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

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ABSTRACT

Artificial intelligence (AI) is opening new ways to support interactive, student-centered learning in schools. In remote island schools, however, AI-supported learning is still difficult to implement because technological infrastructure is limited, access to digital resources is restricted, and learning opportunities are unequal. This study examines the implementation of Artificial Intelligence-Supported Project-Based Learning (AI-Supported PjBL) and explores its role in enhancing students' digital engagement in a remote island school context. A mixed-method approach was used with 30 junior high school students attending a small school on Lae-Lae Island, Indonesia. Students worked on contextual projects in which AI-assisted digital tools were used for information exploration, project planning, and digital content creation. Quantitative data came from a digital engagement questionnaire covering the cognitive, emotional, and behavioral dimensions of engagement; qualitative data were gathered through classroom observations, interviews, and project documentation. Students showed relatively high levels of digital engagement during the AI-supported project activities. Cognitive engagement recorded the highest percentage (76.23%), followed by emotional engagement (76.02%) and behavioral engagement (75.55%). The qualitative data further indicated that, despite limitations in technological infrastructure, the project activities encouraged active participation, collaborative inquiry, digital communication, and contextual problem-solving. The study suggests that AI-Supported PjBL can offer meaningful and engaging digital learning experiences to students in geographically isolated schools and may serve as a contextual approach to strengthening digital participation in resource-limited educational environments.

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

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Background

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 behavioral 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).

Although digital technology is increasingly integrated into education, many schools in remote and geographically isolated areas still face considerable difficulties in implementing technology-supported learning (Ferri *et al.*, 2020; Firdaus & Ritonga, 2024). Island schools commonly deal with limited internet connectivity, inadequate digital infrastructure, restricted access to learning resources, and too little technology-based instructional support (Harahap *et al.*, 2025). Under such conditions, students may have fewer opportunities to interact meaningfully with digital learning environments, and technology is frequently used only for basic communication or entertainment rather than as a tool for inquiry and knowledge construction (Al Mamun & Lawrie, 2023). In many remote schools, teacher-centered instruction also continues to dominate classroom activity, which limits students' chances to explore collaboratively and work through problems (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 advances in artificial intelligence open further possibilities for implementing project-based learning (Ruiz Viruel *et al.*, 2025). AI-supported tools can help students search for information, generate ideas, organize project plans, create digital artifacts, and reflect on how they learn (Pesovski *et al.*, 2024).

Rather than taking over the teacher's role, AI technologies may serve as cognitive scaffolds that support students during inquiry and project work. AI-supported learning environments may also prompt more active participation in digital learning, since students have immediate access to information, interactive feedback, and flexible room for exploration (Yaseen *et al.*, 2025). Yet most studies of AI integration in education have taken place in urban or technologically well-equipped schools, and research on remote island contexts is still limited.

Previous research on project-based learning in remote schools has also concentrated mainly on outcomes such as academic achievement, digital literacy, or critical thinking skills. Fewer studies have looked at how AI-supported project-based learning facilitates students' digital engagement while the learning itself is taking place. Digital engagement deserves attention because it reflects how students interact cognitively, emotionally, and behaviorally with digital learning experiences. Examining these aspects may give a deeper understanding of how AI-supported learning can work effectively in schools where technological resources are limited.

Objectives

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

Literature Review

Student engagement is a multidimensional construct comprising cognitive, emotional, and behavioral involvement, and digital technologies can strengthen each dimension when they invite active interaction rather than passive consumption (Bond *et al*., 2020; Nahum-Shani *et al*., 2022). Engagement with digital content has been linked to self-regulated inquiry and better learning outcomes (Al Mamun & Lawrie, 2023; Wang *et al*., 2022). Project-Based Learning (PjBL) offers a suitable frame for such engagement, as authentic projects foster collaboration, problem-solving, and twenty-first-century skills (Chistyakov *et al*., 2023; Guo *et al*., 2020; Rehman *et al*., 2023), particularly when tasks draw on local environmental issues (Nurhidayati *et al*., 2024; Suryawati *et al*., 2020). Artificial intelligence extends PjBL by supporting idea generation, personalized learning, and scaffolding, while teachers remain essential facilitators (Li & Wilson, 2025; Pesovski *et al*., 2024; Ruiz Viruel *et al*., 2025). Interactive AI tools can raise student engagement, with digital literacy moderating this effect (Yaseen *et al*., 2025), although inaccurate AI-generated content calls for critical evaluation (Sun *et al*., 2024). Remote schools, however, face weak connectivity and limited infrastructure (Harahap *et al*., 2025; Hesti Putri *et al*., 2025), and evidence on AI-supported PjBL in island settings remains scarce, a gap this study addresses.

