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AI-Assisted Project-Based Language Learning in Indonesian Secondary Education: Enhancing Literacy and 21st-Century Competence

[1] *Taufik, [2]Arif Bulan, [1]Hasan, [1]Leni Marlina
[1] Study Program of Indonesian Language Education and Literature, STKIP Yapis Dompu, Jln. Syech Muhammad Lingkar Utara Bali I, Dompu, West Nusa Tenggara, Indonesia
[2] Study Program of English Education, STKIP Yapis Dompu, Jln. Syech Muhammad Lingkar Utara Bali I, Dompu, West Nusa Tenggara, Indonesia

*Corresponding Author e-mail: taufikbima25@gmail.com

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Abstract

The Society 5.0 era requires language education that integrates digital technology with humanistic, learner-centered pedagogy; yet in many Indonesian rural junior secondary schools, instruction remains lecture-dominated, literacy is confined to technical reading and writing, and the integration of artificial intelligence (AI) into Project-Based Language Learning (PBLL) is still underexplored. This study aims to explore how AI-based tools are integrated into PBLL to support literacy and 21st-century competence in Indonesian language instruction at SMPN 2 Woja, Dompu Regency. Employing a qualitative case study design, data were collected over three months (April–June 2025) through participatory observation (12 sessions), in-depth and focus group interviews, and documentation analysis. Participants, selected purposively, were one Indonesian language teacher, 28 eighth-grade students, and the school principal. Findings are reported as descriptive, context-bound evidence rather than causal proof. Four key results emerged: (1) AI tools such as Grammarly, Speech-to-Text, automated feedback, and educational chatbots were integrated as complements across pre-project, development, and revision phases; (2) students showed noticeable improvement in narrative and expository writing, with 21 of 28 students (75%) reaching the proficiency threshold in the final project assessment; (3) students responded positively, reporting increased motivation, autonomy, and metacognitive awareness, while voicing concerns about over-reliance; and (4) the teacher's role shifted from information provider to learning facilitator. Challenges included uneven digital literacy and limited infrastructure. The study concludes that AI-assisted PBLL is a feasible, humanistic model for Indonesian secondary language education, and recommends that teachers adopt it gradually, schools invest in infrastructure and sustained professional development, and policymakers embed equitable, ethical AI guidance within the Kurikulum Merdeka framework.

Keywords: AI-based tools; Project-based language learning; Literacy competence; Society 5.0 era

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INTRODUCTION

The emergence of Society 5.0 necessitates comprehensive educational transformation, particularly in strengthening 21st-century competencies (González-Pérez & Ramírez-Montoya, 2022; Handayani et al., 2024; Ydyrysbayev et al., 2022). This era integrates advanced technologies with human life harmoniously, aiming to create a human-centered society through digital technology, IoT, artificial intelligence, and big data utilization (Ferreira & Serpa, 2018; Haniah et al., 2021). In educational contexts, mastering critical thinking, collaboration, communication, and creativity skills becomes

crucial (Alifah et al., 2023; Thornhill-Miller et al., 2023). These skills represent fundamental abilities for success in modern work environments and the global economy, as they enable individuals to adapt to rapidly changing technological landscapes and solve complex problems (Autor et al., 2003; Trilling & Fadel, 2009; Van Laar et al., 2020). Indonesian language education plays a vital role in reinforcing these competencies, where literacy encompasses not only reading and writing skills but also critical thinking and digital literacy (Ali, 2020).

Project-Based Language Learning (PBLL) emerges as a pedagogical approach that encourages collaborative resolution of real-world problems, thereby enhancing language skills and critical thinking (Bhandari et al., 2025). This approach allows students to construct knowledge through deep and contextual learning experiences, positioning learners at the center of the learning process while challenging conventional education practices (Alfi & Syamsi, 2024). Rooted in constructivist learning theories, PBLL makes learning more engaging and relevant by connecting academic content with authentic, real-world applications (Kokotsaki et al., 2016). When combined with artificial intelligence (AI)-based technologies, PBLL becomes more adaptive to student needs through automated feedback, personalized learning support, and real-time assessment capabilities (Dewi Yana et al., 2025).

