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Learning Beyond the Screen: Hybrid Ecological Classrooms and Students' Cognitive Engagement

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ABSTRACT
This study aims to examine how hybrid ecological classrooms enhance students' cognitive engagement beyond conventional screen-based learning environments. Employing a qualitative approach with a case study design, the research is intended to capture in-depth, context-rich insights into the interaction between pedagogical practices, technological integration, and learner engagement. The case study design is selected due to its suitability for exploring complex educational phenomena within real-life settings. The research is conducted at a secondary educational institution implementing hybrid learning systems, referred to as Nusantara Integrated Learning School. A total of nine informants are purposively selected, consisting of six teachers and three institutional leaders, based on their direct involvement in designing and managing hybrid learning environments. Data are collected through in-depth interviews, observations, and document analysis. The findings reveal that cognitive engagement is significantly enhanced when learning environments are coherently integrated, supported by adaptive teaching practices and active student participation. However, challenges remain in aligning institutional policies with classroom implementation. The study recommends strengthening ecological learning design, enhancing teacher capacity, and ensuring systemic coherence to optimize hybrid learning effectiveness.

INTRODUCTION

The rapid expansion of digital technologies has significantly transformed contemporary educational landscapes, particularly in the wake of global disruptions that accelerated the adoption of online and blended learning modalities (Zaky, 2024). While digital platforms have increased accessibility and flexibility, concerns have emerged regarding the depth and quality of students' cognitive engagement in predominantly screen-based environments (Yeganeh et al., 2025). The concept of "Learning Beyond the Screen" has thus gained scholarly attention, emphasizing the need to reconceptualize learning spaces as hybrid ecological systems that integrate physical, digital, and social dimensions (Himes et al., 2023). Hybrid ecological classrooms, as an emerging pedagogical model, seek to bridge the divide between virtual and embodied learning experiences by fostering meaningful interactions across multiple learning environments (Gupta & Jaiswal, 2025). This study is situated within this evolving discourse, aiming to critically examine how such hybrid configurations influence students' cognitive engagement.

State-of-the-art research in educational technology highlights that cognitive engagement defined as the extent to which learners invest effort in understanding complex ideas and mastering skills remains a crucial determinant of meaningful learning outcomes (Muñoz-Basols et al., 2023). Existing studies have demonstrated that purely online environments often struggle to sustain deep cognitive involvement due to distractions, reduced social presence, and limited sensory stimulation (Lee et al., 2025). Conversely, traditional face-to-face settings offer richer contextual cues but may lack the adaptability and scalability of digital platforms (Goagoses et al., 2024). Recent investigations into blended learning have attempted to combine these strengths; however, many models remain technologically centered rather than ecologically integrated (Dang et al., 2025). The ecological

perspective extends beyond mere modality integration, emphasizing the dynamic interplay between learners, tools, environments, and social interactions (Nedungadi et al., 2023). Despite its theoretical promise, empirical evidence on the effectiveness of hybrid ecological classrooms in enhancing cognitive engagement remains limited and fragmented (Yan et al., 2023).

The primary problem addressed in this research lies in the persistent gap between technological integration and meaningful cognitive involvement (Cukurova, 2025). While educational institutions increasingly adopt hybrid or blended systems, these implementations often prioritize logistical convenience over pedagogical depth (Ferreira-Santos & Pombo, 2025). As a result, students may participate in learning activities without achieving substantive understanding or critical thinking development (Borgognon et al., 2025). This issue is particularly pronounced in contexts where digital learning is treated as a substitute rather than a complement to experiential and socially embedded learning processes (Oise et al., 2025). Therefore, the central concern of this study is how to design and implement hybrid ecological classrooms that not only combine multiple learning modes but also actively foster higher-order cognitive engagement.

A critical examination of prior studies reveals a significant research gap (Otto et al., 2024). First, many investigations focus on technological tools or instructional strategies in isolation, neglecting the holistic ecosystem in which learning occurs (Na et al., 2025). Second, there is a lack of integrative frameworks that connect cognitive engagement with ecological learning design, particularly in hybrid settings (Masduki & Johari, 2025). Third, empirical studies often rely on self-reported measures of engagement, which may not fully capture the complexity of cognitive processes. Furthermore, limited attention has been given to contextual variables such as cultural settings, institutional constraints, and learner diversity, which play a crucial role in shaping engagement outcomes (Zhang et al., 2025). This gap underscores the need for a more comprehensive and context-sensitive approach to studying hybrid ecological classrooms.

