	2.97	0.003
H7c	ISPBL -> TSEIPBL -> PE	0.008	3.45	0.001
H8a	PBPBL -> TSEIPBL -> TWIPBL	0.002	4.12	0.000
H8b	TFPBL -> TSEIPBL -> TWIPBL	0.166	2.75	0.006

H8c	ISPBL -> TSEIPBL -> TWIPBL	0.057	3.68	0.000

N0te: *p< 0.05

Moderation Assessment

Table 6 shows the moderation analysis's findings on PBL's PBL effectiveness (PE), teachers' desire to use it, their self-efficacy in implementing PBL (TSEIPBL), and access to technology. The data show that instructor technical availability and self-efficacy affect PBL efficacy. T = 1.926, p = 0.027. The AT x TSEIPBL -> PE interaction impact route coefficient is 0.084. Technology may boost self-efficacy and PBL effectiveness. This shows that instructors' self-confidence and technology boost PBL's perceived efficacy. Technical resources improve PBL in academic English courses, as instructors' self-efficacy is greatly affected by PBL evaluation as technology improves. Technology availability and self-efficacy affect instructors' PBL motivation. T = 1.812, p = 0.035%. Moderation impact route coefficient (AT x TSEIPBL -> TWIPBL) is 0.046. Instructors' digital accessibility boosts self-efficacy and project-based learning readiness. Teachers with confidence and good technology are more likely to use PBL. This discovery underscores the need for educators to have the technology and confidence to use creative PBL teaching techniques. It maintains that technology is needed to develop creative teaching approaches. The findings show how technology and self-efficacy affect PBL educators' behavior.

Table 6. Moderation Analysis

Hypotheses	Relation	Path coefficient	t Value	P value
H9a	AT x TSEIPBL -> PE	0.084	1.926	0.027
H9b	AT x TSEIPBL -> TWIPBL	0.046	1.812	0.035