AI-based technologies have demonstrated transformative potential in language education contexts. Recent systematic reviews indicate that conversational AI tools and chatbots yield positive outcomes in both affective and cognitive skills among language learners (Lai & Lee, 2024). The exponential growth in AI research publications, particularly since 2023 with the advent of generative AI tools like ChatGPT, reflects increasing recognition of AI's potential to transform learning outcomes (Li et al., 2025). In language learning, these technologies can analyze students' linguistic data, ranging from writing errors and speaking intonation to text comprehension, providing personalized learning capabilities (Purnami & Widiadnya, 2024). AI-powered writing assistance tools have proven effective in supporting students during and after the writing process, offering sentence completion suggestions and automated corrections (Alharbi, 2023). AI-enhanced project-based learning, in particular, can foster proficiency, motivation, engagement, and transferable skills (Azamatova et al., 2023; Crompton et al., 2024).

Despite this expanding evidence base, three gaps remain that this study addresses directly. First, research on technology integration in language learning is concentrated in developed contexts, higher education, and Asian EFL settings, with limited evidence from Indonesian rural junior secondary schools where infrastructure and digital-literacy constraints are most acute (Lai & Lee, 2024). Second, existing studies frequently examine technology and pedagogy separately rather than as a synergistic system, leaving unclear how AI specifically functions within the project cycle of PBLL. Third, few studies connect AI-assisted PBLL explicitly to the multidimensional literacy and 21st-century competencies emphasized in Society 5.0 and the Kurikulum Merdeka. This study is therefore needed to provide context-grounded evidence on how AI can be embedded in PBLL to serve, rather than displace, humanistic language learning.

The local problem at SMPN 2 Woja sharpens this gap. Initial observation and interviews revealed three concrete issues. (1) Instruction was dominated by lectures and rote memorization, leaving students passive and minimally engaged. (2) Student literacy remained at a technical level — reading and answering questions — and had not reached critical or digital literacy. (3) Teachers' technology use was confined to video playback and PowerPoint, with no AI integration, even though the students are digital natives. These conditions make the school an information-rich site for examining whether AI-assisted PBLL can convert a teacher-centered, low-literacy environment into a learner-centered, multiliterate one.

When students are faced with challenging, contextual projects, they are encouraged to explore, discuss, write, and present results creatively, enriching their literacy and communication (Lisa & Muthohar, 2024). To ensure PBLL functions optimally, technological support providing real-time feedback is necessary (Anugraha & Padmadewi, 2023), enabling in-depth analysis of sentence structure, vocabulary, and writing style (Purwanto et al., 2025). This human–technology interaction reflects the spirit of Society 5.0, where technology enhances rather than replaces human roles, and aligns with the Merdeka Belajar principle of giving students freedom over topics, methods, and final products such as vlogs, blogs, digital short stories, or infographics (Amalia et al., 2024).

Accordingly, this study aims to explore the integration of AI-based tools in PBLL for enhancing literacy and 21st-century competence at SMPN 2 Woja in the Society 5.0 era. It is guided by four research questions: How are AI-based tools integrated into the phases of Project-Based Language Learning in Indonesian language instruction at SMPN 2 Woja? How does AI-assisted PBLL relate to students' literacy development across technical, critical, digital, and collaborative dimensions? How do students respond to the integration of AI-based tools in PBLL? And How does the teacher's role transform within AI-assisted PBLL implementation?

METHOD

Research Design

This study employed a qualitative case study design to explore in depth the integration of AI-based tools within the PBLL model in Indonesian language instruction (Creswell & Creswell, 2018; Hastuti & Suktiningsih, 2019). A single, holistic case study was chosen because the study focuses on one bounded system — one school, one teacher, and one class — examined intensively in its authentic context (Braun & Clarke, 2013). This design is the most suitable for answering the research questions because they are exploratory and process-oriented ("how" questions) rather than confirmatory; they require rich, contextual description of teacher–student interaction within real learning cycles rather than measurement of isolated variables. The descriptive-interpretive orientation emphasizes comprehensive description of phenomena based on empirical evidence rather than hypothesis testing.

