ChatGPT in Secondary Education: A Multi-Theoretical Case Study from a Developing Country

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Abstract

The rapid advancement of generative artificial intelligence (AI) has created opportunities and challenges for secondary education, particularly in resource-constrained contexts. This study examines the integration of ChatGPT in classroom learning through a qualitative instrumental case study conducted in a public secondary school in Indonesia. Data were collected through semi-structured interviews, classroom observations, and focus group discussions involving students, teachers, and school leadership. The findings reveal that ChatGPT is primarily used in concept-driven subjects such as Economics, Indonesian Language, and English, while its application in Mathematics remains limited. Students reported that ChatGPT supports learning efficiency, facilitates conceptual understanding, and enhances confidence in completing academic tasks. However, challenges related to information accuracy, potential dependency, and uncritical use were also identified. Importantly, the study highlights the central role of teacher mediation in shaping responsible and reflective ChatGPT use, particularly through strategies such as verification of ChatGPT-generated content and guided explanation in students' own words. Based on these findings, the study proposes a teacher-mediated and context-sensitive framework to support pedagogically grounded ChatGPT integration. The study contributes empirical evidence from a Global South context and

offers transferable insights for the responsible pedagogical integration of ChatGPT in under-resourced secondary education settings.

Keywords: ChatGPT; generative AI; secondary education; learning motivation; teacher mediation

Introduction

The proliferation of artificial intelligence (AI) tools, particularly large language models (LLMs) such as ChatGPT, has transformed the educational landscape by enabling new forms of interaction, personalisation, and access to information. In developed countries, the adoption of generative AI has been increasingly integrated into formal education settings to enhance teaching and learning outcomes. However, the diffusion and impact of such technologies in developing countries remain underexplored, despite growing interest in digital transformation within educational systems.

Indonesia, as the fourth most populous nation with significant regional disparities in digital infrastructure and teacher digital literacy, presents a compelling case for studying the adoption of ChatGPT and similar generative AI tools in education. According to national policy frameworks, including the Act of the Republic of Indonesia Number 20, Year 2003 on the National Education System, the integration of technology into education is a strategic imperative. Yet, implementation gaps persist, particularly in public secondary schools where access, training, and pedagogical readiness vary widely. These issues are particularly pressing in secondary education (Timotheou et al. 2023), where digital competency and pedagogical innovation are crucial to meet the demands of 21st-century learning (Aslan, Alanoğlu, and Karabatak 2025; Kiryakova and Kozhuharova 2024). In the Indonesian educational contexts, where digital literacy levels vary widely and ChatGPT-based instruction is still in its infancy, these challenges are further compounded (Muawanah, Marini, and Sarifah 2024; Rusydiyah, Purwati, and Prabowo 2020).

While existing studies have highlighted the potential benefits of AI tools such as ChatGPT in promoting engagement, comprehension, and self-directed learning, most are situated in higher education or Western contexts. There is a paucity of empirical research focusing on how such tools are perceived and utilised in under-resourced secondary school environments. Furthermore, the ethical, cognitive, and pedagogical implications of ChatGPT integration at the high school level in developing countries remain insufficiently examined (Bond et al. 2024).

This study seeks to fill these gaps by conducting an exploratory case study in a public senior high school in North Sumatra, Indonesia. Anchored in constructivist learning theory, the technology acceptance model (Davis and Granić 2024), and the artificial intelligence in education (AIED) framework (Lameras and Arnab 2021), this research investigates how students and teachers engage with ChatGPT, what benefits and limitations they perceive, and how such technologies shape learning behaviours and

instructional practices. Through a multi-stakeholder and theory-informed lens, the study aims to provide actionable insights for educators, policymakers, and technology developers seeking to implement ChatGPT responsibly in secondary education.

In many semi-urban areas in Indonesia, students' access to digital learning is shaped more by personal smartphone ownership than by school-provided infrastructure. Most students rely on prepaid mobile internet services to connect to online learning platforms, while institutional digital facilities remain relatively limited. As a result, learning activities that involve digital tools often take place through students' own devices. This situation has gradually created a learning environment in which personal technology plays a central role in accessing online resources, including emerging ChatGPT-based applications. Recognising this context is essential for understanding how generative AI is introduced, used, and experienced in everyday classroom practice.

While this study is situated in one public secondary school, the challenges identified such as uneven infrastructure, limited teacher preparedness, and emerging ethical concerns mirror conditions found in many secondary education systems in the Global South. For this reason, the case provides analytically transferable insights into how generative AI may operate within comparable resource-constrained educational settings.