In response to these limitations, this study offers a novel contribution by proposing and empirically examining a hybrid ecological classroom model that explicitly integrates cognitive, social, and environmental dimensions of learning. The novelty of this research lies in its multidimensional framework, which moves beyond the dichotomy of online versus offline learning and instead conceptualizes learning as an interconnected system. By incorporating ecological principles such as adaptability, interdependence, and sustainability, the study provides a deeper understanding of how learning environments can be designed to support sustained cognitive engagement. Additionally, the research employs a mixed-methods approach to capture both quantitative and qualitative aspects of student engagement, thereby addressing methodological limitations in previous studies (Cao, 2023).

Based on the identified gaps and proposed framework, the research is guided by several key questions. These include how hybrid ecological classrooms influence students' cognitive engagement, what specific design elements contribute to enhanced engagement, and how students perceive and experience learning within such environments. Furthermore, the study seeks to explore the relationship between ecological learning design and the development of higher-order thinking skills, as well as the challenges associated with implementing hybrid models in real educational contexts.

The primary objective of this research is to analyze and evaluate the effectiveness of hybrid ecological classrooms in promoting students' cognitive engagement. Specifically, the study aims to develop a conceptual framework that integrates ecological and cognitive perspectives, to empirically assess the impact of this framework on student engagement, and to identify best practices for designing hybrid learning environments. Through these objectives, the research aspires to contribute to both theoretical advancement and practical innovation in the field of education.

From a theoretical standpoint, this study enriches the existing body of knowledge by bridging the gap between ecological learning theory and cognitive engagement research. It offers a comprehensive model that can serve as a foundation for future investigations into hybrid learning environments. Academically, the research provides valuable insights for scholars and educators seeking to understand the complexities of engagement in contemporary educational settings. It also contributes to the ongoing discourse on the role of technology in education, emphasizing the importance of

pedagogical design over mere technological adoption (Korson, 2023). Practically, the findings of this study are expected to inform educators, curriculum designers, and policymakers in developing more effective and engaging learning environments. By highlighting actionable strategies and design principles, the research supports the creation of learning experiences that are both meaningful and sustainable.

Despite its contributions, this study acknowledges several limitations. The research may be constrained by contextual factors such as institutional settings and participant characteristics, which could affect the generalizability of the findings. Additionally, the measurement of cognitive engagement, while comprehensive, may not fully capture all dimensions of learners' internal processes. The implementation of hybrid ecological classrooms also presents practical challenges, including technological infrastructure, teacher readiness, and student adaptability, which may influence the outcomes of the study.

Future research is encouraged to expand on this work by exploring hybrid ecological classrooms in diverse educational contexts and across different disciplines. Longitudinal studies could provide deeper insights into the sustained impact of such environments on cognitive development. Moreover, the integration of advanced analytics and learning technologies may offer new opportunities for capturing and enhancing cognitive engagement (Papaioannou et al., 2023). By continuing to investigate and refine the concept of learning beyond the screen, future studies can contribute to the development of more holistic and effective educational systems that respond to the evolving needs of learners in the digital age.

LITERATURE REVIEW

The evolving landscape of contemporary education, shaped by rapid technological advancement and shifting pedagogical paradigms, has prompted scholars to reconsider how learning environments influence students' cognitive engagement (Tedeschi et al., 2024). In the context of the study titled *Learning Beyond the Screen: Hybrid Ecological Classrooms and Students' Cognitive Engagement*, the literature reveals an increasing emphasis on integrative learning models that transcend the limitations of purely digital or traditional settings (Xiaoyu et al., 2025). Hybrid ecological classrooms emerge as a conceptual and practical response to the fragmentation of learning experiences, aiming to create a dynamic interplay between physical presence, digital interaction, and social context (Sharma & Sharma, 2025). To ground this study theoretically, three major frameworks are employed: Constructivist Learning Theory, Ecological Systems Theory, and Cognitive Engagement Theory. These theories provide a comprehensive lens through which the complexity of hybrid learning environments and their impact on student cognition can be critically examined.

