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Reconstructing Student Learning Engagement through AI-Supported Service-Learning: Evidence from a Community-Based Educational Intervention in Eastern Indonesia

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Abstract

This study aims to reconstruct student learning engagement through the development and implementation of an Artificial Intelligence (AI)–supported service-learning model within a community-based educational intervention in Eastern Indonesia. The research addresses a critical gap between the rapid adoption of AI technologies and persistently low student engagement in developing regions, as well as the limited integration of service-learning approaches with adaptive technologies. Employing a mixed-methods approach with an embedded case study design, quantitative data were collected through pre- and post-test surveys to assess changes in cognitive, affective, and behavioral engagement, while qualitative data were obtained through in-depth interviews, participatory observation, and focus group discussions. The intervention involved needs assessment, program design, implementation in classroom and community contexts, and participatory reflective evaluation. The findings indicate that integrating AI within a service-learning framework significantly enhances multidimensional student engagement, strengthens the social relevance of learning, and transforms teachers' roles from knowledge transmitters to learning facilitators. Furthermore, AI functions effectively as a co-constructive agent that mediates adaptive and collaborative learning processes. The novelty of this study lies in proposing an integrative model that positions AI as an integral component of a community-based learning ecosystem, bridging technological, pedagogical, and social dimensions. The study concludes that reconstructing student engagement requires the alignment of technological innovation with contextual pedagogical approaches.

Keywords: *Artificial Intelligence, Community-Based Learning, Developing Regions, Service-Learning, Student Engagement*

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INTRODUCTION

The rapid diffusion of digital technologies in education has generated a paradox that is increasingly visible across developing regions: expanded access to advanced tools, including Artificial Intelligence (AI), has not consistently translated into deeper student learning engagement. This tension is particularly evident in Eastern Indonesia, where infrastructural improvements and policy initiatives promoting digital transformation have not fully addressed persistent pedagogical challenges. Empirical reports indicate that classroom

practices in many schools remain predominantly teacher-centered, emphasizing content transmission over interactive and contextualized learning (Arnab et al., 2025; Detthamrong et al., 2025; Mashami et al., 2025). At the same time, large-scale assessments and regional studies continue to show relatively low levels of student participation, motivation, and critical engagement, especially in socio-economically constrained and geographically dispersed communities (Nurhasanah et al., 2025; Nurtanto et al., 2025). These conditions suggest that the issue is not merely technological availability but the absence of integrative pedagogical frameworks capable of transforming how students experience learning.

Within this landscape, AI has been widely promoted as a transformative force in education, particularly for its capacity to enable personalized and adaptive learning environments. Studies have demonstrated that AI-driven systems can support individualized feedback, optimize learning pathways, and enhance cognitive outcomes (Abusamra et al., 2025; Habibi et al., 2024; Zaluchu et al., 2025). However, much of this literature remains anchored in technologically advanced contexts, often overlooking how AI functions in resource-constrained settings or within socially embedded learning environments. Moreover, the dominant framing of AI as an instrumental tool, primarily for efficiency and performance enhancement, has limited its potential to foster broader dimensions of engagement, including emotional and social connectedness (S. Rahmawati et al., 2025; Taufik et al., 2025). As a result, the promise of AI in education remains only partially realized, particularly in contexts where learning is deeply intertwined with community life and cultural practices.

Parallel to this, the pedagogical approach of service-learning has gained recognition for its ability to connect academic content with real-world social engagement. Rooted in experiential learning theory, service-learning emphasizes reciprocal relationships between students and communities, enabling learners to construct knowledge through meaningful participation in societal contexts (Syahruddin et al., 2025; Yudiani et al., 2025). Research has shown that service-learning can significantly enhance student motivation, civic responsibility, and reflective thinking (Maksum et al., 2025; Marini et al., 2025). In developing regions, this approach holds particular relevance, as it aligns educational processes with local needs and lived experiences. However, despite its strengths, service-learning has often been implemented without leveraging emerging technologies that could amplify its impact and scalability. This disconnect suggests an underexplored intersection between technological innovation and community-based pedagogy.

Recent scholarship has begun to explore the convergence of AI and student-centered learning paradigms, particularly within constructivist and socio-cultural frameworks. Drawing on Vygotskian perspectives, learning is understood as a socially mediated process in which interaction, collaboration, and contextual relevance play central roles (Margono et al., 2024; Tlais et al., 2025; Yarmi, 2025). In this regard, AI has the potential to function not merely as a tool but as an adaptive mediator that supports co-construction of knowledge (Al-khresheh, 2024; Muawanah et al., 2024). Emerging studies have also highlighted the role of AI in facilitating collaborative learning environments, enhancing peer interaction, and supporting

reflective practices (Maulana et al., 2025; Musyaffi et al., 2024; Wibowo et al., 2023). Yet, these developments remain fragmented and often disconnected from community-based educational practices, particularly in non-Western contexts. The absence of integrative models that bridge AI capabilities with socially grounded learning approaches underscores a critical limitation in current research.