The case is bounded as follows: the implementation of AI-assisted PBLL in eighth-grade Indonesian language instruction at SMP Negeri 2 Woja over one term. The site, in Dompu Regency, West Nusa Tenggara, was selected purposively because it represents a typical rural Indonesian secondary school: institutionally open to project-based curriculum innovation yet constrained by limited infrastructure — precisely the under-researched setting identified in the gap. Data collection spanned three months (April–June 2025), covering multiple learning cycles. The AI-assisted PBLL implementation proceeded in six project cycles of 2–3 weeks each, structured around three recurring phases: (1) a pre-project planning phase, (2) a project development phase, and (3) a revision-and-presentation phase, with AI tools introduced as scaffolds within each phase (detailed in Findings).

Participants

Participants were selected through purposive sampling based on direct involvement in AI-assisted PBLL. The class was selected because it was the only eighth-grade group implementing the project-based curriculum with the participating teacher during the study period, ensuring relevance to the research focus. Participants comprised: One Indonesian language teacher (male, eight years of teaching experience), holding a bachelor's degree in Indonesian language education, with prior technology use limited to PowerPoint and video — and therefore representative of teachers beginning their AI journey rather than expert adopters. Twenty-eight eighth-grade students (aged 13–14), of mixed achievement

and, per the baseline assessment, predominantly at a technical literacy level; approximately 60% had access to personal devices, reflecting the digital divide central to the study. The school principal, included as a key informant because of his role in institutional policy, resource allocation, and support for technology integration.

All participants provided informed consent; student participation was approved by parents or guardians through signed consent forms. Ethical protection was maintained throughout: pseudonyms replaced all real names in field notes, transcripts, and reporting; interview and observation data were stored in password-protected files; participants were informed of their right to withdraw at any time without consequence; and student work was analyzed only with prior permission.

Data Collection

Data were collected through three methods, sequenced to triangulate the four research questions. First, participatory observation comprised 12 sessions of 2×40 minutes, focused respectively on AI integration patterns (RQ1), evidence of literacy practices (RQ2), student responses (RQ3), and teacher facilitation behavior (RQ4). Field notes followed structured observation protocols covering learning activities and procedures, AI-tool use, student participation, and challenges. Second, semi-structured interviews included three teacher sessions (45–60 minutes), six student focus group discussions (4–5 students per group, 30–40 minutes), and one principal interview (60 minutes). The interview guide was organized around four thematic clusters: (a) experiences of integrating AI into project phases; (b) perceived changes in literacy and competence; (c) benefits, frustrations, and concerns; and (d) shifts in teaching roles. All interviews were audio-recorded with permission and transcribed verbatim within 48 hours; transcripts were returned to participants for confirmation. Third, documentation analysis examined lesson plans, teaching materials, assessment rubrics, students' reflection journals, and project outputs (digital short stories, podcasts, presentations). Specifically, Google Docs revision histories and successive draft versions were analyzed as direct evidence of the writing process.

Data Analysis

Data were analyzed using the interactive model of Miles and Huberman (1994): data reduction, data display, and conclusion drawing/verification. Coding was conducted manually, then organized in spreadsheets; no qualitative software was used. Two researchers coded a subset independently and compared codes to strengthen analytical consistency (inter-coder checking) before resolving discrepancies through discussion.
To make the process transparent, the table below illustrates the movement from raw data to initial codes, categories, and final themes.

Table 1. Illustrative Examples of the Analytical Progression from Raw Data to Final Themes

Illustrative raw data	Initial code	Category	Final theme (linked to RQ)
"Grammarly shows me mistakes as I type… I can fix them immediately." (Student FGD)	immediate-feedback	real-time correction	AI integration patterns (RQ1)
Draft revision adding punctuation, capitalization, descriptive detail	convention-improvement	technical literacy	Literacy development (RQ2)
"Now I evaluate each suggestion before applying it." (Student FGD)	critical-evaluation	digital/critical literacy	Literacy development (RQ2)

Illustrative raw data	Initial code	Category	Final theme (linked to RQ)
"Now with projects and technology, it's more interesting." (Student)	engagement-up	motivation	Student responses (RQ3)
"My role has fundamentally changed… freeing me to focus on deeper aspects." (Teacher)	role-shift	facilitation	Teacher transformation (RQ4)

In the data display stage, reduced data were organized into matrices and thematic networks (e.g., a matrix mapping pre-implementation conditions, intervention processes, and post-implementation outcomes). In conclusion drawing and verification, preliminary conclusions were checked through triangulation across observation, interview, and documentary data and through member checking until thematic saturation was reached. The study adhered to principles of informed consent, voluntary participation, confidentiality, and the right to withdraw, with prior approval from the school administration.

