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Artificial Intelligence-Supported Project-Based Learning for Enhancing Students' Digital Engagement in Remote Schools

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Abstract

The integration of artificial intelligence (AI) into education has created new opportunities for supporting interactive and student-centered learning environments. However, the implementation of AI-supported learning in remote island schools remains challenging due to limited technological infrastructure, restricted access to digital resources, and unequal learning opportunities. This study aims to examine the implementation of Artificial Intelligence-Supported Project-Based Learning (AI-Supported PjBL) and explore its role in enhancing students' digital engagement in a remote island school context. The study employed a mixed-method approach involving 30 junior high school students in a small island school on Lae-Lae Island, Indonesia. Learning activities were implemented through contextual project-based learning integrated with AI-assisted digital tools for information exploration, project planning, and digital content creation. Quantitative data were collected using a digital engagement questionnaire covering cognitive, emotional, and behavioural engagement dimensions, while qualitative data were obtained through classroom observations, interviews, and project documentation. The findings revealed that students demonstrated relatively high levels of digital engagement during AI-supported project activities, with cognitive engagement showing the highest percentage (76.23%), followed by emotional engagement (76.02%) and behavioural engagement (75.55%). Qualitative findings further indicated that AI-supported project activities encouraged active participation, collaborative inquiry, digital communication, and contextual problem-solving despite limitations in technological infrastructure. The study suggests that AI-Supported PjBL can provide meaningful and engaging digital learning experiences for students in geographically isolated schools and may serve as a contextual learning approach for strengthening digital participation in resource-limited educational environments.

Keywords: Contextual Learning, Digital Engagement, Project-Based Learning, Remote Island Schools, Slow Artificial Intelligence

Introduction

The rapid development of digital technology and artificial intelligence (AI) has transformed many aspects of education, including how students access information, communicate, and participate in learning activities (Chen et al., 2020; Zou et al., 2025). In recent years, AI-supported technologies such as generative AI platforms, intelligent search systems, and digital content creation tools have increasingly been integrated into classroom practices to support inquiry, collaboration, and problem-solving (Tong et al., 2025). These technologies are considered to have the potential to create more interactive and student-centered learning environments, particularly in learning approaches that emphasize active participation and authentic problem-solving experiences (Artasari & Setyaningrum, 2025). Along with these developments, schools are also expected to strengthen students' engagement in digital learning activities as part of preparing learners for the demands of 21st-century education (Zou et al., 2025).

Digital engagement has become an important issue in contemporary education because students are no longer positioned merely as consumers of information but also as active participants, who interact, evaluate, and produce knowledge using digital technology (Bond et al., 2020). Digital engagement refers not only to students' ability to use technological devices, but also to their cognitive, emotional, and behavioural involvement during digital learning activities (Nahum-Shani et al., 2022). Students with high digital engagement tend to participate more actively in collaborative learning, explore information independently, communicate ideas more confidently, and demonstrate stronger persistence in completing learning tasks (Al Mamun & Lawrie, 2023). Previous studies have also shown that meaningful digital engagement contributes to learning motivation, knowledge construction, and the development of higher-order thinking skills (Wang et al., 2022).

Review of Related Literature

The growing integration of digital technology in education, many schools located in remote and geographically isolated areas continue to experience considerable challenges in implementing technology-supported learning (Ferri et al., 2020; Firdaus & Ritonga, 2024). Schools in island regions often face limited internet connectivity, inadequate digital infrastructure, restricted access to learning resources, and a shortage of technology-based instructional support (Harahap et al., 2025). These conditions may reduce students' opportunities to interact meaningfully with digital learning environments and frequently result in technology being used only for basic communication or entertainment purposes rather than as a tool for inquiry and knowledge construction (Al Mamun & Lawrie, 2023). In many cases, learning activities in remote schools also remain dominated by teacher-centered instruction, limiting opportunities for students to engage in collaborative exploration and problem-solving activities (De Jong et al., 2022; Le et al., 2018).