Methods

Research Design

This study employed a mixed-method approach with 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 approach was chosen because it gives a more comprehensive picture of how students took part cognitively, behaviorally, and emotionally in AI-supported project activities. The quantitative data served to identify

patterns in students' digital engagement during the learning intervention. The qualitative data were used to describe students' learning experiences, participation, and interactions over the course of the project.

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.

The participants were 30 lower secondary school students involved in the implementation of AI-Supported PjBL activities. They were selected purposively, based on their involvement in project-based learning activities and their access to basic digital devices during learning. Several teachers also took part as facilitators while the project activities were carried out, and they contributed qualitative observations of students' engagement during learning.

Learning Intervention

The learning intervention consisted of a series of contextual project-based learning activities that incorporated AI-supported digital tools. Projects were built around environmental and social issues that are part of students' daily lives in island communities, among them waste management, clean water availability, coastal environmental problems, and local energy use.

AI-Supported PjBL was carried out in several stages: contextual problem identification, collaborative project planning, AI-assisted information exploration, project development, digital product presentation, and reflection. In the information exploration stage, students used AI-supported tools to look up information, generate project ideas, summarize learning materials, and develop digital content. They also worked on digital platforms to produce project outputs such as posters, presentations, short videos, and digital reports.

Throughout the learning activities, teachers acted as facilitators, guiding students as they evaluated digital information, organized project tasks, and reflected on the learning process. AI technologies were treated not as a replacement for classroom instruction but as supporting tools that helped students during inquiry and collaborative learning activities.

Instruments

Both quantitative and qualitative instruments were used to collect data. The quantitative data came from a questionnaire on students' digital engagement, administered after the learning intervention had been implemented. The questionnaire was built around three dimensions of engagement in digital learning activities: cognitive, behavioral, and emotional engagement. Items were rated on a five-point Likert scale from strongly disagree to strongly agree.

Indicators of cognitive engagement covered students' involvement in analyzing information, evaluating digital sources, and developing project ideas. Behavioral engagement concerned 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 gathered through classroom observations, semi-structured interviews, and documentation of students' project activities. Observations ran throughout the learning intervention and looked at students' interactions, patterns of collaboration, and participation in project activities. Students and teachers were interviewed to gain deeper insight into their experiences with AI-supported digital tools during learning. The documentation comprised digital artifacts, project reports, photographs of learning activities, and the products students presented.

Data Analysis

Quantitative data obtained from the digital engagement questionnaire were analyzed descriptively, using mean scores, percentages, and standard deviations, to identify patterns in students' engagement during AI-supported project activities. This analysis was carried out separately for each engagement dimension: cognitive, behavioral, and emotional engagement.

Thematic analysis was applied to the qualitative data from observations, interviews, and documentation. The process involved data reduction, coding, categorization, and interpretation, with the aim of identifying recurring patterns in students' participation, interaction, and experiences during AI-supported project-based learning activities. Quantitative and qualitative findings were integrated to give a more comprehensive account of how AI-supported project-based learning facilitated students' digital engagement in the context of remote island schools.

Results and Discussion

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

In the remote island school, the implementation of Artificial Intelligence-Supported Project-Based Learning (AI-Supported PjBL) showed positive patterns of student engagement during learning activities. Students took an active part in the various stages of project development, from identifying contextual problems and exploring digital information to discussing project ideas together and producing digital learning artifacts. Bringing AI-supported tools into the 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 behavioral engagement during the implementation of AI-Supported PjBL.

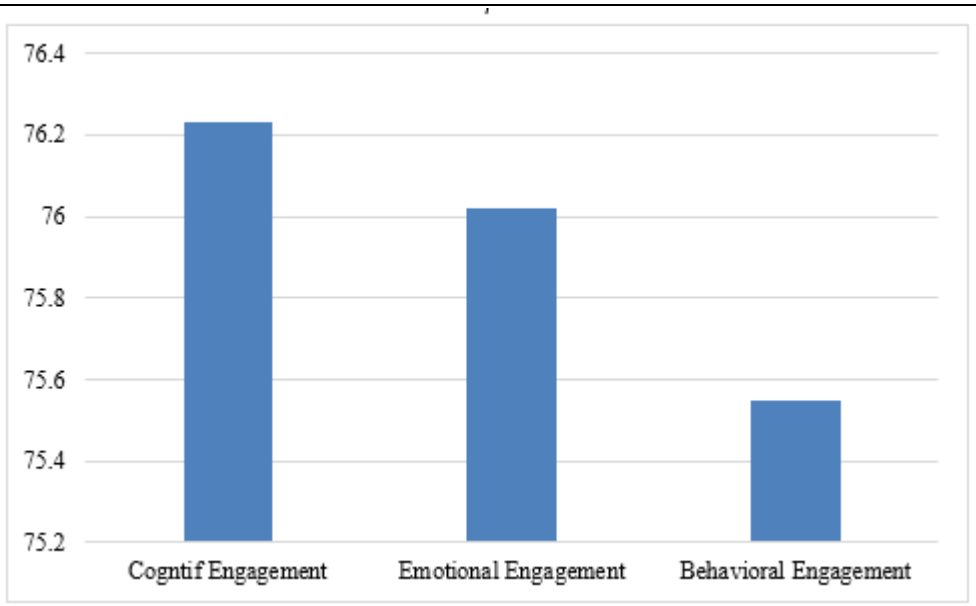


Figure 1. *Students' Digital Engagement during AI-Supported Project-Based Learning*