RESULTS AND DISCUSSION

Research Findings

Overview of Findings. Aligned with the four research questions, the data converge on four interrelated findings. (1) AI tools were integrated as complements — not replacements — across the three PBLL phases, anchored by a small set of accessible applications (RQ1). (2) Students showed noticeable, descriptive gains in writing across four literacy dimensions, with 21 of 28 students (75%) reaching the proficiency threshold, although one quarter progressed little (RQ2). (3) Student responses were predominantly positive — higher motivation, autonomy, and metacognition — tempered by concerns about over-reliance and technical access (RQ3). (4) The teacher's role shifted markedly from information provider to facilitator, accompanied by new competencies and challenges (RQ4). These findings are presented below as context-bound, descriptive evidence rather than as causal or statistically generalizable claims.

Patterns of AI-Based Tools Integration in PBLL (RQ1)

The teacher implemented PBLL systematically over six project cycles, each lasting 2–3 weeks and focused on different text types. Consistent with the bounded case, AI tools were integrated as supporting resources rather than substitutes for teacher expertise (Du & Daniel, 2024). The teacher used Grammarly (free version) for grammar and spelling correction, Google Docs Smart Compose for collaborative writing, Speech-to-Text via Google Voice Typing for students with writing difficulties, Google Forms for automated quiz feedback, and a simple chatbot in Google Classroom for frequently asked questions. As the teacher explained, "I started with simple tools that don't require advanced technical skills… These tools make feedback faster and more specific" (Teacher interview, May 15, 2025).

Three integration patterns emerged. In the pre-project phase, AI supported brainstorming and planning (mind-mapping suggestions, chatbot guidance, research support). In the project development phase, AI provided continuous support (real-time writing assistance, collaborative editing, Speech-to-Text drafting). In the revision and presentation phase, AI facilitated improvement (feedback on structure and coherence, voice analysis for podcasts, peer feedback via collaborative platforms). This pattern illustrates how AI can supply real-time, personalized, and continuous support within PBLL (Crompton et al., 2024).

Table 2. AI Tools Integration in PBLL Projects

Project Type	**AI Tools Used**	**Primary Function**	**Student Response***
Digital Short Story	Grammarly, Google Docs	Grammar checking, collaborative writing	Highly positive (92%)
Literacy Podcast	Speech-to-Text, voice recorder apps	Transcription, articulation feedback	Positive (85%)
Informative Presentation	Canva AI, automated research tools	Design suggestions, content organization	Very positive (88%)
Creative Essay	Grammarly, thesaurus tools	Language enhancement, vocabulary expansion	Positive (79%)

Note: Percentages are descriptive survey responses (N=28) indicating perceived helpfulness, not measures of learning effect. Source: Observation data and student surveys.

Several challenges emerged. Infrastructure limits meant only 60% of students had personal devices, connectivity was unstable, and laboratory access was shared. One student noted, "Sometimes I can't complete revisions at home because I don't have a laptop" (Student FGD, May 22, 2025) — consistent with access and affordability barriers reported elsewhere (Crompton et al., 2024). Teacher digital-competency gaps were evident: "Initially, I was overwhelmed by the technical aspects. I had to learn through YouTube tutorials and trial-and-error" (Teacher interview, June 5, 2025). Students also needed 2–3 weeks to adapt, with some still preferring traditional methods.

Student Literacy Development (RQ2)

Using a descriptive rubric assessing text structure, coherence, language accuracy, and originality (1–4 scale), the teacher's classroom assessment showed consistent improvement between the baseline (March 2025) and the final project (June 2025).