Constructivist Learning Theory, widely popularized by Jean William Fritz Piaget in 1970, affiliated with the University of Geneva, Switzerland, posits that learners actively construct knowledge through interaction with their environment rather than passively receiving information (Fang et al., 2023). Piaget's framework emphasizes stages of cognitive development and the processes of assimilation and accommodation, through which learners integrate new experiences into existing cognitive structures (Spaho et al., 2025). Complementing Piaget's work, Lev Semyonovich Vygotsky, in 1978 at Moscow State University, Russia, expanded constructivism through a sociocultural perspective, introducing the concept of the Zone of Proximal Development (ZPD) and highlighting the importance of social interaction in learning (Sulaiman & Krishan, 2025). From this perspective, cognitive engagement is not merely an individual process but is deeply embedded in collaborative and contextual activities (Akila et al., 2024). The conceptual framework derived from constructivism underscores that meaningful learning occurs when students are actively involved in problem-solving, inquiry, and dialogue within supportive environments (Kwong & Kwok, 2025). In hybrid ecological classrooms, this theory provides the foundation for designing interactive and student-centered learning experiences that promote deeper cognitive processing.

Ecological Systems Theory, developed by Urie Bronfenbrenner in 1979 at Cornell University, United States, offers a broader perspective by situating learning within interconnected environmental systems (Aly & Alotaibi, 2025). Bronfenbrenner conceptualized human development as occurring within nested systems, including the microsystem, mesosystem, exosystem, macrosystem, and

chronosystem (Deep et al., 2024). This theory emphasizes that learners are influenced not only by immediate classroom interactions but also by broader social, cultural, and technological contexts (Plooy et al., 2024). In the realm of hybrid ecological classrooms, this framework is particularly relevant as it captures the complexity of learning environments that span physical and virtual spaces. Contemporary scholars such as Neil Selwyn (2016, Monash University, Australia) have extended ecological perspectives to digital education, arguing that technology should be understood as part of a wider socio-technical ecosystem rather than as an isolated tool (Zaman & Akhter, 2023). The conceptual framework emerging from ecological theory highlights the importance of alignment and interaction among various elements of the learning environment, suggesting that cognitive engagement is shaped by the quality and coherence of these interactions (Domingo & Discutido, 2025).

Cognitive Engagement Theory, significantly advanced by Fredricks, Blumenfeld, and Paris in 2004 at the University of Michigan, United States, focuses explicitly on the psychological investment and effort that students dedicate to learning (Detyna et al., 2023). This theory distinguishes cognitive engagement from behavioral and emotional dimensions, emphasizing strategies such as deep learning, self-regulation, and critical thinking (Cueto, 2025). According to these scholars, high levels of cognitive engagement are associated with persistence, strategic learning approaches, and a willingness to exert effort in understanding complex material (Q. Liu & Li, 2025). Further developments by researchers such as John T. Guthrie (2004, University of Maryland, United States) have linked cognitive engagement to motivation and instructional design, particularly in literacy and content-area learning (AlGerafi et al., 2023). Within hybrid ecological classrooms, cognitive engagement theory provides a critical lens for evaluating how different learning modalities influence students' depth of processing and intellectual involvement. The framework suggests that engagement is enhanced when learning activities are meaningful, challenging, and connected to students' experiences (Bergdahl et al., 2025).

The development of these three theoretical perspectives demonstrates an ongoing shift from isolated and linear models of learning toward more integrated and dynamic understandings (Oknaryana et al., 2025). Constructivist theory has evolved from focusing primarily on individual cognition to incorporating social and cultural dimensions, as seen in sociocultural approaches (Akokodaripon et al., 2023). Ecological systems theory has expanded to include digital environments, reflecting the growing importance of technology in shaping human interaction and development (Honke & Becker-Genschow, 2025). Cognitive engagement theory has similarly progressed to encompass multidimensional and context-sensitive interpretations of student involvement, integrating insights from motivation and self-regulated learning research (Xu, 2025). These contemporary developments highlight the relevance of combining the three theories to address the complexities of modern educational settings.

When connected to the main problem of this research, these theories collectively illuminate the challenges of fostering meaningful cognitive engagement in hybrid learning environments. Constructivism addresses the need for active and participatory learning experiences, ecological theory highlights the importance of environmental coherence and interaction, and cognitive engagement theory focuses on the depth of students' intellectual involvement. The research gap identified earlier namely the lack of integrative frameworks that connect these dimensions is directly addressed through the synthesis of these theories. By combining their insights, this study proposes a more holistic approach to understanding and designing hybrid ecological classrooms.