The results indicate that cognitive engagement obtained the highest percentage score (76.23%), followed by emotional engagement (76.02%) and behavioral 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 behavioral 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 reached a relatively high percentage, which suggests that students were positively involved on an emotional level during learning activities. Observations showed students displaying enthusiasm and curiosity as they worked with AI-assisted digital tools to develop their projects. Many students said they had become more interested in the learning activities because the projects dealt directly with real problems in their local environment. The AI-supported applications also appeared to make the learning atmosphere more interactive, which encouraged students to take part more confidently in classroom discussions and collaborative activities.

Behavioral engagement, meanwhile, showed that students participated actively throughout project implementation. They took part in collaborative discussions, project planning, digital content creation, and presentations. While developing their projects, students showed responsibility in completing their assigned tasks and contributed actively to group work. Several groups used AI-assisted platforms to organize project ideas, prepare presentation materials, and develop digital learning products such as posters and short videos.

These findings suggest that AI-Supported PjBL was able to facilitate students' participation in digital learning activities, even with the technological limitations found in remote island schools. Combining contextual projects with AI-supported inquiry activities gave students opportunities to engage with digital technology in a more meaningful way during learning. Students did not act merely as consumers of information. They became active participants who explored information, discussed ideas with one another, and produced digital artifacts relevant to their local environmental context.

Qualitative observations further indicated that AI-supported project learning encouraged more interaction among students during collaborative inquiry activities. Students often exchanged information, evaluated AI-generated responses, and discussed whether digital information sources were relevant before incorporating them into their projects. Such interactions reflected deeper cognitive engagement in the learning process, not only behavioral participation.

Internet access and digital infrastructure remained limited in several learning sessions, yet with teacher guidance and peer collaboration students still made effective use of the digital tools available to them. This indicates that AI-supported project-based learning may offer a flexible, contextually adaptable approach for promoting digital engagement in geographically isolated educational settings.

The findings indicate that implementing Artificial Intelligence-Supported Project-Based Learning (AI-Supported PjBL) facilitated relatively high levels of digital engagement among students in remote island schools. All three dimensions—cognitive, emotional, and behavioral engagement—showed consistently positive patterns during the project activities. This suggests that integrating AI-supported digital tools into contextual project-based learning may create more meaningful and participatory learning experiences for students who live in geographically isolated areas with limited technological infrastructure.

A notable finding of this study is that cognitive engagement recorded the highest percentage of the three engagement dimensions. This indicates that students were actively involved in exploring information, evaluating digital sources, discussing project ideas, and analyzing the contextual problems they met during project implementation. AI-supported tools appeared to help students in their inquiry by giving them faster access to information and assisting them in generating ideas for project development. Instead of depending only on teacher explanations, students took a more active part in constructing knowledge through digital exploration and collaborative problem-solving.

This result is consistent with earlier studies suggesting that project-based learning promotes deeper cognitive participation, because students must investigate authentic problems and work out contextual solutions through inquiry-oriented activities. In this study, AI-supported technologies reinforced that process by acting as cognitive scaffolding tools during project implementation. Students used AI-assisted platforms to identify relevant information, compare alternative ideas, summarize learning materials, and organize project plans (Li & Wilson, 2025). Activities of this kind may help students engage more deeply with learning tasks, since digital tools offer flexible opportunities for exploration and knowledge construction.

Emotional engagement also stayed relatively high throughout the implementation of AI-Supported PjBL. Students showed enthusiasm, curiosity, and increased confidence as they took part in project activities and worked with AI-assisted digital tools. This result indicates that contextual, technology-supported project activities may make learning more enjoyable and motivating for students in remote educational settings. In many traditional classrooms in resource-limited areas, learning tends to be dominated by direct instruction and routine task completion, which may lower students' emotional involvement. Project-based activities combined with AI-supported exploration, by contrast, appeared to encourage students to

participate more actively and confidently in 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 was likewise positive during project implementation. Students took an active part in collaborative discussions, digital content development, project presentations, and group problem-solving. AI-Supported PjBL encouraged students to engage more actively in the learning process instead of acting as passive recipients of information (Antony *et al.*, 2025). In the project activities, students shared responsibilities within their groups, discussed project strategies, and helped create digital artifacts such as posters, presentations, and videos. This collaborative work promoted participation and interaction among students, despite the limited educational resources available at the school (Omodan *et al.*, 2024).