Table 3. Student Writing Performance Comparison (descriptive rubric scores)

Assessment Criteria	Pre-Implementation Mean (N=28)	Post-Implementation Mean (N=28)	Change
Text Structure	2.1	3.2	+1.1
Cohesion & Coherence	1.9	3.1	+1.2
Language Accuracy	2.3	3.4	+1.1
Originality of Ideas	2.0	3.0	+1.0
Overall Average	2.08	3.18	+1.10

*Note: These are descriptive, teacher-assigned rubric scores within a single class; no statistical significance testing was conducted, and the changes are not interpreted as causal effects of AI alone.

In the final assessment, 21 of 28 students (75%) reached 3.0 or above, compared with 5 students (18%) at baseline; seven students (25%) improved more modestly and remained below the threshold. These descriptive patterns are consistent with systematic reviews reporting AI's promise for writing quality and engagement (Lai & Lee, 2024; Zhang et al., 2025), though, given the qualitative design, they are best read as indicative rather than confirmatory.

Document analysis and interviews revealed four literacy dimensions. Technical literacy improved in writing conventions; one student's draft progressed from a run-on sentence with missing punctuation in April to a structured, descriptive passage with corrected capitalization and sentence variation in June. Critical literacy developed as students questioned information: "Now, with AI feedback showing me where my arguments are weak, I learned to ask: Is this claim supported?" (Student reflection journal, June 2025). The teacher observed more constructive peer challenge during reviews (Teacher interview, June 5, 2025). Digital literacy grew as students learned to evaluate,

not blindly accept, AI suggestions: "Some suggestions didn't fit Indonesian language context… Now I evaluate each suggestion before applying it" (Student FGD, May 29, 2025) — a competency central to the age of AI (Alharbi, 2023). Collaborative literacy flourished: Google Docs histories showed an average of 47 collaborative edits per group, with constructive peer comments rising from 8 to 23 per project, illustrating co-construction beyond traditional methods (Azamatova et al., 2023). Text-analysis tasks showed improved identification of main ideas (from 65% to 87% descriptive accuracy), and reflection journals revealed growing metacognitive awareness — "AI tools help me see my mistakes, but I'm the one who decides how to fix them" (June 10, 2025) — a hallmark of self-regulated learning (Cao, 2024).

Student Responses to AI-Based Technology (RQ3)

A final-week survey (N=28) indicated that 24 students (86%) found AI tools helpful or very helpful, 22 (79%) reported increased motivation, 26 (93%) wished to continue using them, and 4 (14%) were neutral or slightly negative — figures reported as descriptive perceptions. Six benefit categories emerged: immediate feedback ("Grammarly shows me mistakes as I type"; Student FGD, May 22, 2025); increased confidence ("I feel braver to try different writing styles"; May 29, 2025); learning autonomy ("The chatbot answers questions when the teacher isn't available"; June 1, 2025); engagement and reduced monotony ("Now with projects and technology, it's more interesting"; June 3, 2025); accessibility for diverse learners, especially via Speech-to-Text ("I can express my ideas without worrying about handwriting"; May 25, 2025); and collaborative enhancement ("It's easier to help each other and combine our ideas"; June 1, 2025).

Students also voiced concerns. Some feared over-reliance ("What if I have to write without it?"; May 29, 2025), a concern noted in the literature with calls to safeguard foundational skills (Alharbi, 2023). Others reported connectivity and interface frustrations, and a minority preferred human feedback ("Sometimes I need the teacher to explain why something is wrong"; June 7, 2025), underscoring the irreplaceable human role. Observation revealed a typical adaptation arc: curiosity and confusion (weeks 1–2), growing comfort (weeks 3–4), selective and critical use (weeks 5–6), and routine, balanced integration (week 7 onward).

Transformation in the Teacher's Role (RQ4)

The teacher described a fundamental shift: "Before, I was the primary source of information and correction. Now, AI handles routine corrections, freeing me to focus on deeper aspects" (June 5, 2025) — aligning with the move from knowledge provider to facilitator (Du & Daniel, 2024). Time-use observation supported this.

