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Enhancing Student Engagement, Academic Performance, and Character through Problem- and Project-Based Learning: A Cross-National Study

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Abstract. This study examines the comparative effectiveness of Problem-Based Learning (PBL) and Project-Based Learning (PjBL) in enhancing student engagement, academic achievement, and character development among primary school students in Indonesia and Malaysia. A total of 120 fifth-grade students participated, equally divided into two groups: 60 students in the PBL group and 60 in the PjBL group, drawn from Unismuh Elementary School in Indonesia and the Indonesian School of Kuala Lumpur, Malaysia. Each group underwent a six-week intervention using either PBL or PjBL strategies. Student engagement was assessed using standardized observation sheets, academic achievement was measured through curriculum-aligned cognitive tests, and character development was evaluated using validated character questionnaires encompassing responsibility, honesty, empathy, cooperation, and initiative. Data were analysed using independent t-tests, analysis of covariance (ANCOVA), and effect size calculations (Cohen's d and partial eta squared) to determine both statistical significance and practical relevance. The results indicate that PjBL was more effective in promoting student engagement and character development, whereas PBL yielded stronger gains in academic achievement. These differentiated outcomes highlight the importance of aligning pedagogical approaches with

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specific educational objectives and contextual conditions, thereby contributing to the broader discourse on evidence-based, student-centred education.

Keywords: Problem-Based Learning; Project-Based Learning; Student Engagement; Academic Achievement; Character Development

1. Introduction

Twenty-first century education necessitates a transformative shift in pedagogical strategies to address not only the cognitive development of students but also their socio-emotional and character growth. Education systems worldwide are increasingly expected to prepare learners who are not only knowledgeable but also adept in collaboration, creativity, critical thinking, and communication (Alsulaimani, 2022; Chaoqun, 2022). Within this paradigm, active learning approaches such as Problem-Based Learning (PBL) and Project-Based Learning (PjBL) have gained prominence for their ability to engage students in authentic, student-centred learning environments (Demirdag et al., 2025; Liu et al., 2022; Petersen et al., 2023). These strategies provide pedagogical frameworks that encourage learners to take ownership of their learning through inquiry and practical application, aligning closely with the competencies required in the 21st century (Hananingsih et al., 2024; Laeheem, 2025).

Despite broad endorsement, comparative empirical evidence on the efficacy of PBL and PjBL—particularly in primary education—remains limited. While both models have demonstrated positive effects on student engagement, academic outcomes, and character formation, relatively few studies have examined their relative advantages in cross-cultural educational settings. Existing research suggests that PBL is especially effective in enhancing critical thinking and analytical skills, whereas PjBL is frequently commended for fostering character and interpersonal competencies through project-oriented tasks (Akhsani & Mohamed, 2023; Ge et al., 2025; Orhan, 2025; Ramos-Mejía & Padilla, 2025; Sharma et al., 2023). Given the global emphasis on developing holistic learners capable of thriving in diverse, rapidly changing environments, it is essential to evaluate these models across varied sociocultural contexts (Famaye et al., 2025; Shadiev et al., 2024).

The central challenge addressed in this study lies in identifying the most effective pedagogical approach to simultaneously promote academic achievement and character development among primary school students. Conventional instructional models often emphasize rote memorization and standardized testing, thereby overlooking the cultivation of essential life skills and ethical values (Chairunnisa, 2022; Mistiani et al., 2022; Ritonga & Desrani, 2023). In seeking to bridge this gap, PBL and PjBL present alternative frameworks that integrate cognitive and affective learning outcomes. However, the literature remains divided regarding their comparative effectiveness. Some scholars advocate PBL for its capacity to develop higher-order thinking and self-directed learning, while others emphasize PjBL's effectiveness in fostering responsibility,

collaboration, and contextual learning (Astalini et al., 2023; Laeheem, 2025; Pujiastuti et al., 2023).

Given these ambiguities, the proposed solution is to empirically investigate the implementation of PBL and PjBL in structured educational interventions and evaluate their impact through robust methodological approaches. This involves deploying quasi-experimental designs to assess changes in student performance and behaviour before and after exposure to these instructional models. Educational technologies—such as digital collaboration tools and online learning platforms—have also been identified as potential enhancers of both PBL and PjBL, particularly in geographically and culturally diverse environments (Chang, 2025; Shadiev et al., 2024; Zhang, 2023). These tools can provide scaffolding for each model by enriching instructional delivery, supporting reflection, and promoting intercultural understanding.