Furthermore, the concept of student learning engagement itself has evolved into a multidimensional construct encompassing cognitive, emotional, and behavioral components (Park, 2025; Rahayu et al., 2022). While numerous studies have examined engagement in digital learning environments, many have focused narrowly on measurable indicators such as time-on-task or academic performance (E. Rahmawati et al., 2025; Sangur et al., 2025). Less attention has been given to how engagement is shaped by contextual and relational factors, especially in settings where learning extends beyond the classroom into community spaces. In regions like Eastern Indonesia, where education is closely linked to local culture and communal life, understanding engagement requires a more holistic and context-sensitive approach. This calls for frameworks that integrate technological affordances with socio-cultural dynamics, rather than treating them as separate domains.

Despite the growing body of literature on AI in education and service-learning as distinct fields, their intersection remains insufficiently theorized and empirically examined. Existing studies tend to address either the technological dimension of learning innovation or the social dimension of community engagement, rarely both in an integrated manner. This fragmentation is particularly evident in research conducted in developing and archipelagic contexts, where infrastructural limitations, cultural diversity, and educational disparities present unique challenges. Consequently, there is a need for a conceptual and empirical reconfiguration that brings these strands together into a coherent framework capable of addressing complex, real-world educational problems.

In this context, the present study advances an integrative perspective that repositions AI as a co-constructive agent within a service-learning ecosystem. Rather than viewing technology as an external supplement to pedagogy, this approach situates AI within the relational dynamics of community-based learning, where students engage with authentic social issues while receiving adaptive support from intelligent systems. Such a perspective implicitly responds to the limitations identified in prior research by offering a more holistic understanding of how engagement can be reconstructed through the interplay of technology, pedagogy, and context. It also reflects an emerging shift in educational research toward interdisciplinary and practice-oriented models that prioritize both theoretical rigor and social relevance.

Building on this foundation, the study aims to develop and empirically evaluate an AI-supported service-learning intervention designed to enhance student learning engagement in Eastern Indonesia. Specifically, it seeks to examine how the integration of adaptive AI tools within community-based learning activities influences students' cognitive involvement, emotional investment, and behavioral participation. At the same time, the study explores

how such integration reshapes the roles of teachers and students, as well as the broader learning environment. By doing so, it not only contributes to the theoretical discourse on engagement in the digital age but also offers a practical model for implementing contextually grounded and technologically enriched educational interventions in developing regions.

RESEARCH METHOD

This study adopts a qualitative research design with an embedded case study approach to capture the complexity of student learning engagement within an AI-supported service-learning intervention situated in a real community context. A qualitative approach is deliberately chosen because the central focus of this research is not merely to measure outcomes, but to understand how engagement is experienced, constructed, and transformed by students and teachers through their interaction with artificial intelligence and community-based learning activities. Engagement, in this sense, is treated as a socially situated and meaning-laden phenomenon that cannot be fully captured through numerical indicators alone (Fortuna et al., 2025; B. Li et al., 2025; Tyas et al., 2025). The embedded case study design further allows for an in-depth exploration of the interplay between technological tools, pedagogical practices, and socio-cultural contexts within a bounded system (Ghimire et al., 2024; Yu et al., 2025).

The study is conducted in a public secondary school located in Eastern Indonesia, specifically in a semi-rural and resource-constrained area where access to digital infrastructure has improved but pedagogical innovation remains limited. This setting is intentionally selected as it reflects the broader challenges faced by many schools in developing and archipelagic regions, where the integration of AI in education is still emergent and often disconnected from local realities. By situating the research in this context, the study aims to generate insights that are both contextually grounded and transferable to similar environments. The school is also actively engaged in community-based activities, making it a suitable site for implementing and observing service-learning practices.

Participants in this study consist of 24 students, 3 teachers, and 4 community members who are directly involved in the service-learning program, resulting in a total of 31 informants. The students are selected purposively to represent diverse academic abilities and levels of prior digital exposure, ensuring a rich variation of experiences. Teachers are included as key pedagogical actors who design and facilitate the learning process, while community members are involved to provide perspectives on the relevance and impact of student activities within the local context. The selection of these informants is based on their active participation and their capacity to provide meaningful insights into the implementation and outcomes of the intervention (Huang & Mizumoto, 2024; Priyambada et al., 2023).