Table 4. Teacher Activity Allocation Comparison (descriptive time-sampling, 12 sessions)

Teacher Activity	Pre-AI (%)	Post-AI (%)	Change
Direct instruction/lecturing	45	20	−25
Individual student consultation	15	35	+20
Facilitating group work	20	30	+10
Administrative tasks (grading)	20	15	−5

The teacher developed new competencies: TPACK ("I had to learn not just how to use AI tools, but when and why"; June 2025), aligning with Koehler and Mishra (2009); resource curation; technology-enhanced lesson design; and data-informed instruction (designing mini-lessons from common AI-flagged errors; May 28, 2025). Challenges included initial anxiety ("I worried about losing authority"; April 25, 2025), balancing technology with pedagogy ("Does this serve learning objectives, or is it just novelty?"; June 2025), and time investment. Yet professional growth followed ("This experience reignited

my passion for teaching"; June 12, 2025), confirmed by the principal ("The teacher has become a change agent in our school"; June 10, 2025). Assessment shifted from product-focused to process-oriented, with rubrics revised to value revision quality, engagement with feedback, collaboration, and metacognitive reflection.

Discussion

Synergy Between PBLL and AI-Based Tools

The findings of this study illuminate several critical dimensions of AI-assisted PBLL implementation in Indonesian secondary education, contributing to both theoretical understanding and practical application. The successful integration observed in this study aligns with constructivist learning theories, where students actively construct knowledge through authentic tasks (Alfi & Syamsi, 2024). Rooted in constructivist learning theories, PBLL places students at the center of the learning process, challenging conventional education practices and redefining the roles of teaching, learning, and school organization (Kokotsaki et al., 2016). AI tools enhanced this constructivist foundation by providing scaffolding that functioned as dynamic support adapting to individual student needs, consistent with Vygotsky's Zone of Proximal Development where students received support at their current competency level enabling progression to higher-order skills. Immediate feedback loops created rapid iteration cycles essential for skill development, addressing a traditional limitation of teacher-centered instruction where feedback delays can interrupt learning momentum. Personalized learning pathways were enabled as while PBLL provided the authentic context, AI tools enabled differentiation where students with varying abilities worked on the same projects but received customized support, promoting inclusive education.

However, this study reveals that AI tools functioned optimally as complements rather than replacements for teacher expertise. The teacher's role in contextualizing AI feedback, facilitating deeper discussions, and addressing affective dimensions remained irreplaceable. This finding supports the human-centered approach advocated in Society 5.0 philosophy, where technology serves human flourishing rather than displacing human agency. Recent research emphasizes that teachers play significant roles in AI-enhanced learning processes, and effective integration requires collaboration between teachers and AI to enhance student learning outcomes (Du & Daniel, 2024). The literacy improvements documented extend beyond traditional conceptualizations of reading and writing. This study identified four interconnected literacy dimensions: technical literacy involving foundational skills in grammar, structure, and conventions where AI tools demonstrated clear efficacy through automated correction and suggestion features; critical literacy as the ability to question, analyze, and evaluate information developed through students' engagement with AI feedback which prompted reflection on whether suggestions aligned with their communicative intentions; digital literacy encompassing competencies in navigating, evaluating, and purposefully using digital tools emerging as students learned to critically assess AI suggestions rather than blindly accepting them; and collaborative literacy involving skills in co-constructing knowledge through digital interaction fostered by shared document platforms and peer feedback mechanisms.

These findings align with contemporary literacy frameworks emphasizing multimodal, critical, and digital competencies (Ali, 2020). Importantly, the integration created synergies across literacy dimensions—for example, collaborative activities strengthened both technical skills through peer editing and critical thinking through evaluating peers' arguments. The 75% improvement rate, while substantial, also highlights that one-quarter of students showed limited progress. Analysis suggests these students faced compounding challenges including limited device access, lower baseline digital literacy, and in some cases motivational factors. This underscores the necessity of

equitable technology access and differentiated support systems, as research has identified access and affordability of AI as significant challenges in implementation (Crompton et al., 2024).