N0te: *p< 0.05

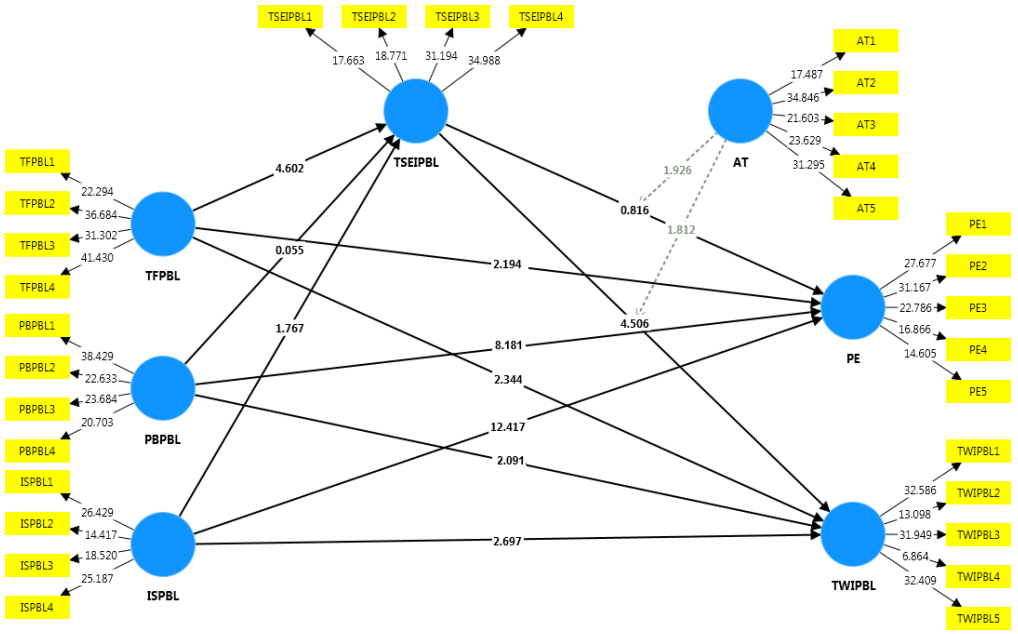

Figure 3. Structural Model

5. Discussion

This research focused on the way instructors' perceived benefits, institutional support, self-efficacy, and knowledge of PBL affect their efficacy and readiness to apply it in academic English courses. The research explored how technology and self-efficacy affect these qualities. Findings demonstrate how these qualities affect higher education educators' PBL attitudes and practices, particularly in academic English courses. Study reveals that knowledge of PBL significantly affects teachers' efficacy and readiness to utilize it. Royani et al. (2024) posit that teachers' evaluations of these strategies depend on their styles and abilities. Familiarity with PBL makes teachers more inclined towards adopting it since they believe it enhances students' learning. Teacher cognition reveals that attitudes and teaching practices influence instruction. Experienced PBL teachers understand how to enhance students' performance. PBL alleviates perceived risk about new teaching approaches, thus increasing chances of adopting them. Critical professional development courses help teachers enhance PBL practices. Effectiveness and capability influenced teacher PBL adoption. Since PBL encourages active student engagement, critical thinking, and collaboration, teachers are more likely to employ it. Wang et al. (2024) found that teacher attitudes towards a teaching method influence its adoption in classrooms. PBL will be employed more by educators who believe it achieves their objectives and is pedagogically sound. The anticipated advantages inspire instructors to use PBL. The results indicate that institutions ought to highlight PBL's advantages, particularly for novice or antagonistic instructors. PBL's advantages, such as increased student engagement and learning outcomes, can help overcome

reluctance and encourage its application. Institutional support influenced PBL's effectiveness and instructors' application. The findings illustrate that newly introduced pedagogy requires institutional support. Studies reveal that teachers need administrative support, resources, and professional development to adopt new teaching methods (Chen et al., 2022). Teachers with institutional support-resources, training, and encouragement-adopt PBL more boldly. Institutional support encourages teachers, who feel their schools are dedicated to the success of students and professional growth. Institutional support can address PBL challenges like student or peer resistance, time, and resources. PBL support should be a priority for schools, such as professional development, peer collaboration, and technical support, as noted in the report. Self-efficacy of teachers as a mediator between the previously identified factors and PBL performance and motivation is an interesting contribution of this work. Statistics indicate that teachers' enthusiasm for PBL is driven by understanding, perceived benefits, and support from institutions. Teacher confidence is required for this approach. This research validates Bandura's (1997) social cognitive assumption that self-efficacy belief shapes behavior and decision-making. Teachers with high self-efficacy are more confident with PBL, which enhances their perception of its effectiveness and adoption. The mediation role of self-efficacy indicates that teachers' confidence in PBL implementation is critical to translating institutional support and familiarity with PBL into positive outcomes. This research revealed that teacher self-efficacy in professional development programs significantly affected teachers' PBL attitudes and readiness to implement it. Technology affects teacher effectiveness, PBL readiness, and self-efficacy. Technology enhances teacher self-efficacy, which influences PBL attitudes and implementation. Technology supports collaboration, research, and presentation, enhancing educators' PBL confidence. Technology enables teachers to apply innovative pedagogy, based on research (Nwosu et al., 2024). Interactive learning, peer-to-peer collaboration, and online resources can help teachers overcome time and resource limitations in PBL. Technology impacts the value of PBL tools and instructor training. PBL teacher attitudes in academic English programs are examined in this research. PBL's effectiveness and instructors' motivation relied on benefits, understanding, and institutional support. The research found that teachers' PBL self-efficacy facilitated these qualities to succeed. Therefore, they require PBL confidence. Technology influences the need for PBL materials and professional development for teachers. This study contributes to the growing corpus of PBL-centered innovative pedagogical approaches. Teachers apply PBL more when technological availability, perceived advantage, institutional resources, self-efficacy, and acquaintance are prioritized. This enhances student success.

6. Implications

The research has far-reaching practical and theoretical implications for PBL-based academic English courses. Investigation enhances knowledge in instructor cognition, self-efficacy, and innovation. The research examines the impact of technology and self-efficacy on innovative education, institutions, and teachers. It demonstrates how teachers' confidence, experience, and attitudes influence approaches. A focus on PBL implementation enhances educational innovation and institutional support studies. These results clarify the acceptance of PBL and how instructors' institutional and personal assets influence innovative teaching. Instructors require PBL-oriented professional training, the findings indicate. Teachers should be educated on PBL advantages and applications in classrooms. Real practice and collaboration should improve teachers in such programs. Teachers become more self-efficacious with problem-based learning (PBL) programs that reduce resistance to change and improve acceptance. School principals should acknowledge that understanding benefits guides teachers' PBL effectiveness evaluations. PBL enhances student engagement, critical thinking, and collaboration, so it can be applied by teachers. Institutional support will facilitate the execution of PBL and teacher understanding, based on research. Administrators should support teachers who seek new methods, training, and funding. Organizations need to value PBL technology, collaboration, and outside assistance. Educational policies should encourage educational innovation. Teachers may use PBL with mentorship, collaborative planning time, and institutional recognition. The research suggests that educators may struggle to implement PBL due to resource limits, time constraints, and student or colleague reluctance, especially without institutional backing. Teachers and institutions will find the study's conclusions on technology availability's moderating effect significant. To maximize PBL benefits, institutions must provide instructors with technology and training. This entails educating teachers how to incorporate digital technology in project-based courses to enhance student collaboration, research, and presentation. Technology matters to contemporary education, and hence schools need to invest in facilities to facilitate incorporating digital tools. Educating teachers on implementing technology in PBL can assist them in overcoming resource limitations and unfamiliarity with digital tools. Technology can facilitate the application of PBL by instructors and increase their utilization self-efficacy for this new pedagogy. Teaching and student learning will be enhanced.