Previous research offers valuable insights into the ways PBL and PjBL influence learning outcomes. For example, Ge et al. (2025) demonstrated that PBL significantly improves clinical reasoning and conceptual mastery in medical education. Sharma et al. (2023) conducted a meta-analysis affirming PBL's efficacy in enhancing academic motivation and achievement, and Orhan (2025) reported superior outcomes for PBL in EFL instruction. Conversely, Ramos-Mejía and Padilla (2025) found that PjBL fosters critical and reflective thinking in science education, while Liu et al. (2022) highlighted its capacity to promote collaborative and autonomous learning in technical fields. Petersen et al. (2023) and Pujiastuti et al. (2023) further demonstrated that PjBL—especially when integrated with virtual reality and ethno-STEM approaches—significantly enhances student engagement and character development.

Furthermore, research on character education within PBL and PjBL frameworks highlights their potential to cultivate ethical, responsible, and socially conscious learners. Ghufron and Wuryandani (2025) emphasized the importance of embedding local cultural values into PBL modules to strengthen moral development. Chairunnisa (2022) underscored the role of value-based instruction in countering radical ideologies and fostering balanced personalities. Ritonga and Desrani (2023) stressed the integration of religious values in character education, while Hananingsih et al. (2024) and Mistiani et al. (2022) advocated participatory and contextual approaches that resonate with students lived experiences.

Furthermore, the integration of educational technology into PBL and PjBL has been proposed as a strategy to address contextual limitations. Xie (2022) reported that online community-based PjBL maintained learning continuity and motivation during the pandemic. Zhang (2023) and Feng et al. (2022) demonstrated that flipped classrooms and team-based projects increased student participation in science and health education. These studies underscore the adaptability of PBL and PjBL to diverse instructional contexts and support their wider applicability across educational systems.

Despite these promising findings, notable gaps remain in the literature concerning the comparative implementation of PBL and PjBL across national and cultural contexts. Most existing studies are confined to single-country settings, with limited investigation into how these models function in multicultural and international school environments. Research by Shadiev et al. (2024) and Calvera-Isabal et al. (2024) advocates for intercultural learning experiences as a means of reducing stereotypes and fostering global citizenship, yet few empirical studies have examined these aspects in primary education. Additionally, although character development is often cited as an outcome of PjBL, its measurement and validation across different contexts remain under-explored (Abdurrahmansyah et al., 2022; Komalasari & Indrawadi, 2023; Komalasari & Masyitoh, 2022).

This study seeks to address these gaps by conducting a comparative analysis of PBL and PjBL in two culturally distinct primary school contexts: Unismuh Elementary School in Indonesia and the Indonesian School of Kuala Lumpur, Malaysia. By focusing on student learning activities, academic achievement, and character development, the study aims to provide a comprehensive understanding of how these models function in real-world classrooms. The research employs a quasi-experimental design with pre-test and post-test assessments, validated instruments, and systematic observation to ensure methodological rigor (Demirdag et al., 2025; Liu et al., 2022; Zhang, 2023).

The novelty of this study lies in its cross-national scope and its emphasis on integrating character education within active learning frameworks. It contributes to the literature by providing empirical evidence on the relative strengths of PBL and PjBL in different cultural and infrastructural contexts. The findings are expected to inform educational policy and practice, particularly in regions seeking to adopt inclusive and context-sensitive pedagogical models. The research also aligns with global educational priorities advocating student-centred learning, digital integration, and intercultural competence (Amaefule et al., 2023; Lucena et al., 2025; Shimomura & Utsumi, 2025).

The study has two main objectives: (1) to evaluate and compare the effectiveness of PBL and PjBL in enhancing learning engagement, academic achievement, and character development among primary school students, and (2) to identify contextual factors that mediate the successful implementation of these models in cross-cultural educational settings. The research is guided by the following questions: (1) How do PBL and PjBL differentially affect student learning activities, outcomes, and character development? and (2) What contextual variables influence the implementation and efficacy of PBL and PjBL in Indonesian and Malaysian primary schools?