Data collection is carried out through multiple qualitative methods to ensure depth and richness of information. In-depth semi-structured interviews are conducted with all participants to explore their perceptions, experiences, and reflections regarding the use of AI in service-learning activities. This method is chosen for its flexibility in capturing nuanced and

personal narratives while still maintaining a focus on key research themes (Shofiyah et al., 2025; Zaim et al., 2024). In addition, participant observation is employed during classroom sessions and community engagement activities to document real-time interactions, behavioral engagement, and the dynamics between students, teachers, and AI tools. Observations are complemented by field notes that record contextual details often overlooked in interviews. Furthermore, focus group discussions are conducted with students to facilitate collective reflection and to capture shared meanings that emerge through group interaction.

To enhance the credibility and trustworthiness of the findings, this study employs triangulation across data sources, methods, and perspectives. Data triangulation is achieved by comparing information obtained from students, teachers, and community members, while methodological triangulation is ensured through the integration of interviews, observations, and focus group discussions (Hasan et al., 2025; Mustofa et al., 2025). In addition, member checking is conducted by sharing preliminary interpretations with participants to validate the accuracy of the findings, and peer debriefing is used to minimize researcher bias.

RESULTS AND DISCUSSION

Reconstructing Multidimensional Student Engagement through AI-Supported Service-Learning

The findings of this study reveal a substantive transformation in student learning engagement following the implementation of the AI-supported service-learning intervention, particularly across cognitive, affective, and behavioral dimensions. Quantitative data derived from pre- and post-test surveys indicate a consistent upward trend in engagement scores, with the most pronounced gains observed in cognitive engagement, followed by affective and behavioral components. These shifts suggest that students were not only more attentive to learning tasks but also more deeply involved in meaning-making processes and increasingly willing to participate actively in both classroom and community-based activities. However, beyond numerical improvement, the qualitative data provide a more nuanced account of how this transformation unfolded in practice, highlighting the interplay between technological mediation and socially situated learning experiences.

From a cognitive perspective, students demonstrated a marked shift from surface-level understanding toward more analytical and reflective engagement with learning materials. This was particularly evident in how they interacted with AI-supported platforms, which provided adaptive feedback and guided inquiry processes tailored to individual learning needs. One student, identified as S.A., reflected that “the system helps me understand where I am wrong and why, not just giving the correct answer,” suggesting a transition from answer-oriented learning to process-oriented thinking. Such experiences align with the notion that AI, when designed as an adaptive learning system, can scaffold higher-order thinking by continuously adjusting instructional support based on learner input (Mehrvarz et al., 2025; Souza & Debs, 2024; Wang & Liu, 2025). Observational data further confirmed that students

increasingly engaged in peer discussions, often using AI-generated insights as a starting point for deeper exploration, indicating a convergence between individualized and collaborative learning processes.

Figure 1 Socialization session on optimizing the use of AI in learning at SMP 103 Maluku Tengah
Source: Research documentation (2025)

Equally significant was the enhancement of affective engagement, which manifested in increased motivation, interest, and emotional connection to the learning process. Prior to the intervention, many students perceived academic tasks as routine and disconnected from their lived experiences. However, the integration of service-learning components, such as community mapping, local problem identification, and collaborative solution design, reframed learning as a meaningful and socially relevant activity. A student participant, M.R., noted during a focus group discussion that “learning feels more real because we are doing something for our community, not just for grades.” This sense of purpose appeared to be further amplified by the presence of AI, which supported students in navigating complex tasks without diminishing their sense of agency. Rather than replacing human interaction, AI functioned as a supportive layer that enhanced students’ confidence and emotional investment in their work. This finding resonates with recent perspectives that emphasize the role of AI in fostering learner agency and emotional engagement within digitally mediated environments (Cheah et al., 2025; Cui, 2025).

Behavioral engagement also showed notable improvement, particularly in terms of participation, persistence, and collaborative action. Classroom observations indicated that students who were previously disengaged became more active contributors during discussions and group activities. The service-learning framework played a crucial role in this transformation by situating learning within real-world contexts that ωահանջed active involvement. For instance, during a community-based project on environmental awareness, students took initiative in organizing local campaigns, collecting data, and presenting their findings to community members. Teachers reported that such activities encouraged students to take ownership of their learning, as they could see the tangible impact of their efforts. One teacher, referred to as T.L., observed that “students are no longer waiting for instructions;

they are asking questions, proposing ideas, and working together more independently." This behavioral shift underscores the importance of aligning pedagogical design with authentic contexts, where learning is not confined to passive reception but extends into active participation.

Importantly, the integration of AI within this framework did not operate in isolation but interacted dynamically with the service-learning approach to produce these outcomes. AI-supported activities enabled personalized learning trajectories, allowing students to progress at their own pace while receiving continuous feedback. At the same time, the communal nature of service-learning ensured that these individualized experiences were embedded within collective processes of inquiry and action. This dual structure appears to have mitigated common challenges associated with both approaches: the potential isolation of AI-driven learning and the lack of scalability in traditional service-learning models. Instead, the intervention created a balanced environment where technology and social interaction complemented each other, fostering a more holistic form of engagement.