Objectives

This study seeks to explore the integration of ChatGPT in Indonesian secondary schools, with a particular emphasis on its application in Economics education. Specifically, the study aims to:

1. Identify patterns of ChatGPT usage across academic subjects.

2. Examine students' perceptions of ChatGPT's usefulness, limitations, and influence on academic engagement.

3. Evaluate the pedagogical impacts of ChatGPT on learning motivation, comprehension, and autonomy.

4. Investigate teacher perspectives on the challenges and benefits of using ChatGPT in the classroom.

5. Recommend strategies for integrating ChatGPT effectively into the curriculum to support student-centred learning.

Conceptual Framework

This study adopts a multi-theoretical framework that integrates constructivist learning theory, the technology acceptance model, and the artificial intelligence in education

paradigm. These perspectives collectively offer a robust foundation for understanding how ChatGPT is adopted and influences pedagogy within secondary school contexts.

Constructivist learning theory, inspired by Piaget and Vygotsky, emphasises that knowledge is actively constructed by learners through interaction, contextual engagement, and exploration. In this view, learning becomes meaningful when students take responsibility for building their own understanding. Within this framework, ChatGPT functions as a cognitive scaffold offering real-time explanations, feedback, and prompts that support higher-order thinking and personalised learning experiences. Its effectiveness, however, depends on how intentionally and critically students engage with it (Ding et al. 2023; Lee et al. 2024; Tsamados, Floridi, and Taddeo 2025).

The technology acceptance model, developed by Davis, explains technology adoption based on two core perceptions: perceived usefulness (PU) and perceived ease of use (PEOU). In this study, the technology acceptance model (TAM) is applied to assess how students and teachers perceive ChatGPT's functionality and usability in the learning process. These perceptions influence their willingness to engage with the tool and determine the extent to which it is embedded into classroom practices particularly important in environments with varying levels of digital literacy such as in Indonesian secondary education (Elkaseh, Wong, and Fung 2016).

The artificial intelligence in education framework further supports the conceptual foundation by emphasising the role of AI in delivering adaptive, interactive, and personalised learning. ChatGPT, as a conversational AI, simulates human dialogue to assist learners in problem-solving, content exploration, and reflection. It aligns with AIED principles by facilitating learner modelling, metacognitive development, and autonomous inquiry (Jauhiainen and Garagorry Guerra 2024).

Together, these theoretical perspectives guide the investigation of how ChatGPT impacts learning engagement, comprehension, and independent learning. They also help contextualise the moderating roles of teacher supervision, digital readiness, and ethical use in ensuring that AI integration supports, rather than replaces, meaningful pedagogy.

Methodology

This qualitative research employed an instrumental case study design to explore how ChatGPT is being introduced, interpreted, and negotiated within everyday secondary school learning practices in Indonesia. This study was guided by a multi-theoretical perspective on constructivist learning theory, the technology acceptance model, and the artificial intelligence in education framework. Rather than treating technology adoption as a purely technical process, this approach allowed the research to foreground learners' experiences, teacher mediation, and the socio-pedagogical conditions that shape ChatGPT-supported learning.

The study was conducted at a public secondary school located in a semi-urban region where digital learning infrastructure is still developing. To protect institutional confidentiality, the school is described contextually rather than identified by name. The site was selected as an instrumental case because it reflects a typical public-school environment in which generative AI tools such as ChatGPT are beginning to enter classroom practice, offering a meaningful setting for examining emerging patterns of ChatGPT use in education.

To situate the case within its broader socio-technical context, this study draws on regional digital access data from a previous large-scale survey conducted in the same geographical area. The survey reported that approximately 96.05% of secondary school students owned personal smartphones and used them intensively on a daily basis, with average usage approaching 4 hours and 45 minutes per day, and reliance on low-cost prepaid mobile data packages approximately US$1.94 to US$3.75 per month. Internet connectivity in the region was found to rely predominantly on prepaid mobile data services, while fixed broadband infrastructure remained limited (Pardede, Pardede, and Pardede 2025). Although school-based digital facilities are relatively modest, students' widespread reliance on personal devices has enabled access to online learning platforms and emerging AI-based applications such as ChatGPT. This background provides important context for interpreting participants' reported experiences, particularly the finding that technical barriers were not perceived as a major obstacle in everyday learning activities.

Participants in this study included students, teachers, and school leadership. Using purposive sampling, 17 students from grades 10 through 12 were selected based on their consistent use of ChatGPT for academic purposes. This sampling strategy was adopted not to represent the entire student population, but to gain in-depth insights into how ChatGPT is actually used by learners who have already adopted the tool. These students were able to provide reflective accounts of how ChatGPT shaped their learning strategies, task completion practices, and engagement with subject content. In addition, six educators including subject teachers from Economics and language disciplines, as well as the school principal, participated to provide complementary pedagogical and institutional perspectives on ChatGPT integration and classroom regulation.

In this study, students were positioned as key informants (KIs) because they were the primary users of ChatGPT and directly experienced its impact on learning processes. Teachers and the school principal were treated as supporting informants (SIs), offering insights into instructional strategies, supervision practices, and institutional decision-making related to ChatGPT use. To ensure confidentiality, all interview excerpts were anonymised using pseudonymous codes indicating informant category and sequence number. Not all participant codes appear in the findings, as some responses were consolidated during thematic analysis.