2. Literature Review

Problem-Based Learning (PBL) has emerged as one of the dominant pedagogical approaches for fostering critical thinking, problem-solving, and self-directed learning across diverse educational contexts. This approach places learners at the centre of the learning process by engaging them in solving authentic and complex problems (Y. Liu & Pásztor, 2022; Trullàs et al., 2022). In contrast to traditional

methods that emphasize the transmission of knowledge from instructors to students, PBL encourages active learner participation in constructing understanding through interaction and collaboration (Smith et al., 2022; Ssemugenyi, 2023).

The effectiveness of PBL has been documented in multiple disciplines, including medicine, engineering, and the social sciences. Meta-analyses indicate that PBL not only enhances academic achievement but also cultivates essential interpersonal, communication, and collaborative skills required in professional contexts (Orhan, 2025; Sharma et al., 2023; Uluçinar, 2023). Nevertheless, the implementation of PBL faces challenges related to instructor readiness, the design of effective learning scenarios, and the development of valid assessment tools for measuring learning outcomes (Dash et al., 2022; Ghaly et al., 2023).

The integration of digital technology into PBL—through strategies such as flipped classrooms, virtual simulations, and hybrid learning—has expanded rapidly to address the limitations of face-to-face instruction and broaden access to learning resources (Alsaif et al., 2023; Nugroho & Hermasari, 2023). Studies further demonstrate that combining PBL with gamification, online collaborative learning, and technology-based assessment can increase learner motivation and participation (Poonsawad et al., 2022; Rodríguez et al., 2022).

3. Theoretical Framework

The theoretical framework of this study is grounded in constructivism, which posits that knowledge is constructed through active learner engagement with the learning environment (C. Feng et al., 2024). In PBL, constructivism is operationalized through problem-solving tasks that integrate prior and new knowledge, leading to deeper and more meaningful understanding (Aires et al., 2023).

In addition, Vygotsky's social learning theory highlights the importance of social interaction, collaboration, and scaffolding. In PBL, small group work enables learners to exchange ideas, support one another, and develop communication skills, thereby expanding their Zone of Proximal Development (ZPD) (Boelt et al., 2023; Du, Lundberg, et al., 2022; Du, Nomikos, et al., 2022).

Self-determination theory is also relevant, as it emphasizes the role of intrinsic motivation in successful learning. Autonomy in problem-solving, facilitator support, and the contextual relevance of problems provided enhance motivation and engagement (Elderson-Van Duin et al., 2023; W. Li et al., 2023). Consequently, PBL functions as a strategic approach to developing 21st-century skills—critical thinking, collaboration, communication, and creativity—that are essential for success in complex and dynamic environments (Amanda et al., 2022; Kasuga et al., 2022).

3.1 Research Methods

This study employed a quantitative approach using a quasi-experimental design with a pretest–posttest control group methodology to examine the comparative

effectiveness of Problem-Based Learning (PBL) and Project-Based Learning (PjBL) in enhancing student learning activities, academic achievement, and character development. This approach aligns with best practices in educational research when the objective is to compare the impact of different pedagogical interventions across defined groups (Ge et al., 2025; Sharma et al., 2023). The design allowed for controlled comparisons between experimental groups exposed to different instructional models, while preserving ecological validity within authentic classroom environments (Orhan, 2025).

Participants were fifth-grade students from two primary schools selected through purposive sampling: Unismuh Elementary School in Makassar, Indonesia, and the Indonesian School of Kuala Lumpur, Malaysia. The inclusion criteria ensured comparable educational backgrounds and curricular standards, thereby strengthening the internal validity of the comparative framework (Abdurrahmansyah et al., 2022; Xie, 2022). The cultural and infrastructural differences between the two schools also provided a meaningful basis for examining contextual influences on the effectiveness of the two learning models (Famaye et al., 2025; Shadiev et al., 2024).

School selection was guided by the following criteria:
1. Curriculum compatibility – Both schools implement similar national curriculum standards, ensuring equivalence in learning content.
2. Student characteristics – Both schools have comparable student age ranges (10–11 years) and similar levels of prior academic achievement.
3. Infrastructure readiness – Both schools possess the necessary resources to implement PBL and PjBL, including adequate classroom facilities and teacher capacity.
4. Administrative support – School administrations granted permission and facilitated teacher training to ensure fidelity of implementation.

This careful selection ensured that observed differences in outcomes could be attributed primarily to the instructional models rather than to variations in curriculum or infrastructure.