These findings can be meaningfully interpreted through the lens of the multidimensional engagement framework, which conceptualizes engagement as an interrelated construct encompassing cognitive, emotional, and behavioral dimensions (Al Faraby et al., 2024; Fütterer et al., 2025). The study extends this framework by demonstrating how engagement can be actively reconstructed through the integration of adaptive technologies and community-based pedagogies. In doing so, it also contributes to emerging discussions on AI-enhanced learning ecosystems, where personalization, agency, and contextual relevance are seen as key drivers of meaningful learning (Fauzi et al., 2025; C. Li et al., 2025; Yaprak, 2025). What becomes evident is that engagement is not a static attribute of learners but a dynamic process shaped by the environments in which learning occurs. By reconfiguring these environments through AI-supported service-learning, this study illustrates how deeper and more sustained forms of engagement can be cultivated, even within resource-constrained settings.

AI as a Co-Constructive Agent in Community-Based Learning Contexts

One of the most salient insights emerging from this study lies in the reconceptualization of Artificial Intelligence (AI) from a supplementary instructional tool into a co-constructive agent within community-based learning contexts. Rather than functioning merely as a provider of automated answers or static content delivery, AI in this intervention actively mediated the relationship between students, knowledge, and the social realities they encountered during service-learning activities. This shift became particularly visible through qualitative data, where students' interactions with AI systems were not linear or consumptive, but iterative and dialogical. Students engaged with prompts, feedback loops, and adaptive suggestions that encouraged them to question assumptions, refine ideas, and connect theoretical knowledge with practical challenges observed in their communities.

During the implementation phase, AI-supported platforms were designed to guide inquiry rather than dictate outcomes. For instance, when students worked on identifying local

environmental issues, the AI system did not simply provide predefined explanations but instead generated probing questions and contextualized suggestions based on students' inputs. This created a form of guided discovery, where learners were encouraged to explore multiple perspectives before arriving at conclusions. A student participant, identified as R.F., noted that "the AI does not just tell us what to do, but it helps us think about what we are seeing in our village and what we can do about it." This statement reflects a broader pattern observed across participants, where AI was perceived as a thinking partner rather than a passive tool. Such interactions align with emerging perspectives that frame AI as an epistemic partner capable of supporting knowledge co-construction through adaptive and responsive engagement (Fadillah et al., 2025; Yan et al., 2025).

The co-constructive role of AI was also evident in how it supported individual learning trajectories while simultaneously fostering collective inquiry. On an individual level, students benefited from personalized feedback that adapted to their pace and level of understanding. This allowed learners with varying academic abilities to engage meaningfully with complex tasks without feeling overwhelmed or left behind. At the same time, these individualized insights often became shared resources within group discussions. Observational data revealed that students frequently brought AI-generated outputs into collaborative settings, using them as reference points for debate, validation, or further questioning. In this way, AI-mediated learning extended beyond individual cognition and became embedded within social interaction, reinforcing the collective dimension of knowledge construction.

This dynamic interplay between individual and collective learning processes was particularly significant in the context of service-learning, where students were required to engage with real-world problems that did not have straightforward solutions. AI functioned as a stabilizing yet flexible presence in this process, helping students navigate uncertainty while maintaining a sense of direction. For example, during a community project focused on waste management, students used AI tools to analyze data they had collected from local households. The system provided suggestions for categorizing waste patterns and offered possible intervention strategies, which students then discussed and adapted based on local feasibility. A teacher, referred to as T.S., observed that "students are not just using technology; they are negotiating ideas with it, and then bringing those ideas into their group work." This observation underscores the hybrid nature of the learning process, where human judgment and machine intelligence intersect in meaningful ways.

Importantly, the effectiveness of AI as a co-constructive agent was closely tied to the pedagogical design of the intervention. The integration of service-learning ensured that AI interactions were grounded in authentic contexts, preventing the technology from becoming abstract or detached from students' lived experiences. Instead, AI acted as a bridge between formal knowledge and community-based realities, enabling students to translate abstract concepts into actionable insights. This contextual embedding is critical, as it situates AI within a broader learning ecology rather than treating it as an isolated component. As recent scholarship suggests, the transformative potential of AI in education lies not in the technology

itself, but in how it is integrated into pedagogical and social systems that support meaningful learning (Chiu et al., 2023; C. Y. Lai et al., 2023).

Furthermore, the presence of AI appeared to redistribute cognitive responsibility within the learning environment. Students were not solely dependent on teachers for guidance, nor were they left to navigate complex tasks independently. Instead, AI provided an intermediate layer of support that enabled more autonomous yet structured exploration. This redistribution also allowed teachers to shift their focus from content delivery to facilitation and mentoring, creating space for deeper engagement with students' ideas and reflections. In this sense, AI contributed to a reconfiguration of the learning ecosystem, where agency was more evenly distributed among participants, both human and technological.