The challenges experienced by remote island schools indicate the need for learning approaches that are not only technology-oriented but also contextual and adaptable to local conditions (Hesti Putri et al., 2025). One learning approach that has been widely recognized for promoting active learning and authentic problem solving is Project-Based Learning (PjBL) (Chistyakov et al., 2023; Guo et al., 2020). Through project activities, students are encouraged to investigate real-world problems, collaborate with peers, and develop solutions that are relevant to their surrounding environment (Evains et al., 2024; Rehman et al., 2023). PjBL also provides opportunities for students to integrate digital

technology into inquiry activities, communication, and the creation of learning products. In the context of remote schools, project-based learning may help students connect classroom learning with local environmental and social issues that are closely related to their daily experiences (Nurhidayati et al., 2024).

Recent developments in artificial intelligence further expand the possibilities of project-based learning implementation (Ruiz Viruel et al., 2025). AI-supported learning tools can assist students in searching for information, generating ideas, organizing project plans, creating digital artifacts, and reflecting on learning processes (Pesovski et al., 2024). Rather than replacing the role of teachers, AI technologies may function as cognitive scaffolding tools that support students during inquiry and project activities. AI-supported learning environments may also encourage students to participate more actively in digital learning activities because students are provided with immediate access to information, interactive feedback, and flexible opportunities for exploration (Yaseen et al., 2025). However, most studies examining AI integration in education have been conducted in urban or technologically well-equipped schools, while research focusing on remote island contexts remains limited.

Objectives

The purposes of this project-based learning in remote schools have primarily emphasized learning outcomes such as academic achievement, digital literacy, or critical thinking skills. Comparatively fewer studies have explored how AI-supported project-based learning facilitates students' digital engagement during the learning process itself. Understanding digital engagement is important because engagement reflects how students cognitively, emotionally, and behaviourally interact with digital learning experiences. Investigating these aspects may provide a deeper understanding of how AI-supported learning can function effectively in schools with limited technological resources.

Therefore, this study examines the implementation of Artificial Intelligence-Supported Project-Based Learning (AI-Supported PjBL) in a remote island school context and explores how this learning approach facilitates students' digital engagement during project activities. By focusing on students' participation in AI-assisted inquiry, collaboration, digital communication, and project development, this study seeks to contribute to the growing discussion regarding the role of AI in contextual and resource-limited educational environments. The findings are expected to provide insights into how AI-supported project-based learning can create more meaningful and engaging digital learning experiences for students in geographically isolated schools.

Methodology

Research Design

This study employed a mixed-method approach using an embedded design to examine the implementation of Artificial Intelligence-Supported Project-Based Learning (AI-Supported PjBL) in a remote island school context and to explore its influence on students' digital engagement during learning activities. The mixed-method approach was selected to provide a more comprehensive understanding of how students participated cognitively, behaviourally, and emotionally in AI-supported project activities. Quantitative data were used to identify patterns of students' digital engagement during the learning intervention, while qualitative data were utilized to describe students' learning experiences, participation, and interactions throughout the project process.

The study was conducted during the implementation of project-based learning activities integrated with AI-assisted digital tools. Learning activities were designed to encourage students to explore contextual problems found in their surrounding environment and develop collaborative digital project products. Artificial intelligence tools were utilized as learning support systems during information exploration, idea generation, project planning, and digital content development.

Research Site and Participants

The research was conducted at a junior high school located on Lae-Lae Island, Makassar, Indonesia. Lae-Lae Island is categorized as a small island area with limited educational infrastructure and constrained access to digital technology compared to urban schools. Internet connectivity in the area is relatively unstable, and the availability of digital learning resources remains limited. Most students come from families whose primary occupations are related to fishing and informal economic sectors.

Participants in this study consisted of 30 lower secondary school students who were involved in the implementation of AI-Supported PjBL activities. The participants were selected purposively based on their involvement in project-based learning activities and their accessibility to basic digital devices during the learning process. In addition, several teachers participated as facilitators during the implementation of project activities and contributed to qualitative observations regarding students' engagement during learning.

Learning Intervention

The learning intervention was implemented through a series of contextual project-based learning activities integrated with the use of AI-supported digital tools. The projects were developed based on environmental and social issues relevant to students' daily lives in island communities, including waste management, clean water availability, coastal environmental problems, and local energy use.