Two experimental groups were established, each receiving either PBL or PjBL interventions in science and social studies classes over a six-week instructional period. The PBL model followed the structured problem-solving phases outlined by Orhan (2025) and incorporated instructional steps from Chang et al. (2025), emphasizing inquiry, analysis, and reflection. In contrast, the PjBL model was based on pedagogical frameworks proposed by Petersen et al. (2023) and Pujiastuti et al. (2023), highlighting collaborative project execution and real-world relevance. To ensure implementation fidelity across both school sites, teachers received training adapted from modules developed by Akhsani & Mohamed (2023).

3.3 Instruments

Three primary instruments were used to evaluate the outcomes:

1. Student learning activity was assessed using observation sheets developed with reference to indicators from Chaoqun (2022) and Indra et al. (2022). These instruments captured participation, attentiveness, collaboration, and initiative during class sessions. Observations were conducted by trained raters following standardized protocols to maintain consistency and objectivity (Alsulaimani, 2022; Shadiev et al., 2024).
2. Academic achievement was measured using a test aligned with the national curriculum and adapted from validated assessment tools described by Feng et al. (2022). The test comprised multiple-choice and open-ended items designed to assess conceptual understanding and application skills.
3. Character development was measured using a questionnaire adapted from Ghufron & Wuryandani (2025), Mistiani et al. (2022), and Ritonga & Desrani (2023), assessing responsibility, honesty, empathy, cooperation, and initiative. The instrument was grounded in established character education frameworks incorporating local values and ethical reasoning (Chairunnisa, 2022; Komalasari & Masyitoh, 2022). All instruments underwent expert review and theoretical triangulation to confirm content validity and construct relevance (Hu et al., 2025).

3.4 Procedure

The research followed a structured sequence. A pretest was administered to all participants to establish baseline equivalence between groups. The PBL and PjBL interventions were then implemented under close supervision. Weekly monitoring reports documented adherence to pedagogical procedures and any necessary instructional adjustments (Shimomura & Utsumi, 2025; Xie, 2022). Observational data were collected throughout the six-week period, followed by a posttest to measure changes in academic achievement and character development.

In the PBL group, students engaged in structured problem-solving activities guided by Orhan's (2025) steps, including problem identification, hypothesis formulation, investigation, discussion, and reflection. In the PjBL group, students participated in collaborative projects following the frameworks proposed by Petersen et al. (2023) and Pujiastuti et al. (2023), involving project planning, design, execution, and presentation.

Both models were implemented consistently across the two school sites. Teachers received a six-hour structured training programme, adapted from Akhsani & Mohamed (2023), covering: (1) conceptual understanding of PBL and PjBL; (2) step-by-step implementation aligned with Orhan (2025) for PBL and Petersen et al. (2023) for PjBL; (3) lesson planning and curriculum adaptation; and (4) assessment alignment with the targeted learning outcomes. Training activities included role-play simulations, collaborative lesson design, and peer feedback sessions.

All instructional sessions and data collection processes were documented through field notes, audiovisual recordings, and student–teacher reflection journals. These

records served as supplementary data to validate primary measurements and capture nuances in student engagement (Chaoqun, 2022; Demirdag et al., 2025; Zhang et al., 2023). Cross-verification between the Indonesian and Malaysian research teams enhanced transparency, as recommended by Calvera-Isabal et al. (2024) and Antonietti et al. (2023).

3.5 Data Analysis

Descriptive statistics were used to examine the distribution and trends of each variable in both groups. For inferential analysis, independent t-tests evaluated mean differences in student learning activity and character development between groups. Analysis of covariance (ANCOVA) assessed posttest academic achievement, controlling for pretest scores to improve statistical precision (Hananingsih et al., 2024; Laeheem, 2025; Santoso & Santoso, 2024). All analyses were conducted using SPSS, consistent with approaches used in similar studies (Feng et al., 2022; Liu et al., 2022).

3.6 Ethical Considerations

Ethical standards were strictly followed. Informed consent was obtained from students, guardians, and school administrators. The research design, instruments, and procedures were reviewed and approved by an institutional ethics committee, ensuring compliance with international guidelines (Alsulaimani, 2022; Hu et al., 2025; Zhang, 2023). Anonymity and confidentiality were maintained during data processing and reporting.