Student Agency and Teacher Transformation

The predominantly positive student responses reflect increased sense of agency where students felt empowered to work independently, experiment with writing strategies, and self-correct errors. This aligns with self-determination theory, which posits that autonomy, competence, and relatedness drive intrinsic motivation. AI tools supported all three psychological needs: autonomy as students made choices about when and how to use AI assistance, competence through immediate feedback and visible improvement fostering efficacy beliefs, and relatedness as collaborative platforms enabled meaningful peer connections. Research demonstrates that AI-enhanced project-based learning increases learner motivation and engagement by actively involving students in interactive projects (Azamatova et al., 2023). However, the concern about over-reliance expressed by some students represents healthy metacognitive awareness. This suggests the importance of explicitly teaching students to use AI tools strategically rather than dependently, viewing them as learning aids rather than crutches.

The finding that engagement increased even among previously disengaged students has important implications for addressing educational equity. Technology-enhanced PBLL may offer entry points for students who struggle with traditional pedagogies, though care must be taken to ensure that technology access doesn't create new inequities. The teacher's transformation exemplifies the Technological Pedagogical Content Knowledge or TPACK framework where successful technology integration requires not just technical skills but the ability to synthesize technological, pedagogical, and content knowledge in context-specific ways (Koehler & Mishra, 2009). The challenges faced including technological anxiety, balancing pedagogy with technology, and time constraints are common in educational technology adoption. This study's findings suggest several success factors: gradual implementation starting with accessible tools like Grammarly and Google Docs rather than complex systems reduced cognitive overload and built confidence progressively; reflective practice as the teacher's continuous reflection on what worked and why fostered adaptive expertise rather than routine expertise; and institutional support where although limited, the school's openness to experimentation and provision of computer laboratory access enabled implementation.

These findings have implications for teacher professional development. Rather than one-time training workshops, sustained support through professional learning communities, peer coaching, and action research approaches may be more effective for technology integration. The shift from instructor to facilitator represents a fundamental reconceptualization of teaching. This shift aligns with 21st-century learning paradigms emphasizing student-centered, inquiry-based approaches (Lutfiyana et al., 2024). However, it also raises questions about teacher preparation programs—are pre-service teachers being equipped with the competencies needed for this facilitative role in technology-rich environments? The challenges identified including infrastructure limitations, digital literacy gaps, and resource constraints are characteristic of many Indonesian schools, particularly in rural areas. This study's context at SMPN 2 Woja in Dompu Regency represents a common scenario: institutional willingness to innovate constrained by material limitations.

Several strategies emerged as potentially transferable: leveraging free or freemium tools using freely available AI applications like Grammarly basic and Google suite reduced financial barriers; shared device models where students without personal devices utilized computer laboratory sessions and collaborated with device-owning peers; hybrid

approaches combining technology-enhanced activities with traditional methods ensured all students could participate meaningfully; and teacher as learner where the teacher's willingness to learn alongside students created a growth-oriented classroom culture that normalized experimentation and error. However, these strategies represent workarounds rather than solutions. Sustainable implementation requires systemic support including infrastructure investment, teacher training programs, curriculum frameworks that accommodate technology integration, and policies addressing digital equity. This study's findings illuminate how educational practices can embody Society 5.0 principles of human-centered technology integration that enhances rather than displaces human capabilities. The AI-assisted PBLL model demonstrated technology as enabler where AI tools enabled more personalized, responsive, and engaging learning without reducing students to passive technology consumers; preservation of human elements as teachers' relational, affective, and higher-order cognitive roles remained central with technology handling routine tasks; collaborative human-AI partnership where students learned to work with AI as a tool for augmenting their capabilities while developing critical judgment about when and how to use such tools; and preparation for future demands as students developed competencies including critical thinking, collaboration, digital literacy, and adaptability essential for thriving in increasingly technology-integrated societies.