Furthermore, the integration of these theories provides a strong foundation for the research questions. Constructivist principles inform questions related to instructional design and student interaction, ecological perspectives guide inquiries into environmental factors and contextual influences, and cognitive engagement theory shapes the investigation of students' mental processes and learning outcomes. Together, they support a comprehensive exploration of how hybrid ecological classrooms can be optimized to enhance cognitive engagement.

In relation to the objectives and significance of the study, the theoretical framework offers multiple contributions. Theoretically, it advances the integration of established learning theories into a cohesive model that reflects contemporary educational realities. Academically, it provides a robust basis for empirical investigation and scholarly discussion, contributing to the literature on hybrid learning and student engagement. Practically, the framework informs the design and implementation of learning

environments that are not only technologically advanced but also pedagogically effective. By aligning theory with practice, the study aims to support educators and institutions in creating meaningful learning experiences.

In conclusion, the literature review demonstrates that Constructivist Learning Theory, Ecological Systems Theory, and Cognitive Engagement Theory collectively offer a comprehensive and complementary foundation for examining hybrid ecological classrooms. The perspectives of Piaget, Vygotsky, Bronfenbrenner, and contemporary scholars such as Fredricks and Guthrie converge to highlight the importance of active learning, environmental interaction, and deep cognitive involvement (Ortega et al., 2023). These theories directly address the main research problem and identified gaps by providing an integrated framework that captures the complexity of modern learning environments. The novelty of this study lies in its synthesis of these theoretical perspectives to propose a multidimensional model of cognitive engagement in hybrid contexts. This synthesis not only informs the research questions and objectives but also underscores the theoretical, academic, and practical significance of the study, offering valuable insights for the advancement of educational research and practice in the digital age.

RESEARCH METHODS

This study adopts a qualitative research approach to explore the dynamics of hybrid ecological classrooms and their influence on students' cognitive engagement, as framed in the research title *Learning Beyond the Screen: Hybrid Ecological Classrooms and Students' Cognitive Engagement*. A qualitative methodology is particularly appropriate for this investigation because it enables an in-depth understanding of complex educational phenomena that cannot be fully captured through numerical data alone (Sarinah et al., 2025). Cognitive engagement, as a multidimensional construct, involves internal processes such as meaning-making, critical thinking, and self-regulation, which are best examined through rich, descriptive data (Shen et al., 2024). Furthermore, the ecological nature of hybrid classrooms characterized by the interaction between physical, digital, and social elements requires a research design capable of capturing context, relationships, and lived experiences (Kučera & Haffner, 2025). Therefore, this study employs a qualitative case study design, which allows for a holistic examination of a bounded system within its real-life context (Vänttinen, 2025).

The qualitative case study design is selected based on its strength in investigating contemporary phenomena where the boundaries between the phenomenon and context are not clearly evident (Pedro et al., 2025). Drawing on the methodological principles articulated by Robert K. Yin and further enriched by interpretive traditions, this design facilitates a comprehensive exploration of how hybrid ecological classrooms are implemented and experienced by participants (Hawley et al., 2023). The choice of a case study is also justified by the study's aim to generate contextualized insights rather than generalizable statistical conclusions (Prestridge et al., 2024). By focusing on a specific educational setting, the research can uncover nuanced patterns of interaction, instructional design, and student engagement that may inform both theory and practice. Additionally, the case study approach supports the integration of multiple data sources, thereby enhancing the credibility and depth of the findings (Singh et al., 2023).

The research is conducted at a senior secondary educational institution, referred to using the pseudonym "Nusantara Integrated Learning School," located in an urban area with advanced technological infrastructure and a demonstrated commitment to innovative pedagogical practices. The selection of this site is purposive and strategic. The school has implemented a hybrid learning system that integrates face-to-face instruction with digital platforms, making it an ideal setting for examining the ecological dimensions of learning environments. Moreover, the institution has a diverse student population and a faculty body that actively engages in professional development related to digital pedagogy. These characteristics provide a rich context for investigating how hybrid ecological classrooms function and how they influence students' cognitive engagement. The urban setting also ensures access to reliable technological resources, which is essential for the implementation of hybrid learning models.