The implementation of AI-Supported PjBL consisted of several stages: contextual problem identification, collaborative project planning, AI-assisted information exploration, project development, digital product presentation, and reflection. During the information exploration stage, students used AI-supported tools to search for information, generate project ideas, summarize learning materials, and develop digital content. Students also utilized digital platforms to create project products such as posters, presentations, short videos, and digital reports.

Throughout the learning activities, teachers functioned as facilitators who guided students in evaluating digital information, organizing project tasks, and reflecting on the learning process. AI technologies were not positioned as replacements for classroom instruction but rather as supporting tools that assisted students during inquiry and collaborative learning activities.

Instruments

Data collection was conducted using both quantitative and qualitative instruments. Quantitative data were collected through a students' digital engagement questionnaire administered after the implementation of the learning intervention. The questionnaire was developed based on three dimensions of engagement: cognitive engagement, behavioural

engagement, and emotional engagement in digital learning activities. The instrument employed a five-point Likert scale ranging from strongly disagree to strongly agree.
Cognitive engagement indicators included students' involvement in analyzing information, evaluating digital sources, and developing project ideas. Behavioural engagement focused on participation in collaborative activities, completion of project tasks, and active involvement in digital learning activities. Emotional engagement measured students' interest, motivation, confidence, and enthusiasm during AI-supported project learning.

Qualitative data were collected through classroom observations, semi-structured interviews, and documentation of students' project activities. Observations were conducted throughout the learning intervention to examine students' interactions, collaboration patterns, and participation during project activities. Interviews with students and teachers were conducted to obtain deeper insights into their experiences in using AI-supported digital tools during learning. Documentation included digital artifacts, project reports, photographs of learning activities, and students' presentation products.

Analysis

Quantitative data obtained from the digital engagement questionnaire were analyzed descriptively using mean scores, percentages, and standard deviations to identify patterns of students' engagement during AI-supported project activities. The analysis was conducted for each engagement dimension, including cognitive engagement, behavioural engagement, and emotional engagement.

Qualitative data from observations, interviews, and documentation were analyzed using thematic analysis. The analysis involved data reduction, coding, categorization, and interpretation to identify recurring patterns related to students' participation, interaction, and experiences during AI-supported project-based learning activities. The integration of quantitative and qualitative findings was conducted to provide a more comprehensive understanding of how AI-supported project-based learning facilitated students' digital engagement in the context of remote island schools.

Findings and Discussion

Students' Digital Engagement in AI-Supported Project-Based Learning

The implementation of Artificial Intelligence-Supported Project-Based Learning (AI-Supported PjBL) demonstrated positive patterns of students' engagement during learning activities in the remote island school context. Students were actively involved in various stages of project development, including identifying contextual problems, exploring digital information, discussing project ideas collaboratively, and producing digital learning artifacts. The integration of AI-supported tools within project activities also encouraged students to participate more actively in digital learning processes.

The quantitative analysis of students' digital engagement showed that all dimensions of engagement were categorized at a relatively high level. Figure 1 presents the mean percentage scores of students' cognitive engagement, emotional engagement, and behavioural engagement during the implementation of AI-Supported PjBL.