These findings contribute to emerging scholarship on AI in education by demonstrating that effective integration is not merely about technology adoption but about thoughtful pedagogical redesign that maintains humanistic educational values while leveraging technological affordances. This study's limitations must be acknowledged. As a qualitative case study in a single school, findings may not transfer to all contexts, and comparative studies across different school types, regions, and student populations would strengthen understanding. Research indicates that most empirical studies on AI in language learning are conducted in higher education settings, with limited research in K-12 contexts (Lai & Lee, 2024), highlighting the need for more diverse research settings. The three-month implementation duration may not reveal long-term effects, and longitudinal research could examine sustainability and deeper impacts on student learning trajectories. Systematic reviews emphasize the need for longitudinal studies to understand long-term impacts of AI integration in education (Li et al., 2025). Without experimental controls, attributing improvements solely to AI-PBLL integration is problematic as multiple factors including teacher enthusiasm, novelty effects, and student maturation likely contributed. This study examined relatively simple AI applications, and research on more advanced AI systems such as adaptive learning platforms and AI tutors with natural language processing could extend these findings.

Future research directions include comparative effectiveness studies of different AI tools in PBLL, longitudinal tracking of students' literacy development and technology competencies, investigation of optimal teacher professional development models for AI integration, examination of equity issues in AI-assisted learning across different socioeconomic contexts, and exploration of student data privacy and ethical considerations in educational AI. Research gaps include limited studies in K-12 settings, insufficient longitudinal research, need for more diverse language representation beyond English, and addressing ethical concerns such as data privacy and algorithmic bias (Lai & Lee, 2024; Li et al., 2025).

CONCLUSION

This qualitative case study examined how AI-based tools were integrated into Project-Based Language Learning to support literacy and 21st-century competence among eighth-grade students at SMPN 2 Woja. Within this single, bounded context, four findings stand out: AI tools functioned as complements across the PBLL phases; students showed

noticeable, descriptive gains in technical, critical, digital, and collaborative literacy, with 75% reaching the proficiency threshold; students responded with greater motivation, autonomy, and metacognition while voicing healthy concerns about over-reliance; and the teacher's role shifted from information provider to facilitator, supported by emerging TPACK. These outcomes are interpreted as context-specific and indicative rather than as causal proof of effectiveness.

The study's central contribution is to demonstrate, at the level of everyday classroom practice, that AI can enhance rather than replace humanistic language education — preserving the relational and affective work of teaching while augmenting personalization and feedback. Its scope is necessarily limited: the evidence comes from one school, one teacher, and one class, and broader, longer, and comparative studies are needed to test transferability. For practitioners, the model offers a feasible path emphasizing gradual, purposeful adoption; for policymakers, it underscores the need for infrastructure investment, sustained teacher development, and equity-oriented, ethical AI guidance. Ultimately, the promise of AI in Indonesian language education lies not in the sophistication of its tools but in the wisdom with which teachers and students keep human judgment at the centre.

RECOMMENDATION

Future Research Directions. Subsequent studies should employ longitudinal designs of at least one academic year to examine sustained effects; comparative studies across urban/rural, public/private, and varied socioeconomic settings to assess transferability; investigation of more sophisticated AI systems (adaptive platforms, NLP-based tutoring); quasi-experimental designs with control groups to address attribution; and focused inquiry into data privacy, algorithmic bias, and the ethics of educational AI in Indonesian K-12 contexts.

Recommendations for Practice and Policy. Schools should prioritize digital infrastructure (stable connectivity, equitable device access) as a prerequisite for sustainable integration. Teacher development should move from one-time training toward sustained professional learning communities, peer coaching, and action research that build long-term TPACK. Curriculum developers and policymakers should embed explicit, equitable, and ethical AI-pedagogy guidelines within the Kurikulum Merdeka framework.

Anticipated Barriers. Persistent infrastructure gaps in rural regions risk deepening inequities; uneven teacher digital literacy may slow adoption; the rapid evolution of AI complicates curriculum alignment; and concerns over over-reliance, data privacy, and ethical use require policy frameworks that do not yet fully exist in the Indonesian landscape.

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DECLARATION OF THE USE OF AI TOOLS

The authors declare that AI-based language tools were used during the preparation of this manuscript solely to assist with language editing, grammar refinement, and improving readability. No AI tool was used to generate research data, analyse findings, or produce scholarly interpretations. All research design, data collection, analysis, and conclusions

are the authors' own. The authors reviewed and verified all AI-assisted text and take full responsibility for the content and integrity of the manuscript.

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