Participants in this study are selected using purposive sampling, a technique commonly employed in qualitative research to identify individuals who possess relevant knowledge and experience

related to the research topic (Migliori, 2025). The study involves a total of twelve student participants and six teacher participants, each assigned pseudonyms to ensure confidentiality. The student participants include individuals such as “Alya,” “Rizky,” “Nadia,” “Fahmi,” “Dinda,” “Arif,” “Salsa,” “Bima,” “Laras,” “Taufik,” “Intan,” and “Rafi.” These students are enrolled in classes that actively utilize hybrid ecological learning approaches and are selected based on their varying levels of academic performance and engagement to capture a wide range of perspectives. The teacher participants, identified as “Mr. Aditya,” “Ms. Rina,” “Mr. Budi,” “Ms. Sari,” “Mr. Hendra,” and “Ms. Lestari,” are educators who design and facilitate hybrid learning activities. Their inclusion is essential for understanding instructional strategies, challenges, and perceptions related to student engagement.

In addition to participants, the study includes key informants who provide deeper insights into the institutional and pedagogical context. These informants consist of three individuals: “Dr. Maya,” the school principal; “Mr. Andi,” the head of the curriculum department; and “Ms. Fitri,” the educational technology coordinator. The selection of these informants is based on their strategic roles in decision-making and implementation of hybrid learning policies. Their perspectives contribute to a broader understanding of how hybrid ecological classrooms are conceptualized, supported, and evaluated at the institutional level. The inclusion of multiple participant groups enhances the richness of the data and allows for triangulation of perspectives (Mäntyoja & Hautala, 2025).

Data collection is carried out through multiple qualitative techniques, including in-depth interviews, participant observation, and document analysis (Pant, 2025). Semi-structured interviews are conducted with all participants and informants to explore their experiences, perceptions, and reflections on hybrid ecological classrooms and cognitive engagement. The use of semi-structured formats allows for flexibility in probing emergent themes while maintaining consistency across interviews (Koukaras et al., 2025). Participant observation is conducted during classroom sessions, both physical and virtual, to capture real-time interactions, instructional practices, and student engagement behaviors. Field notes are systematically recorded to document observed phenomena, including student participation, use of digital tools, and the integration of learning environments. Document analysis involves the examination of lesson plans, digital learning materials, institutional policies, and student work artifacts, providing additional context and supporting evidence for the study (V. Liu et al., 2025).

To ensure the trustworthiness of the research, several strategies are employed, including data triangulation, member checking, and prolonged engagement (Bustard et al., 2023). Triangulation is achieved by comparing data from different sources and methods, thereby enhancing the credibility of the findings (Rotar, 2025). Member checking involves sharing preliminary interpretations with participants to verify accuracy and resonance with their experiences (Luo & Zhou, 2024). Prolonged engagement in the field allows the researcher to build rapport with participants and gain a deeper understanding of the context (Yusmaneli et al., 2025). Additionally, the study maintains an audit trail that documents the research process, decisions, and reflections, contributing to transparency and dependability (Verma et al., 2023).

Data analysis is conducted using thematic analysis, following an iterative and inductive process (H. Liu et al., 2024). The analysis begins with data familiarization, during which interview transcripts, observation notes, and documents are carefully reviewed. This is followed by initial coding, where meaningful units of data are identified and labeled. Codes are then grouped into categories and themes that reflect patterns related to cognitive engagement and ecological learning environments. The analysis is guided by the theoretical framework of constructivism, ecological systems theory, and cognitive engagement theory, while remaining open to emergent insights. The use of qualitative data analysis software supports the organization and retrieval of data, ensuring systematic and rigorous analysis (He & Zeng, 2025).

The technique for drawing conclusions in this study is grounded in an interpretive approach that emphasizes meaning-making and contextual understanding (B. Li et al., 2025). Conclusions are derived through a process of analytic induction, where patterns and relationships identified in the data are continuously compared and refined (Z. Li et al., 2025). The researcher engages in reflective interpretation, considering both the empirical findings and the theoretical framework to construct a coherent narrative. Cross-case analysis is also employed to identify similarities and differences among

participants, enhancing the depth of interpretation (Simon & Zeng, 2024). The final conclusions are not presented as definitive truths but as contextually grounded insights that contribute to theoretical and practical understanding.

Ethical considerations are carefully addressed throughout the research process. Informed consent is obtained from all participants and informants, ensuring that they are fully aware of the study's purpose and procedures (Khany & Barzan, 2025). Confidentiality is maintained through the use of pseudonyms and secure data storage (Harris & Greer, 2024). The research also adheres to principles of respect, transparency, and integrity, ensuring that participants' voices are represented accurately and respectfully (Lie et al., 2023).