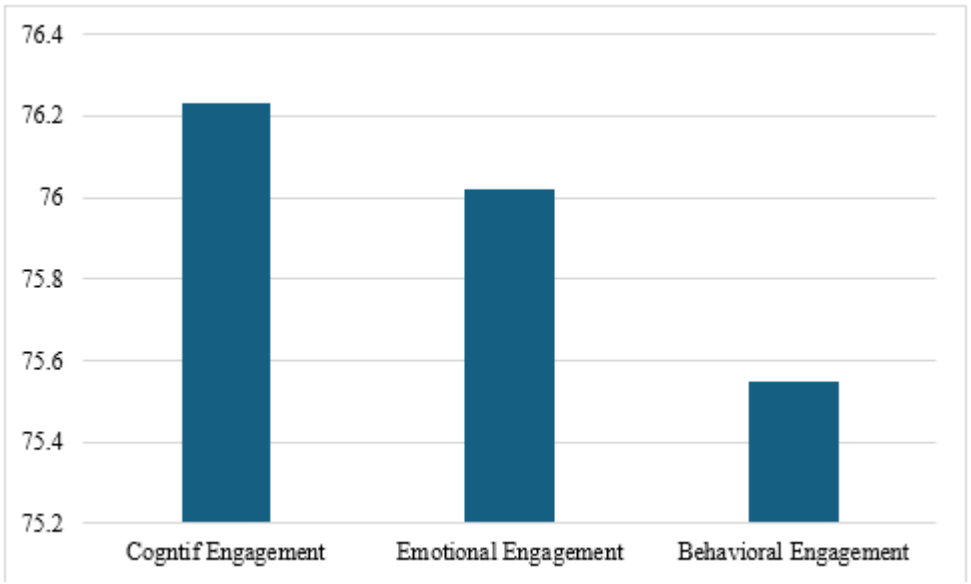

Figure 1. Students' Digital Engagement during AI-Supported Project-Based Learning

The results indicate that cognitive engagement obtained the highest percentage score (76.23%), followed by emotional engagement (76.02%) and behavioural engagement (75.55%). Although the differences among the three dimensions were relatively small, the findings suggest that students demonstrated consistent involvement across cognitive, emotional, and behavioural aspects during AI-supported project activities.

The relatively high cognitive engagement score indicates that students were actively involved in information exploration, idea generation, and problem analysis during project activities. During the learning process, students utilized AI-supported tools to search for information related to contextual environmental problems found in their surrounding communities. Students also compared information obtained from various digital sources and discussed alternative project solutions collaboratively. These activities encouraged students to become more actively engaged in inquiry-oriented learning processes rather than passively receiving information from teachers.

Emotional engagement also showed a relatively high percentage, suggesting that students experienced positive emotional involvement during learning activities. Observational findings revealed that students demonstrated enthusiasm and curiosity when interacting with AI-assisted digital tools during project development. Many students expressed increased interest in learning activities because the projects were directly connected to real problems in their local environment. The use of AI-supported applications also appeared to create a more interactive learning atmosphere, encouraging students to participate more confidently in classroom discussions and collaborative activities

Meanwhile, behavioural engagement showed that students participated actively throughout project implementation. Students were involved in collaborative discussions, project planning, digital content creation, and presentation activities. During project development, students demonstrated responsibility in completing assigned tasks and actively contributed to group activities. Several groups utilized AI-assisted platforms to organize project ideas, create presentation materials, and develop digital learning products such as posters and short videos.

The findings suggest that AI-Supported PjBL was able to facilitate students' participation in digital learning activities despite the technological limitations experienced in remote island schools. The integration of contextual projects with AI-supported inquiry activities provided opportunities for students to engage more meaningfully with digital technology during learning. Rather than functioning merely as information consumers, students became active participants who explored information, discussed ideas collaboratively, and produced digital artifacts relevant to their local environmental context.

Qualitative observations further indicated that the implementation of AI-supported project learning encouraged greater interaction among students during collaborative inquiry activities. Students frequently exchanged information, evaluated AI-generated responses, and discussed the relevance of digital information sources before integrating them into their projects. These interactions reflected not only behavioural participation but also deeper cognitive engagement during the learning process.

Although internet access and digital infrastructure remained limited in several learning sessions, students were still able to utilize available digital tools effectively with teacher guidance and peer collaboration. This finding indicates that AI-supported project-based learning may offer a flexible and contextually adaptable learning approach for promoting digital engagement in geographically isolated educational settings.

The findings of this study indicate that the implementation of Artificial Intelligence-Supported Project-Based Learning (AI-Supported PjBL) facilitated relatively high levels of students' digital engagement in the context of remote island schools. The three dimensions of engagement—cognitive, emotional, and behavioural engagement—showed consistently positive patterns during project activities. These findings suggest that the integration of AI-supported digital tools into contextual project-based learning may create more meaningful and participatory learning experiences for students living in geographically isolated areas with limited technological infrastructure.