3.7 Methodological Strengths

A key strength of this study lies in its cross-national design, which tests the applicability of active learning models across culturally distinct but curriculum-aligned contexts. This approach aligns with the recommendations of Famaye et al. (2025) and Shimomura & Utsumi (2025) for intercultural research collaborations to develop adaptive pedagogical strategies.

The use of educational technologies during teacher training and classroom implementation enhanced the consistency and scalability of the interventions. Online platforms facilitated the dissemination of instructional materials and collection of monitoring data, addressing logistical challenges and supporting pedagogical innovation (Ceha et al., 2022; Pelánek et al., 2024; Petersen et al., 2023). These tools also allowed for asynchronous learning opportunities and greater customization of lesson delivery (Durall Gazulla et al., 2025).

In summary, the methodological rigor of this study is demonstrated through its robust design, validated instruments, cross-national implementation, and comprehensive data analysis. By combining empirical rigor with contextual sensitivity, the study offers a replicable framework for comparing active learning models in primary education across cultural boundaries (Amaefule et al., 2023; Castañeda & Marín, 2023; Lucena et al., 2025).

4. Results

This study presents a nuanced comparison between Problem-Based Learning (PBL) and Project-Based Learning (PjBL) in terms of their effectiveness in enhancing student learning activity, academic performance, and character development. The findings are interpreted within the context of the theoretical frameworks and empirical evidence discussed earlier, thereby providing meaningful contributions to the discourse on active learning in primary education.

4.1 Student Learning Activity

Observational data revealed notable improvements in student learning activity across both experimental groups following the interventions. However, the PjBL group achieved a significantly higher posttest mean score (M = 85.23) than the PBL group (M = 81.75). The gain scores indicated greater improvement for PjBL (+19.13) than PBL (+16.35). An independent t-test confirmed the statistical significance of this difference ($t(58) = 2.41$, $p = 0.019$, Cohen's $d = 0.44$). These findings are consistent with prior studies suggesting that PjBL more effectively stimulates active and contextual engagement owing to its focus on collaborative project execution and experiential learning (Chaoqun, 2022; Famaye et al., 2025; Petersen et al.,

Table 1: Mean Scores of Student Learning Activities Before and After Intervention

Experimental Group	School	Pretest Mean	Posttest Mean	Δ Score	*t*	*p*	Remark	Cohen' s d
PBL	Unismuh Elementary School	65.40	81.75	+16.35	2.41	0.019	Increased	0.44
PjBL	Indonesian School of Kuala Lumpur	66.10	85.23	+19.13			Increased	

The superior gains observed in the PjBL group reinforce the assertion that project-based approaches offer a more interactive platform for student engagement, particularly when integrated with real-world contexts and supported by digital collaboration tools (Feng et al., 2022; Shadiev et al., 2024; Xie, 2022). These environments foster autonomy, initiative, and a sense of ownership in the learning process (Akhsani & Mohamed, 2023; Ramos-Mejía & Padilla, 2025).

4.2 Academic Achievement

Both instructional models led to significant improvements in academic achievement. The PBL group attained a higher mean posttest score (M = 88.10) than the PjBL group (M = 84.45), with gain scores of +20.90 and +17.60, respectively. The ANCOVA analysis, controlling for baseline performance, confirmed the statistical significance of this result ($F = 4.92$, $p = 0.031$, partial $\eta^2 = 0.04$), affirming PBL's advantage in promoting conceptual understanding. These findings align with the established view that PBL enhances analytical reasoning, critical thinking, and deep comprehension through structured problem-solving processes (Ge et al., 2025; Orhan, 2025; Sharma et al., 2023).

Table 2: Mean Scores of Academic Achievement Before and After Intervention

Experimental Group	School	Pretest Mean	Post-test Mean	Δ Score	*t*	*p*	Remark	Partial η^2
PBL	Unismuh Elementary School	67.20	88.10	+20.90	4.92	0.031	Increased	0.04
PjBL	Indonesian School of Kuala Lumpur	66.85	84.45	+17.60			Increased	

These results are consistent with previous research highlighting PBL's effectiveness in disciplines requiring higher-order cognitive skills, such as medical, health, and language education (Lee, 2025; Lucena et al., 2025; Rosanda et al., 2025). The structured, problem-oriented approach of PBL provides clear cognitive scaffolding that facilitates mastery of complex concepts (Liu et al., 2022; Shimomura & Utsumi, 2025).