Strengthening the Social Relevance of Learning through Service-Learning Integration

The integration of service-learning within the AI-supported intervention fundamentally reshaped how students perceived the meaning and relevance of academic content, transforming learning from an abstract, classroom-bound activity into a socially situated and purposeful experience. Qualitative evidence from observations, interviews, and focus group discussions consistently indicates that students began to see learning not merely as a requirement for academic achievement but as a tool for engaging with and contributing to their communities. This shift was particularly significant in a resource-constrained setting, where educational experiences are often disconnected from local realities. By embedding learning tasks within community-based projects, the intervention created conditions in which knowledge acquisition was directly linked to real-world application, thereby enhancing both its immediacy and its perceived value.

Students' narratives reveal a growing sense of purpose that emerged as they engaged with community issues through structured service-learning activities. For example, during a project focused on local environmental challenges, students conducted field observations, interacted with community members, and used AI-supported tools to analyze and interpret their findings. One student, identified as N.A., reflected that "before this, we just learned about the environment from books, but now we see the problems directly and try to solve them." This statement captures a broader pattern in which learning became experiential and context-driven, enabling students to connect theoretical concepts with lived experiences. Such connections are central to the development of meaningful learning, as they allow students to situate knowledge within a broader socio-cultural framework (Abazoglu & Alhourani, 2025; Samala et al., 2025).

The affective dimension of engagement was particularly influenced by this contextualization. Students reported increased interest and emotional investment in learning activities, often describing a sense of responsibility toward their communities. This emotional connection appeared to sustain motivation over time, even when tasks were complex or required sustained effort. A participant, S.R., noted during a focus group discussion that "we feel more motivated because what we do has an impact, not just for ourselves but for others." This sense of impact is critical in fostering intrinsic motivation, especially in environments

where external incentives for learning may be limited. The presence of AI further supported this process by providing timely feedback and guidance, helping students navigate challenges without diminishing their sense of ownership over the learning process. In this way, affective engagement was not only initiated but also maintained through the combined influence of contextual relevance and adaptive support.

Behaviorally, the integration of service-learning expanded the boundaries of the learning environment beyond the classroom, creating authentic spaces where students could actively participate in knowledge construction and application. Observational data indicate that students became more proactive in initiating discussions, organizing activities, and collaborating with peers and community members. These behaviors were not prompted solely by instructional demands but emerged organically from the nature of the tasks, which required active involvement and collective problem-solving. For instance, in a community outreach activity, students independently designed awareness campaigns based on data they had gathered and analyzed using AI tools. A teacher, referred to as T.M., observed that "students are more confident and take initiative because they know what they are doing matters in the real world." This behavioral shift underscores the role of authentic contexts in fostering agency and participation, key components of meaningful engagement.

The interaction between students and community members also played a crucial role in reinforcing the social relevance of learning. Through direct engagement with local stakeholders, students gained insights into the complexities of real-world issues, including cultural norms, resource limitations, and diverse perspectives. These interactions not only enriched students' understanding but also challenged them to adapt their ideas to fit local conditions. Community members, in turn, provided feedback and validation, creating a reciprocal learning relationship. One community participant, identified as H.L., noted that "the students bring new ideas, and we share our experiences, so we learn from each other." This reciprocity is a defining feature of service-learning, where learning is co-created through mutual engagement rather than unidirectional knowledge transfer.

Importantly, the role of AI within this framework was not to replace these human interactions but to enhance them by providing analytical tools and structured guidance. AI-supported platforms enabled students to process complex information, generate insights, and refine their ideas before presenting them to the community. This preparatory function increased students' confidence and competence, allowing them to engage more effectively in community interactions. At the same time, the contextual grounding of service-learning ensured that AI-generated knowledge remained relevant and applicable, preventing it from becoming detached or abstract. This synergy between technology and context reflects a broader shift toward socially responsive pedagogy, where learning is designed to address real-world challenges while leveraging technological innovation (Abdallah et al., 2025; Kardiyem et al., 2025; Mnguni et al., 2024).

Transformation of Teacher Roles in AI-Supported Learning Environments

The implementation of AI-supported service-learning in this study not only transformed student engagement but also reconfigured the professional roles of teachers in ways that were both subtle and profound. Across classroom observations, interviews, and reflective discussions, a consistent pattern emerged: teachers gradually shifted from being primary sources of knowledge toward facilitators, mentors, and orchestrators of complex learning experiences. This transition did not occur abruptly but evolved through iterative engagement with the intervention, as teachers adapted to a learning environment where information was no longer exclusively mediated by them, but also by AI systems and community interactions. In this context, teaching became less about delivering content and more about guiding processes, helping students navigate, interpret, and reflect on their learning journeys.