7. Limitations

This work has limitations despite its significant contributions. The research involved academic English reading teachers in one Chinese college. The findings, therefore, may not be generalizable to varying educational contexts or disciplines. The sample was drawn from a single institution, so the findings could be used in this context but might not accurately capture teachers elsewhere in regions, countries, or educational systems. Future studies should utilize a more representative and larger sample to enhance external validity since differences in culture, institution, and regions when adopting educational innovations such as PBL might result in varying outcomes. Causal inferences are hindered in cross-sectional designs. Hindsight bias and social desirability bias are typical with self-reported data. Culture and personal experiences could affect teachers' knowledge of PBL, self-efficacy, and institutional support. Future research on these components' progression over time may benefit from longitudinal designs. Despite focusing on the main elements affecting teachers' PBL adoption, the study ignored students' opinions, the learning environment's subjectivity, and external pressures like standardized testing. Future research should examine these factors to better understand PBL implementation. Because students' interest and readiness for PBL may influence teachers' decisions to use it, their involvement is crucial. Future studies ought to combine student attitudes, that is,

their attitudes toward PBL and its impact on learning outcomes, to enhance knowledge on implementation. Instructor-student opinion interaction and the learning environment explain how to implement PBL.

8. Future Directions

Future studies can study the impact of teacher self-efficacy and institutional support on the implementation and sustainability of PBL in schools. Longitudinal study could investigate how teachers' belief in PBL and perception of its effectiveness shift when they build competence and support. This will guide institutional policy and professional development to enable long-term sustainability of PBL practices. Future research should also examine the broader impacts of technology access, particularly in resource-poor environments. The present study illustrated that technology access moderates PBL practice in diverse schooling environments. Subsequent research needs to investigate the impact of technology access on PBL implementation. An investigation of student engagement with technology, institutional assistance, and the technological skills of instructors can potentially assist in implementing PBL more effectively with technology. Subsequent research can investigate the impact of PBL on educational disciplines outside academic English courses to determine if the findings presented in this study hold. As PBL has been extensively implemented in science, mathematics, and social studies, one can consider whether similar variables (including teachers' exposure to PBL, perceived advantages, and self-confidence) influence readiness to implement PBL in these areas. Considering discipline-specific issues and chances in PBL implementation can provide pragmatic recommendations suited to different school contexts and enhance our insight. Investigating how PBL intersects with other pedagogies such as inquiry-based learning or flipped classrooms may provide teachers with a more integrated model for enhancing student learning and insight into pedagogical innovation.

9. Conclusion

PBL in academic English classes is thoroughly explored in this research. It measures teachers' self-efficacy, perceived advantages of PBL, institutional support, and PBL experience to find their readiness to implement this special teaching method. PBL's supposed success and instructors' inclination to apply it rely on their perceptions and judgment of its advantages. The research indicates that instructors utilize PBL since they believe in its pedagogical value. Instructing PBL abilities by way of professional development might improve perceptions of its implementation. PBL achievement relies on organizational support, supposed advantages, and acquaintance. Teachers perceive themselves as competent with resources, training, and instigation from organizations. Institutions are required to systematically develop a teaching culture that promotes instructional creativity and experimentation and provides technical supports and staff development. Educating using new methods such as PBL demands institutionally supported education, the study indicates. A study established that teacher self-efficacy enhances PBL readiness and perceived impact. Instructor self-efficacy to alter their instructional methods was boosted by their belief in PBL and measures of effectiveness. Teacher development programs enhance PBL competence and self-efficacy. The applicability of technology is underscored by its low impact on PBL. Researchers established that technology enhances teachers' self-efficacy, PBL attitudes, and readiness for implementation. Effective PBL requires skillful and technology-literacy teachers. This study elucidates the complex dynamics of PBL and provides universities with recommendations for implementing new pedagogies.

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Authors' contributions

Y.L.: Conceptualization, Data Collection, Writing—original draft preparation

M.M.: Methodology, Validation, Data Curation, Writing—review and editing

N.A.S.: Visualization, Validation, Writing—review and editing

All authors read and approved the final manuscript.

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No additional data are available.

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