One important aspect emerging from this study concerns the role of AI-supported tools as learning facilitators rather than replacements for teachers. The findings indicate that AI technologies can serve as supportive instructional resources, helping students with information exploration, idea generation, and digital content development. Teachers in the present study remained essential as facilitators, guiding students as they evaluated information, organized project activities, and reflected on their learning experiences. This suggests that effective AI integration in remote schools should emphasize human-centered approaches to learning, in which technology supports the educational process rather than dominating it (Ruiz Viruel *et al.*, 2025; Wan & Hu, 2022).

The study also shows that AI-supported learning may help reduce some of the educational limitations faced by geographically isolated schools. Students in remote island schools frequently have restricted access to learning resources, little exposure to digital learning environments, and inadequate technological infrastructure. In such conditions, AI-assisted digital tools may offer alternative ways of accessing information and taking part in inquiry-oriented learning activities. Although internet connectivity was occasionally unstable during project implementation, students still used the 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 where technological conditions are constrained.

Nevertheless, several challenges also arose in implementing AI-Supported PjBL. Limited internet connectivity sometimes interrupted information exploration, and some students at first found it difficult to judge the reliability of AI-generated information (Sun *et al.*, 2024). Differences in how familiar students were with digital tools also affected how quickly groups completed their projects. These findings indicate that integrating AI into classroom learning should be accompanied by adequate teacher facilitation, digital literacy guidance, and structured learning support so that students can use AI technologies critically and responsibly.

This study adds to the growing discussion on the use of artificial intelligence in education, especially in underrepresented educational contexts such as remote island schools. Many studies on AI-supported learning have focused on technologically advanced or urban settings, but this study demonstrates that AI-

supported project-based learning may also offer meaningful learning opportunities in geographically isolated schools with limited resources. It further highlights that digital engagement depends not only on whether technology is available but also on how that technology is integrated into authentic, collaborative, and contextually relevant learning activities.

Taken together, the implementation of AI-Supported Project-Based Learning created learning experiences in which students were encouraged to participate cognitively, emotionally, and behaviorally in digital learning activities. The combination of contextual projects, collaborative inquiry, and AI-assisted exploration enabled students to interact with digital technology more meaningfully despite existing infrastructural limitations (Katsenou *et al.*, 2025). These findings suggest that AI-supported project learning may be 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. First, it was carried out in a single remote island school with a relatively small sample, which may limit how far the findings generalize to other educational contexts. Second, the implementation period was relatively short, so the long-term development of students' digital engagement could not be examined. The study also focused mainly on digital engagement and did not investigate other outcomes such as academic achievement, digital literacy, self-regulated learning, or critical thinking. Finally, the AI tools served mainly as instructional support, not as fully adaptive learning systems.

Future research should include larger samples drawn from multiple remote schools and use longitudinal designs to examine the long-term effects of AI-Supported Project-Based Learning on students' engagement and learning outcomes. Further studies should also explore what different AI technologies contribute to collaboration, creativity, digital literacy, and critical thinking, and should address teacher readiness, ethics, and digital equity in remote educational settings.

Conclusion

This study examined how Artificial Intelligence-Supported Project-Based Learning (AI-Supported PjBL) was implemented in a remote island school and its role in facilitating students' digital engagement. The findings indicate that bringing AI-supported tools into contextual project-based learning promoted positive cognitive, emotional, and behavioral engagement. Throughout the learning process, students took an active part in exploring information, collaborating, developing projects, and creating digital artifacts.

Of the three dimensions, cognitive engagement had the highest percentage. Emotional and behavioral engagement also showed positive outcomes, suggesting that the AI-supported contextual projects encouraged students' motivation, collaboration, confidence, and participation in digital learning.

The findings also suggest that AI-Supported PjBL provides meaningful learning opportunities for students in geographically isolated schools, even where technology is limited. AI-assisted platforms acted as supportive learning resources that promoted inquiry, collaboration, and contextual problem-solving, and not merely as technological tools. Overall, the study demonstrates the potential of AI-Supported PjBL to strengthen students' digital engagement and to promote more active, collaborative, and meaningful learning experiences in resource-limited educational settings.

Declarations

Ethics Approval and Consent to Participate: Ethical principles were followed at every stage of the study. Before data collection began, informed consent was obtained from all participants and from the

school administration. Participation was voluntary, and participants' identities and personal information were kept anonymous, treated confidentially, and used for research purposes only.

AI Assistance: The manuscript was reviewed with the assistance of a language improvement tool to enhance its readability and overall presentation.

Conflicts of interest: Not applicable.

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Authors' contributions: Asdar conceived the study. All authors contributed to research, manuscript preparation, revision, and approved the final manuscript.

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