4.3 Character Development

Both instructional models produced significant improvements in character development. However, the PjBL group demonstrated a higher mean posttest score (M = 87.80) than the PBL group (M = 84.95), with gain scores of +18.70 and +16.60, respectively. An independent t-test confirmed the statistical significance of this difference ($t(58) = 2.19$, $p = 0.032$, Cohen's $d = 0.40$). This finding underscores PjBL's unique strength in fostering affective competencies—such as cooperation, responsibility, and initiative—through group-based, goal-oriented activities (Ghufron & Wuryandani, 2025; Pujiastuti et al., 2023; Wardhani et al., 2022).

Table 3: Mean Scores of Student Character Before and After Intervention

Experimental Group	School	Pretest Mean	Post-test Mean	Δ Score	**t**	**p**	Remark	Cohen's d
PBL	Unismuh Elementary School	68.35	84.95	+16.60	2.19	0.032	Increased	0.40
PjBL	Indonesian School of Kuala Lumpur	69.10	87.80	+18.70			Increased	

These results align with character education literature, which asserts that participatory learning environments—such as those fostered in PjBL—facilitate the internalization of ethical values and social behaviours (Chairunnisa, 2022; Hananingsih et al., 2024; Mistiani et al., 2022). The collaborative, project-oriented structure of PjBL inherently cultivates moral reasoning and civic responsibility (Astalini et al., 2023; Komalasari & Masyitoh, 2022; Ritonga & Desrani, 2023).

4.4 Qualitative Insights

Teacher reflection logs enriched these quantitative findings. Educators reported that PjBL demanded more complex planning and time management but generated higher levels of student collaboration and motivation. In contrast, PBL was perceived as easier to integrate into constrained instructional schedules while maintaining focus on academic discussion. These observations mirror previous research highlighting PjBL's logistical challenges and PBL's adaptability within structured curricula (Calvera-Isabal et al., 2024; Chang et al., 2022; Sharma et al., 2023).

4.5 Contextual Factors

The results also revealed contextual influences. The Indonesian School of Kuala Lumpur's superior digital infrastructure facilitated smoother implementation of online project components, while students from Unismuh Elementary School demonstrated enthusiasm for contextually grounded problem-solving activities, likely due to localized content integration. These findings underscore the importance of aligning instructional models with institutional resources and cultural contexts (Adnan et al., 2023; Komalasari & Indrawadi, 2023; Ritonga & Desrani, 2023).

4.6 Comparative Interpretation

Overall, PBL appears advantageous for academic contexts that require higher-order cognitive processing, particularly in subjects emphasizing logical reasoning and synthesis. Conversely, PjBL seems more effective in fostering interpersonal skills and ethical awareness—key components of holistic student development (Amanda et al., 2024; Bilgin & Yildiz, 2024; Devika et al., 2024).

In light of these findings, integrating both PBL and PjBL—tailored to specific educational objectives—emerges as a promising pedagogical approach. Such integration would combine PBL's academic strengths with PjBL's capacity for character building, aligning with theoretical perspectives that advocate blended pedagogies responsive to learner diversity and contextual realities (Li & Tu, 2024; Sagatbek et al., 2024; Vargas-Vera et al., 2024).

These results contribute empirical evidence supporting the complementary strengths of PBL and PjBL in primary education. The findings emphasize the need for strategic selection of instructional models based on targeted outcomes, contextual limitations, and student needs, thereby informing educators, policymakers, and curriculum developers seeking to optimize learning in diverse, digitally mediated classrooms (Amaefule et al., 2023; Castañeda & Marín, 2023; Lucena et al., 2025).

5. Discussion

The findings of this study provide compelling evidence that both Problem-Based Learning (PBL) and Project-Based Learning (PjBL) positively influence student engagement, academic achievement, and character development in cross-national primary school settings. These results contribute significantly to the ongoing discourse on active learning by reinforcing the need for pedagogical approaches that extend beyond traditional cognitive outcomes to encompass affective and

social competencies. The higher learning activity scores observed in the PjBL group (M = 85.23) compared to the PBL group (M = 81.75), as presented in Table 1, are consistent with earlier studies asserting that project-based frameworks foster contextualized and student-centred learning environments (Chaoqun, 2022; Famaye et al., 2025; Petersen et al., 2023). The dynamic nature of PjBL promotes exploration, responsibility, and collaborative inquiry, all of which are essential for sustaining student engagement (Akhsani & Mohamed, 2023; Liu et al., 2022).