One important finding of this study is that cognitive engagement obtained the highest percentage among the three engagement dimensions. This indicates that students were actively involved in exploring information, evaluating digital sources, discussing project ideas, and analyzing contextual problems encountered during project implementation. The use of AI-supported tools appeared to support students during inquiry activities by providing faster access to information and assisting them in generating ideas related to project development. Rather than relying solely on teacher explanations, students became more actively involved in constructing knowledge through digital exploration and collaborative problem-solving processes.

This finding aligns with previous studies suggesting that project-based learning encourages deeper cognitive participation because students are required to investigate authentic problems and develop contextual solutions through inquiry-oriented activities. In this study, AI-supported technologies strengthened this process by functioning as cognitive scaffolding tools during project implementation. Students utilized AI-assisted platforms to identify relevant information, compare alternative ideas, summarize learning materials, and organize project plans (Li & Wilson, 2025). Such activities may help students engage more deeply with learning tasks because digital tools provide flexible opportunities for exploration and knowledge construction.

The findings also demonstrate that emotional engagement remained relatively high during the implementation of AI-Supported PjBL. Students showed enthusiasm, curiosity, and increased confidence while participating in project activities and interacting with AI-assisted digital tools. This result indicates that contextual and technology-supported project activities may create more enjoyable and motivating learning experiences for students in remote educational settings. In many traditional classrooms located in resource-limited areas, learning activities are often dominated by direct instruction and routine task completion, which may reduce students' emotional involvement during learning. By contrast, project-based activities integrated with AI-supported exploration appeared to encourage students to participate more actively and confidently during classroom interaction.

The contextual nature of the projects likely contributed to students' emotional engagement. The learning activities were connected to real environmental and social issues found in students' daily lives, such as waste management, environmental problems, and local resource use (Suryawati et al., 2020). When students perceive learning tasks as relevant to their own experiences and communities, they are more likely to develop stronger emotional connections to the learning process. The integration of digital tools and AI-assisted exploration further enhanced students' interest because students experienced learning activities that differed from conventional classroom practices (Agyemang et al., 2023). This finding supports the view that meaningful and authentic learning experiences are important for promoting students' emotional involvement in digital learning environments.

Behavioral engagement also showed positive results during project implementation. Students actively participated in collaborative discussions, digital content development, project presentations, and group problem-solving activities. The implementation of AI-Supported PjBL encouraged students to become more actively involved in the learning process rather than functioning as passive recipients of information (Antony et al., 2025). During project activities, students shared responsibilities within groups, discussed project strategies, and contributed to the creation of digital artifacts such as posters, presentations, and videos. These collaborative activities promoted participation and interaction among students despite the limited educational resources available in the school environment (Omodan et al., 2024).

An important aspect emerging from this study is the role of AI-supported tools as learning facilitators rather than replacements for teachers. The findings indicate that AI technologies can function as supportive instructional resources that help students during information exploration, idea generation, and digital content development. In the present study, teachers continued to play essential roles as facilitators who guided students in evaluating information, organizing project activities, and reflecting on their learning experiences. This suggests that effective AI integration in remote schools should emphasize human-centered learning approaches in which technology supports, rather than dominates, the educational process (Ruiz Viruel et al., 2025; Wan & Hu, 2022).

The study also demonstrates that AI-supported learning may help reduce some educational limitations experienced in geographically isolated schools. Students in remote island schools often encounter restricted access to learning resources, limited exposure to digital learning environments, and inadequate technological infrastructure. Under these conditions, AI-assisted digital tools may provide alternative pathways for

accessing information and participating in inquiry-oriented learning activities. Even though internet connectivity was occasionally unstable during project implementation, students were still able to utilize available digital resources effectively through collaborative learning and teacher guidance. These findings suggest that contextual and flexible AI-supported learning models may be adapted to educational settings with constrained technological conditions.

Nevertheless, the implementation of AI-Supported PjBL also revealed several challenges. Limited internet connectivity occasionally disrupted information exploration activities, and some students initially experienced difficulties in evaluating the reliability of AI-generated information (Sun et al., 2024). In addition, differences in students' familiarity with digital tools influenced the pace of project completion among groups. These findings indicate that the integration of AI into classroom learning should be accompanied by adequate teacher facilitation, digital literacy guidance, and structured learning support to ensure that students can utilize AI technologies critically and responsibly.