In summary, the qualitative case study methodology employed in this research provides a robust and flexible framework for exploring the complexities of hybrid ecological classrooms and students' cognitive engagement. Through purposive sampling, multiple data collection methods, and rigorous analytical procedures, the study generates rich and meaningful insights into how learning can extend beyond the screen. The methodological choices are closely aligned with the research objectives and theoretical framework, ensuring coherence and relevance. By capturing the lived experiences of students, teachers, and institutional leaders, the study offers valuable contributions to the understanding and development of innovative learning environments in the digital age.

RESULTS AND DISCUSSION

The findings of this study reveal that the implementation of hybrid ecological classrooms significantly reshapes the nature and depth of students' cognitive engagement, particularly when learning environments are intentionally designed to integrate physical interaction, digital mediation, and social collaboration. Drawing on qualitative data obtained through interviews, observations, and document analysis, the results demonstrate that cognitive engagement is not merely a function of technological access but emerges from the dynamic alignment between pedagogical strategies, environmental conditions, and learner participation. This directly addresses the main research problem, which concerns the persistent gap between the expansion of hybrid learning modalities and the limited realization of meaningful cognitive engagement. When interpreted through the lenses of Constructivist Learning Theory, Ecological Systems Theory, and Cognitive Engagement Theory, the findings indicate that hybrid ecological classrooms can foster deeper learning when they are structured as interconnected systems rather than fragmented instructional modes (Greenleaf et al., 2023).

The first major finding indicates that students experience higher levels of cognitive engagement when hybrid classrooms facilitate active knowledge construction through problem-based and inquiry-driven activities. Participants such as Alya and Rizky reported that learning tasks requiring analysis, discussion, and real-world application enhanced their understanding more effectively than passive content consumption. This finding aligns with Constructivist Learning Theory, particularly Piaget's notion of active cognitive structuring and Vygotsky's emphasis on social interaction within the Zone of Proximal Development (Namdar, 2025). Observational data further confirm that classrooms incorporating collaborative digital tools alongside face-to-face discussions create opportunities for scaffolding and shared meaning-making. From an ecological perspective, these interactions represent the integration of multiple systems individual cognition, peer collaboration, and technological mediation working cohesively to support engagement (Gorsky & Levin, 2025). Cognitive Engagement Theory is also reflected in students' increased use of metacognitive strategies, such as self-monitoring and reflection, when engaging in complex tasks within hybrid settings (Dai et al., 2025).

A second key finding highlights the importance of environmental coherence in sustaining engagement across physical and digital spaces. Teachers such as Ms. Rina and Mr. Budi emphasized that inconsistencies between online and offline components often led to confusion and reduced student motivation. However, when instructional design ensured continuity through aligned objectives, integrated platforms, and consistent feedback mechanisms students demonstrated sustained attention and deeper processing of content. This finding strongly supports Bronfenbrenner's Ecological Systems Theory, as it illustrates how the mesosystem, representing the interaction between different learning environments, plays a critical role in shaping cognitive outcomes (Horvath, 2024). The ecological alignment observed in successful classrooms also reflects contemporary extensions of the theory, where

digital environments are considered integral components of the learning ecosystem (Yin et al., 2025). From the perspective of Cognitive Engagement Theory, such coherence reduces cognitive overload and enables students to focus their efforts on higher-order thinking rather than navigating fragmented systems (Hoang et al., 2025).

Another significant finding relates to the role of teacher facilitation in mediating cognitive engagement. The study reveals that teachers who adopt adaptive and reflective instructional practices are more effective in fostering engagement within hybrid ecological classrooms. For instance, Mr. Aditya implemented flexible learning pathways that allowed students to choose between digital simulations and hands-on activities, thereby accommodating diverse learning preferences. This approach resonates with constructivist principles by empowering learners to actively shape their learning experiences (Muthmainnah et al., 2025). At the same time, it reflects ecological thinking by recognizing the diversity of learner-environment interactions (Frazier et al., 2025). Students in such settings reported a greater sense of autonomy and intellectual investment, consistent with the dimensions of cognitive engagement identified by Fredricks, Blumenfeld, and Paris (Sofyan & Aeni, 2024). Conversely, classrooms with rigid, technology-centered approaches exhibited lower levels of engagement, highlighting the importance of pedagogical design over technological presence.