These findings align with literature highlighting the value of generative and participatory learning. Students engaged in PjBL demonstrated greater ownership of their learning processes, consistent with research emphasizing the motivational impact of project-based approaches (Xie, 2022; Zhang, 2023). In the Malaysian context, enhanced digital infrastructure further supported seamless integration of technology-mediated PjBL activities (Pelánek et al., 2024; Shadiev et al., 2024). These conditions amplify the effectiveness of active learning models by enabling asynchronous collaboration, content creation, and multimodal engagement (Ceha et al., 2022; Durall Gazulla et al., 2025).

In contrast, PBL yielded superior outcomes in academic performance, as indicated by higher posttest scores (M = 88.10) relative to PjBL (M = 84.45), corroborated by ANCOVA results ($F = 4.92$, $p = 0.031$). This finding aligns with prior research identifying PBL as particularly effective in fostering higher-order thinking, problem-solving, and conceptual synthesis (Ge et al., 2025; Orhan, 2025; Sharma et al., 2023). Through iterative cycles of problem formulation, hypothesis testing, and evidence-based reasoning, PBL supports cognitive growth in ways that correspond with inquiry-based instruction in science and social studies (Chang & Chen, 2025; Lee, 2025; Lucena et al., 2025).

This distinction is noteworthy when considering the curricular orientation of each model. While PjBL often prioritizes the final product of a collaborative project, PBL emphasizes the process of knowledge construction and intellectual exploration. This observation is consistent with findings by Shimomura & Utsumi (2025) and Liu et al. (2022), who note that PBL fosters self-directed learning and metacognitive awareness. The structured format of PBL also enhances its suitability for time-constrained educational environments, as reflected in teacher observations during the intervention.

Character development, another key outcome, improved significantly in both groups, with PjBL again achieving higher post-test scores (M = 87.80 versus M = 84.95 for PBL). This outcome supports claims that project-based environments offer fertile ground for the cultivation of affective and interpersonal skills (Ghufron & Wuryandani, 2025; Pujiastuti et al., 2023; Wardhani et al., 2022). Gains in traits such as cooperation, responsibility, and initiative align with arguments that PjBL's collaborative structure inherently fosters pro-social behaviours and ethical reasoning (Chairunnisa, 2022; Hananingsih et al., 2024; Mistiani et al., 2022).

These results are further strengthened by research emphasizing the integration of cultural and religious values into pedagogy. Komalasari & Masyitoh (2022) advocate for character instruction grounded in local wisdom, which aligns well with the contextual themes in PjBL activities at the Indonesian School of Kuala Lumpur. Similarly, Ritonga & Desrani (2023) underscore the importance of religious values in character formation—an element subtly reinforced through project content in the Malaysian context.

Infrastructure and digital access emerged as influential variables affecting the fidelity of implementation. At the Indonesian School of Kuala Lumpur, advanced digital infrastructure supported seamless deployment of PjBL, particularly in activities involving online collaboration and multimedia integration (Feng et al., 2022; Petersen et al., 2023). Conversely, Unismuh Elementary School's more limited infrastructure favoured a flexible model like PBL, which relies less on technology and can be implemented effectively through dialogue and hands-on problem-solving (Chang et al., 2022; Zhang et al., 2023).

Teacher reflections and observational data further illuminated the strengths and limitations of each approach. PjBL required more extensive planning and coordination, which could be challenging in settings with limited time and resources (Antonietti et al., 2023; Calvera-Isabal et al., 2024). These challenges were mitigated in contexts with sufficient digital support and teacher readiness (Amaefule et al., 2023; Castañeda & Marín, 2023). In contrast, PBL was commended for its structured yet adaptable format, which allowed teachers to guide students through scaffolded inquiry within limited instructional periods (Laeheem, 2025; Santoso & Santoso, 2024).

The cross-cultural design of this study adds weight to its findings. By comparing two national systems with similar curricula but different cultural and infrastructural contexts, the study reinforces the principle that pedagogical strategies should be tailored to local conditions and learner characteristics (Abdurrahmansyah et al., 2022; Adnan et al., 2023; Komalasari & Indrawadi, 2023). This observation aligns with global perspectives on intercultural pedagogy that emphasize adaptability and inclusivity (Lucena et al., 2025; Shadiev et al., 2024).