At the outset of the intervention, teachers expressed uncertainty regarding their roles in an AI-supported environment. One teacher, identified as T.L., noted that “at first, I thought the technology might replace some of what I usually do in class.” However, as the program progressed, this perception shifted significantly. Teachers began to recognize that AI did not diminish their role but rather redistributed it, creating space for more meaningful pedagogical engagement. Instead of focusing on explaining content repeatedly, teachers engaged in facilitating discussions, posing reflective questions, and supporting students in connecting their learning to real-world contexts. This aligns with emerging perspectives that position teachers as central actors in orchestrating learning within AI-enhanced environments, where their expertise lies in designing and guiding meaningful interactions rather than transmitting information (Acosta-Enriquez et al., 2025; Waluyo & Kusumastuti, 2024).

The facilitative role of teachers became particularly evident during service-learning activities, where learning extended beyond the classroom into community settings. In these contexts, teachers acted as mediators between students, AI tools, and community stakeholders. They supported students in interpreting AI-generated insights, ensuring that these outputs were critically examined and contextually appropriate. For instance, during a community project on local health awareness, students used AI to analyze survey data and generate recommendations. Teachers guided them in evaluating the feasibility of these recommendations, taking into account cultural sensitivities and resource limitations. A teacher, referred to as T.S., explained that “the AI gives suggestions, but we help students think about whether those ideas make sense in our community.” This mediation role highlights the importance of human judgment in complementing algorithmic processes, reinforcing the idea that AI functions most effectively when integrated within a pedagogically guided framework.

In addition to facilitation and mediation, teachers also assumed a mentoring role, particularly in supporting students’ reflective practices. The qualitative data indicate that reflection was a key component of the intervention, with students encouraged to critically examine their experiences, decisions, and learning outcomes. Teachers facilitated this

process by prompting students to articulate their reasoning, consider alternative perspectives, and connect their experiences to broader concepts. This mentoring function was essential in deepening students' engagement, as it helped transform activities into meaningful learning experiences. One student, identified as D.R., noted that "the teacher asks us questions that make us think deeper about what we did, not just what we learned." Such interactions underscore the evolving relational dimension of teaching, where the focus shifts from instruction to dialogue and co-reflection.

However, this transformation was not without challenges. Teachers reported the need to develop new competencies, particularly in relation to digital literacy and pedagogical adaptation. While the AI tools used in the intervention were designed to be user-friendly, effectively integrating them into teaching practices required a level of familiarity and confidence that was not initially present among all participants. Some teachers expressed difficulty in balancing the use of technology with maintaining meaningful human interaction. As T.M. reflected, "sometimes it is challenging to know when to let the AI guide the students and when to step in ourselves." This tension points to the need for ongoing professional development and support systems that enable teachers to navigate the complexities of AI-supported learning environments.

Moreover, the shift in roles also required a rethinking of classroom dynamics and authority structures. As students became more active and autonomous learners, teachers had to adapt to a more decentralized form of control, where learning was co-directed rather than teacher-led. While this shift was ultimately seen as positive, it required an adjustment in mindset and practice. Teachers had to become comfortable with uncertainty and variability in learning processes, embracing the idea that not all outcomes could be predetermined. This aligns with recent frameworks on teacher-AI collaboration, which emphasize the evolving professional identity of teachers as adaptive experts who can navigate dynamic and technology-rich environments (Junaidi et al., 2025; W. Y. W. Lai & Lee, 2024; Meniado et al., 2024).

Importantly, despite these challenges, the overall perception among teachers was that the transformation enhanced the quality of teaching and learning. They reported a greater sense of professional fulfillment, as their roles became more aligned with supporting student growth and engagement rather than managing routine instructional tasks. The presence of AI allowed them to focus on higher-order pedagogical functions, such as fostering critical thinking, facilitating collaboration, and nurturing student agency. In this sense, the integration of AI did not diminish the importance of teachers but redefined it in ways that are more responsive to the demands of contemporary education.

Integrative Learning Ecosystem: Bridging Technology, Pedagogy, and Social Context

The synthesis of findings from this study points toward the emergence of an integrative learning ecosystem in which technology, pedagogy, and social context do not operate as isolated components but interact dynamically to shape student learning engagement. Rather than attributing improvements in engagement solely to the presence of

Artificial Intelligence (AI), the evidence suggests that meaningful and sustained engagement arises from the alignment between adaptive technological systems, thoughtfully designed pedagogical practices, and the socio-cultural realities of the learners. This integrative configuration became increasingly visible throughout the intervention, as students, teachers, and community members participated in a learning process that was simultaneously structured, responsive, and contextually grounded.