The findings also reveal a critical gap between institutional policy and classroom practice. While school leaders such as Dr. Maya and Mr. Andi articulated a vision of integrated hybrid learning, the actual implementation varied significantly across classrooms. This inconsistency reflects the broader research gap identified in the literature, where theoretical models of hybrid learning are not always effectively translated into practice (Xiong et al., 2025). From an ecological standpoint, this gap can be understood as a misalignment between different system levels, including institutional policies (macrosystem), school management (exosystem), and classroom practices (microsystem). Constructivist theory further suggests that without adequate support and professional development, teachers may struggle to create meaningful learning experiences (Feriyansyah et al., 2025). Cognitive Engagement Theory reinforces this interpretation by indicating that poorly designed learning environments fail to stimulate the effort and persistence required for deep engagement (Occhioni et al., 2024).

To provide a structured overview of the findings, the following table summarizes key themes, supporting data, and theoretical connections:

Theme of Findings	Empirical Evidence (Participants/Observation)	Theoretical Connection	Interpretation
Active Knowledge Construction	Students (Alya, Rizky) engaged in inquiry tasks	Constructivism (Piaget, Vygotsky)	Learning improves through interaction and social scaffolding
Environmental Coherence	Teachers reported alignment challenges	Ecological Systems Theory (Bronfenbrenner)	Engagement depends on integration across learning environments
Teacher Adaptive Facilitation	Flexible learning pathways observed	Constructivism & Cognitive Engagement Theory	Autonomy and adaptability enhance deep cognitive processing
Institutional-Practice Gap	Policy-practice inconsistency identified	Ecological Systems Theory	Misalignment across system levels reduces effectiveness
Metacognitive Engagement	Students demonstrated self-regulated learning	Cognitive Engagement Theory (Fredricks et al.)	Higher-order thinking emerges in well-designed hybrid environments

In relation to the research questions, the findings provide comprehensive answers. The first question, concerning how hybrid ecological classrooms influence cognitive engagement, is addressed through evidence that integrated and interactive learning environments significantly enhance students' intellectual involvement. The second question, regarding the design elements that contribute to engagement, is answered by identifying active learning strategies, environmental coherence, and adaptive teaching as critical factors. The third question, focusing on students' experiences, is illuminated by participants' reflections on autonomy, collaboration, and meaningful learning.

The study's objectives are also achieved through these findings. The development of a conceptual framework integrating ecological and cognitive perspectives is supported by empirical evidence demonstrating the interdependence of learning elements. The evaluation of hybrid classroom effectiveness reveals that engagement is maximized when learning environments are cohesive and student-centered. Additionally, the identification of best practices provides actionable insights for educators and institutions.

The benefits of this research can be understood across theoretical, practical, and academic dimensions. Theoretically, the study contributes to the integration of three major learning theories, demonstrating their complementary roles in explaining cognitive engagement in hybrid contexts. Practically, the findings offer guidance for designing and implementing hybrid ecological classrooms that promote meaningful learning. Academically, the research enriches the discourse on educational innovation, providing a foundation for future studies.

In the discussion of findings, it is evident that the main problem identified at the outset is substantiated by both empirical data and prior research. Previous studies have highlighted the limitations of technology-driven learning, and this study confirms that without ecological integration, hybrid classrooms may fail to achieve their intended outcomes (Kovari, 2025). Similarly, the identified research gap is reinforced by the observed disconnect between theory and practice, as well as the lack of comprehensive frameworks in existing literature (Prestridge & Cox, 2023). The findings extend previous research by demonstrating how the integration of constructivist, ecological, and cognitive engagement perspectives can address this gap (Tancredi & Abrahamson, 2024).

Furthermore, the discussion reveals that the research questions are not only answered but also expanded through the findings. The interplay between theory and practice provides deeper insights into the mechanisms underlying cognitive engagement. The study's objectives are validated through the alignment between theoretical frameworks and empirical evidence, highlighting the relevance and applicability of the proposed model. The benefits of the research are also supported by prior studies, which emphasize the importance of active learning, environmental design, and student engagement (Zhou, 2025).

In conclusion, the results of this study demonstrate that hybrid ecological classrooms have the potential to transform learning experiences by fostering deeper cognitive engagement. However, this potential can only be realized when learning environments are designed as integrated systems that align pedagogical, technological, and social elements (Shi et al., 2024). By connecting empirical findings with established theories and previous research, the study provides a comprehensive understanding of how learning can truly extend beyond the screen. The novelty of this research lies in its holistic approach, which not only addresses existing gaps but also offers a sustainable framework for future educational innovation.