The triangulation of quantitative results, observational data, and teacher reflections enhances the robustness of the study. The use of validated instruments and rigorous statistical analysis (Hu et al., 2025; Alsulaimani, 2022) strengthens the credibility and replicability of the findings. Employing SPSS for both descriptive and inferential analyses, in line with established methodological practices (Liu et al., 2022; Feng et al., 2022), further supports the study's methodological rigor.

A critical factor influencing differential outcomes relates to school culture and infrastructural readiness. In Malaysia, the Indonesian School of Kuala Lumpur benefited from advanced digital resources, enabling the full implementation of PjBL. In contrast, Unismuh Elementary School emphasized direct interpersonal

engagement and contextually embedded problem-solving—conditions that align closely with PBL. These findings underscore the necessity of aligning pedagogical choices with institutional capacity and cultural values.

This study also contributes to the broader discourse on educational technology in active learning. The results support the conclusions of Zhang (2023) and Xie (2022), who argue that digital tools can enhance participation and collaboration, particularly in PjBL contexts. However, the differences in outcomes highlight the importance of ensuring equitable infrastructure to fully leverage these tools (Pelánek et al., 2024; Petersen et al., 2023). The link between instructional models and character development also corroborates the work of Astalini et al. (2023) and Suryanti et al. (2022), who advocate participatory, values-based instruction to align cognitive outcomes with moral and social growth.

From a theoretical perspective, this study affirms the complementary nature of PBL and PjBL. PBL excels in fostering analytical and academic competencies, whereas PjBL is more effective in promoting collaborative, emotional, and ethical skills. These complementary strengths suggest that integrating both models—strategically aligned to learning objectives and student profiles—can yield optimal educational outcomes (Li & Tu, 2024; Sagatbek et al., 2024; Vargas-Vera et al., 2024). In sum, these findings provide a comprehensive understanding of how PBL and PjBL function in diverse primary education contexts. They highlight the importance of context-aware planning, infrastructure readiness, and teacher capacity building to maximize the impact of active learning strategies. Grounding instructional design in both empirical evidence and contextual realities enables educators and policymakers to create more effective and inclusive learning environments.

6. Conclusion

This study demonstrates the distinctive yet complementary impacts of Problem-Based Learning (PBL) and Project-Based Learning (PjBL) on primary school students' learning activities, academic achievement, and character development in two culturally distinct educational contexts. Quantitative results indicate that PBL is more effective in enhancing academic outcomes, whereas PjBL more strongly supports student engagement and character growth. These findings underscore the importance of aligning instructional strategies with specific educational objectives, learner characteristics, and contextual conditions.

The implications extend to curriculum design, teacher professional development, and educational policy. Integrating both PBL and PjBL offers a strategic approach to addressing the multifaceted demands of 21st-century education by balancing cognitive mastery with socio-emotional competencies. The success of both models across two national contexts illustrates their adaptability in fostering inclusive, values-based, and student-centred learning environments.

Despite these contributions, the study has several limitations. The relatively short six-week intervention may not fully capture the sustained impact of each model over time, and the cross-sectional design restricts the analysis to short-term

outcomes. The sample size and context, limited to two schools, may constrain the generalizability of the findings. Variations in teacher preparedness and familiarity with active learning methods may have influenced implementation fidelity, while differences in digital infrastructure between the Indonesian and Malaysian schools may have affected relative model performance.

Future research should employ longitudinal designs to examine long-term effects and include larger, more diverse samples to enhance generalizability. Studies exploring hybrid approaches that integrate digital technologies more deeply could provide further insight, as could investigations into the role of institutional readiness and teacher agency in supporting the effective adoption of active learning models. From a practical standpoint, PBL may be most suitable in contexts where analytical reasoning and academic mastery are prioritized, particularly in time-constrained or resource-limited environments. PjBL may be more appropriate where the instructional goal is to promote collaboration, engagement, and character development, especially in settings with stronger infrastructure and greater implementation flexibility. Teacher training should develop targeted competencies for each model, while curriculum planners should strategically combine both approaches to optimize cognitive and socio-emotional outcomes. Educational policymakers should also ensure adequate infrastructure—particularly for PjBL—to maximize the effectiveness of these models across diverse educational contexts.

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