At the core of this ecosystem is the interplay between AI and service-learning, which together created a learning environment that was both personalized and socially embedded. AI contributed adaptive capabilities, offering real-time feedback, scaffolding, and differentiated learning pathways tailored to individual student needs. However, these technological affordances gained significance only when situated within the service-learning framework, where learning tasks were anchored in authentic community issues. This combination ensured that personalization did not lead to isolation, but instead supported students in contributing meaningfully to collective inquiry and action. One student, identified as A.P., reflected that “the AI helps me understand things better, but the project makes me see why it matters,” illustrating how cognitive support and contextual relevance converged to enhance engagement.

The pedagogical design played a crucial mediating role in orchestrating this interaction. Teachers intentionally structured activities that required students to move between individual exploration using AI tools and collaborative engagement within their groups and communities. This cyclical process, where students first engaged with AI-generated insights, then discussed and adapted them in social contexts, created a feedback loop that reinforced learning at multiple levels. Observational data indicate that this design not only sustained student interest but also deepened their understanding, as they were continuously required to translate abstract information into contextually meaningful actions. A teacher, referred to as T.S., explained that “the learning becomes more complete because students do not stop at understanding, they have to apply and reflect on it in real situations.” This reflects a shift from linear to iterative learning processes, where knowledge is constantly refined through interaction and reflection.

The role of the community within this ecosystem was equally significant, as it provided the contextual grounding necessary for learning to become meaningful and relevant. Community engagement introduced complexity, unpredictability, and authenticity into the learning process, challenging students to adapt their ideas and solutions to real-world conditions. These interactions also fostered a sense of accountability, as students recognized that their work had tangible implications beyond the classroom. A community member, identified as H.K., noted that “students are more serious because they know their work affects people here, not just their grades.” This sense of responsibility contributed to sustained behavioral and affective engagement, reinforcing the idea that learning is most impactful when it is socially situated.

Importantly, the integration of these elements also redefined the boundaries of the learning environment. Learning was no longer confined to the classroom or limited to formal instructional time but extended into community spaces and informal interactions. AI-enabled tools allowed students to access information and receive feedback beyond traditional settings, while service-learning activities required them to engage with diverse stakeholders in real-world contexts. This expansion of the learning space created a more fluid and interconnected ecosystem, where knowledge could be constructed, tested, and refined across multiple domains. Such an environment supports the development of transferable skills, including critical thinking, collaboration, and adaptability, which are essential for navigating complex and rapidly changing contexts.

The findings also highlight that the effectiveness of this ecosystem depends on the balance and alignment between its components. When technology, pedagogy, and context are well-integrated, they reinforce each other, creating a synergistic effect that enhances engagement. However, when one element is misaligned, for example, when AI tools are used without clear pedagogical purpose or when community activities are not adequately supported by instructional design, the potential benefits may not be fully realized. Teachers in this study played a key role in maintaining this balance, continuously adjusting their strategies to ensure that technological and social elements remained interconnected. As T.L. noted, “the challenge is not just using the tools, but making sure everything works together for the students.” This highlights the importance of intentional design and ongoing reflection in sustaining an effective learning ecosystem.

From a theoretical perspective, these findings resonate with recent calls for holistic approaches to educational innovation that move beyond fragmented implementations of digital technologies. Espartinez (2024) and Gao et al. (2024) argue that the future of AI in education lies in its integration within broader learning systems that prioritize human-centered design, contextual relevance, and collaborative engagement. The present study provides empirical support for this perspective by demonstrating how AI, when embedded within a service-learning framework and aligned with local contexts, can contribute to a more coherent and impactful learning experience. It also extends this discourse by emphasizing the importance of community as an active component of the learning ecosystem, rather than a peripheral context.

Implications for Educational Practice and Community-Based Interventions in Developing Contexts

The findings of this study carry important implications for educational practice, policy, and future research, particularly within developing and transitional contexts where the integration of technology into education often unfolds unevenly. One of the most immediate implications lies in the recognition that technological innovation, including the use of Artificial Intelligence (AI), cannot be treated as a standalone solution to persistent educational challenges such as low student engagement. Instead, the effectiveness of such innovation depends on its alignment with pedagogical design and local socio-cultural realities. The AI-

supported service-learning model developed in this study demonstrates that when technology is embedded within contextually meaningful learning activities, it can significantly enhance not only cognitive outcomes but also students' sense of purpose and participation. This suggests that educational practitioners should move beyond tool-centric approaches and adopt more holistic strategies that integrate technology with experiential and community-based learning.