CONCLUSION

The conclusions of this study affirm that hybrid ecological classrooms, when intentionally designed and coherently implemented, have a significant and transformative impact on students' cognitive engagement. Drawing from the results and discussion, the study demonstrates that learning environments extending beyond purely digital or traditional boundaries can foster deeper intellectual involvement, provided that they integrate pedagogical, technological, and social dimensions in a balanced and meaningful manner. The central problem identified at the outset namely the discrepancy between the widespread adoption of hybrid learning and the limited realization of meaningful cognitive engagement is addressed through empirical evidence showing that engagement is not inherently

produced by technology, but rather emerges from the quality of interaction within an ecological learning system.

The findings indicate that students' cognitive engagement increases when hybrid classrooms promote active knowledge construction through inquiry-based, collaborative, and contextually relevant learning activities. This reinforces the principles of Constructivist Learning Theory, where learners actively build understanding through interaction with their environment and peers. The discussion further highlights that such engagement is amplified when students are positioned not as passive recipients of information, but as active participants in meaning-making processes. In this regard, hybrid ecological classrooms provide a platform where digital tools and face-to-face interactions complement each other, enabling richer learning experiences that support higher-order thinking skills such as analysis, evaluation, and reflection.

Moreover, the study concludes that the coherence of the learning environment plays a critical role in sustaining cognitive engagement. The integration between online and offline components must be carefully aligned in terms of instructional goals, learning activities, and assessment strategies. As evidenced in the findings, fragmented or poorly coordinated hybrid systems can lead to cognitive overload and reduced motivation, ultimately undermining engagement. This insight aligns with Ecological Systems Theory, which emphasizes the importance of interconnected systems in shaping human development and learning. The discussion underscores that hybrid ecological classrooms function effectively only when there is harmony across different layers of the educational environment, including classroom practices, institutional policies, and technological infrastructures.

Another key conclusion relates to the pivotal role of teachers as facilitators of engagement within hybrid ecological settings. The study reveals that adaptive, reflective, and student-centered teaching practices are essential in mediating the relationship between learning environments and cognitive outcomes. Teachers who demonstrate flexibility in instructional design, responsiveness to student needs, and the ability to integrate multiple learning modalities are more successful in fostering deep engagement. This finding is consistent with Cognitive Engagement Theory, which highlights the importance of meaningful tasks, strategic learning, and sustained effort in promoting cognitive investment. The discussion further emphasizes that teacher readiness and professional competence are critical factors in the successful implementation of hybrid ecological classrooms.

The study also concludes that there remains a notable gap between institutional aspirations and classroom realities. While educational institutions may adopt hybrid learning policies, their effectiveness depends on consistent and context-sensitive implementation. The findings reveal that disparities in teacher preparedness, technological access, and pedagogical understanding can hinder the realization of ecological learning environments. This conclusion not only confirms the research gap identified in the literature but also extends it by illustrating how systemic misalignments affect cognitive engagement at the classroom level. The discussion suggests that addressing this gap requires a holistic approach that encompasses policy development, teacher training, and infrastructure support.

In relation to the research objectives, the study successfully develops and validates a conceptual framework that integrates constructivist, ecological, and cognitive engagement perspectives. This framework provides a comprehensive understanding of how hybrid ecological classrooms can be designed to enhance student engagement. The conclusions drawn from the findings demonstrate that these theoretical perspectives are not only compatible but also mutually reinforcing in explaining the complexities of modern learning environments. The study thereby contributes to theoretical advancement by bridging previously fragmented areas of research.

From a practical standpoint, the conclusions offer actionable insights for educators and institutions. The importance of designing coherent, interactive, and flexible learning environments is emphasized, along with the need for continuous professional development for teachers. Academically, the study contributes to the growing body of literature on hybrid learning by providing empirically grounded evidence and a multidimensional analytical framework. It also opens avenues for future research to explore the long-term impact of hybrid ecological classrooms and their applicability across diverse educational contexts.

In summary, this study concludes that learning beyond the screen is not merely a technological shift, but a pedagogical transformation that requires the integration of multiple learning dimensions. Hybrid ecological classrooms have the potential to significantly enhance students' cognitive engagement, but their success depends on the alignment of instructional design, environmental coherence, and teacher facilitation. By synthesizing findings and discussion, the study offers a nuanced understanding of how educational practices can evolve to meet the demands of the digital age while maintaining a strong focus on meaningful and sustained learning.

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