The findings of this study contribute to the growing discussion regarding the use of artificial intelligence in education, particularly in underrepresented educational contexts such as remote island schools. While many studies on AI-supported learning have focused on technologically advanced or urban educational settings, this study demonstrates that AI-supported project-based learning may also provide meaningful learning opportunities in geographically isolated schools with limited resources. The study further highlights that digital engagement is not determined solely by technological availability, but also by how technology is integrated into authentic, collaborative, and contextually relevant learning activities.

Overall, the implementation of AI-Supported Project-Based Learning created learning experiences that encouraged students to participate cognitively, emotionally, and behaviourally in digital learning activities. The integration of contextual projects, collaborative inquiry, and AI-assisted exploration enabled students to interact more meaningfully with digital technology despite existing infrastructural limitations (Katsenou et al., 2025). These findings suggest that AI-supported project learning may serve as a promising approach for strengthening digital engagement in remote educational environments while also supporting more active and student-centered learning practices.

Limitations and Future Research

This study has several limitations that should be considered when interpreting the findings. First, the research was conducted in a single remote island school with a relatively small number of participants, which may limit the generalizability of the results to other educational contexts. The technological conditions, learning culture, and students' prior experiences with digital tools in other remote regions may differ from those observed in this study. Second, the implementation period of the AI-Supported Project-Based Learning activities was relatively short, making it difficult to examine the long-term development of students' digital engagement and their sustained use of AI-supported learning practices.

In addition, the study primarily focused on students' digital engagement during project activities and did not extensively investigate other important learning outcomes such as academic achievement, digital literacy growth, self-regulated learning, or critical thinking performance. The integration of AI tools in this study also functioned mainly as

instructional support rather than as a fully adaptive AI learning environment. Therefore, the findings should be interpreted within the scope of AI-assisted classroom activities in resource-limited settings.

Future studies may expand this research by involving larger samples from multiple remote schools and conducting longitudinal investigations to examine the long-term influence of AI-supported project-based learning on students' engagement and learning outcomes. Further research could also explore how different types of artificial intelligence tools contribute to students' collaboration, creativity, digital literacy, and critical thinking development. In addition, future investigations may examine teachers' readiness, ethical considerations, and digital equity issues related to AI integration in geographically isolated educational environments.

Conclusion

This study examined the implementation of Artificial Intelligence-Supported Project-Based Learning (AI-Supported PjBL) in a remote island school and explored its role in facilitating students' digital engagement during learning activities. The findings indicate that the integration of AI-supported digital tools within contextual project-based learning created positive patterns of students' cognitive, emotional, and behavioural engagement. Students actively participated in information exploration, collaborative discussions, project development, and digital artifact creation throughout the learning process.

Among the three dimensions of engagement, cognitive engagement showed the highest percentage, indicating that students were actively involved in analyzing information, evaluating digital resources, and developing project ideas during AI-supported inquiry activities. Emotional and behavioural engagement also demonstrated positive outcomes, suggesting that contextual projects integrated with AI-assisted learning tools may foster students' motivation, participation, collaboration, and confidence in digital learning environments.

The findings further suggest that AI-supported project-based learning can provide meaningful learning opportunities for students in geographically isolated schools despite limitations in technological infrastructure and access to educational resources. Rather than functioning solely as technological tools, AI-assisted platforms acted as supportive learning resources that encouraged inquiry, collaboration, and contextual problem solving during project activities. The study highlights that effective technology integration in remote schools depends not only on the availability of digital tools but also on how technology is incorporated into authentic and student-centered learning experiences.

Overall, this study contributes to the growing discussion on artificial intelligence in education by demonstrating the potential of AI-Supported PjBL to strengthen students' digital engagement in remote educational contexts. The integration of contextual project activities and AI-assisted exploration may serve as an alternative approach for promoting more active, collaborative, and meaningful digital learning experiences in resource-limited schools.

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