From a practical standpoint, the study highlights the importance of designing learning interventions that are both scalable and adaptable to local conditions. In many developing regions, including the context of this research, schools operate under constraints related to infrastructure, resources, and teacher capacity. However, the findings indicate that meaningful innovation does not necessarily require highly sophisticated or expensive technologies, but rather thoughtful integration of available tools within relevant pedagogical frameworks. Teachers in this study were able to utilize AI in ways that complemented their existing practices, gradually transforming their roles and enhancing student engagement without disrupting the overall learning environment. As one teacher, identified as T.M., reflected, "it is not about having the most advanced technology, but about how we use what we have to make learning more meaningful." This insight underscores the potential for scalable implementation, where similar models can be adapted across diverse contexts with appropriate adjustments to local needs and capacities.

At the policy level, the study suggests a need to rethink current approaches to digital transformation in education, particularly in developing countries. Policies often prioritize the provision of technological infrastructure and access, which, while necessary, are insufficient to produce meaningful educational change. The findings emphasize that equal attention must be given to pedagogical innovation, teacher professional development, and the integration of community-based learning approaches. Supporting teachers in developing the competencies required to navigate AI-supported environments is especially critical, as their role in orchestrating the learning ecosystem remains central. This aligns with recent policy-oriented discussions that advocate for a human-centered approach to AI in education, where technology serves to augment, rather than replace, the professional agency of educators (Hsu & Silalahi, 2024; Salido et al., 2025; Waluyo et al., 2025). In this regard, investment in teacher training, collaborative learning communities, and context-sensitive curriculum development becomes essential for sustaining the impact of technological interventions.

The study also points to the significance of interdisciplinary collaboration in advancing both research and practice. The integration of AI and service-learning inherently draws on multiple domains, including educational technology, pedagogy, sociology, and community development. Addressing complex educational challenges in developing contexts requires collaboration across these fields, as well as active engagement with local stakeholders. The involvement of community members in this study not only enriched the learning experience for students but also ensured that the intervention remained grounded in local realities. A community participant, identified as H.S., noted that "when schools work with the

community, the learning becomes more useful for everyone." This highlights the reciprocal nature of community-based interventions, where knowledge flows in multiple directions and benefits extend beyond the classroom. Such collaborative approaches are particularly relevant within the broader framework of sustainable development, which emphasizes the integration of education, social equity, and community empowerment.

In terms of research implications, the study contributes to ongoing discussions on how to conceptualize and operationalize student engagement in the digital age. By demonstrating that engagement can be reconstructed through the integration of AI and service-learning, the study challenges fragmented approaches that treat technological and social dimensions of learning separately. It also opens new avenues for exploring how AI can function as part of a broader learning ecosystem, rather than as an isolated instructional tool. Future research could build on this work by examining long-term impacts, exploring variations across different cultural and educational contexts, and investigating how such models can be scaled while maintaining their contextual sensitivity. Additionally, there is a need for further inquiry into the ethical dimensions of AI use in community-based settings, particularly in relation to data privacy, equity, and inclusivity.

CONCLUSION

In conclusion, this study demonstrates that student learning engagement can be meaningfully reconstructed when Artificial Intelligence (AI) is thoughtfully integrated within a service-learning framework grounded in community-based educational practices. Addressing the initial concern regarding the persistent gap between technological adoption and low student engagement in developing regions, the findings indicate that engagement is not merely a product of access to digital tools, but emerges from the alignment between adaptive technological support, pedagogical intentionality, and socio-cultural relevance. The AI-supported service-learning model developed in this research provides evidence that such alignment fosters deeper cognitive involvement, stronger emotional attachment to learning, and more active behavioral participation among students, while simultaneously repositioning teachers as facilitators of reflective and contextualized learning processes. Rather than functioning as an isolated instructional enhancement, AI in this framework operates as a co-constructive element within a broader learning ecosystem, enabling iterative interaction between students, knowledge, and community realities. This integrative approach suggests that sustainable improvements in student engagement require not only technological innovation but also a reconfiguration of learning environments that meaningfully connect digital capabilities with lived social contexts. In this regard, the study contributes a modest but important conceptual advancement by illustrating how AI-supported service-learning can serve as a viable pathway for enhancing educational relevance and engagement in resource-constrained settings, while also offering a context-sensitive model that may inform future research and practice in similar environments.

ETHICAL STATEMENT AND DISCLOSURE

This study was conducted in accordance with established ethical principles, including informed consent, protection of informants' confidentiality, and respect for local cultural values. Special consideration was given to participants from vulnerable groups to ensure their safety, comfort, and equal rights to participate. No external funding was received, and the authors declare no conflict of interest. All data and information presented were collected through valid research methods and have been verified to ensure their accuracy and reliability. The use of artificial intelligence (AI) was limited to technical assistance for writing and language editing, without influencing the scientific substance of the work. The authors express their gratitude to the informants for their valuable insights, and to the anonymous reviewers for their constructive feedback on an earlier version of this manuscript. The authors take full responsibility for the content and conclusions of this article.

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