Data were generated through semi-structured interviews, classroom observations, and focus group discussions (FGDs). Student interviews explored learning experiences, perceived benefits and limitations of ChatGPT, and ethical concerns related to ChatGPT use. Teacher interviews focused on instructional adaptations, observed changes in student behaviour, and strategies for guiding responsible engagement with ChatGPT.

Classroom observations were conducted to examine how ChatGPT was used during learning activities, including patterns of student inquiry, peer interaction, and teacher intervention. These observations served as a critical triangulation source, enabling the study to compare self-reported experiences with actual classroom practices. By capturing real-time learning interactions, classroom observations provided independent behavioural evidence that strengthened the credibility of the findings and reduced reliance on participant self-reports alone.

Focus group discussions were conducted to deepen collective reflection among students and to validate emerging patterns identified during individual interviews and observation. In addition, snowball sampling was applied to include students with varying levels of familiarity with ChatGPT, ranging from novice to frequent users, allowing the study to capture a broader range of ChatGPT-supported learning experiences.

Ethical considerations were carefully addressed throughout the research process. All participants provided informed consent after being briefed about the study's objectives, procedures, and confidentiality measures. Ethical approval was obtained from the relevant institutional authority. Participants' identities were protected through anonymisation, and all data were securely stored with restricted access.

Thematic analysis followed Braun and Clarke's (2006) framework. Interview transcripts, observation notes, and focus group data were first coded to identify recurring patterns and meaningful units of analysis. These codes were then grouped into broader themes that reflected cognitive, motivational, pedagogical, and ethical dimensions of ChatGPT-supported learning. The interpretation process was strengthened through methodological triangulation and peer debriefing with education researchers, ensuring that the findings were grounded in the data and were analytically robust.

Findings

Overview of Key Themes

The thematic analysis generated six overarching themes that capture the multifaceted experiences of students and teachers in using ChatGPT within secondary education. These themes emerged through a systematic inductive–deductive coding process and were triangulated across three qualitative data sources: semi-structured interviews, classroom observations, and focus group discussions.

Each theme is represented by a set of subthemes that highlight key cognitive, motivational, pedagogical, and ethical dimensions of ChatGPT-supported learning. The inclusion of verbatim participant quotations strengthens the credibility and contextual depth of the findings. Importantly, the themes align closely with the study's guiding theoretical frameworks (constructivist learning theory, the technology acceptance model, and the artificial intelligence in education perspective), thereby linking empirical evidence with established educational theory.

Table 1 summarises the key themes, their analytical focus, and the primary data sources from which they were derived.

Table 1: The summary of key themes and data sources

No.	Theme	Subtheme / Focus	Data Source
1	ChatGPT as Cognitive Scaffold	Conceptual learning, task support	Student interviews
2	Perceived Usefulness and Ease of Use	Quick access, practical usability	FGDs, teacher input
3	Motivation and Independent Learning	Initiative, confidence	Student interviews
4	Ethical Concerns and Over-Reliance	Copy-paste, reduced critical thinking	Teacher interviews
5	Teacher's Mediating Role	Supervision, guided use	Teacher interviews
6	Recommendations for Development	More visuals, quizzes, local language options	FGDs

Usage patterns across academic subjects were derived from aggregated self-reports collected during interviews and focus group discussions (FGDs). These data were treated as a descriptive analytical layer informing the first empirical finding rather than as a standalone thematic category.

Building on the six overarching themes, the analysis was further synthesised into seven interrelated findings. While the themes represent core analytical categories, the findings reflect higher-level interpretive patterns that integrate multiple themes to explain how ChatGPT is adopted, experienced, and regulated in classroom practice. The findings are presented sequentially, beginning with usage trends across subjects and progressing towards deeper insights into learning enhancement, motivation, ethical challenges, teacher mediation, and future development.

Thematic Findings

Finding 1: Trends in the Use of ChatGPT in Learning

Interview and FGD data indicate that ChatGPT is used across multiple subjects, with the following distribution:

Table 2: ChatGPT usage by subject

No.	Subject	Percentage of Students Using ChatGPT
1	Economics	58.82%
2	Indonesian Language	17.65%
3	English Language	17.65%
4	Mathematics	5.88%

This distribution suggests that ChatGPT is predominantly employed in conceptual and language-based subjects, where explanation, interpretation, and elaboration are central to learning.

Finding 2: The Impact of ChatGPT on Comprehension and Learning Processes

Main Theme: Enhancing comprehension and accelerating the learning process

Participants consistently reported that ChatGPT supported learning efficiency, and facilitated understanding, particularly when working with difficult material. Students described ChatGPT as facilitating faster task completion:

> ChatGPT is enjoyable and convenient; it helps complete assignments faster. (QQ-KI-002)

From a teacher's perspective, ChatGPT was viewed as helpful in addressing complex learning tasks:

> Using ChatGPT greatly aids in addressing difficult problems. (QQ-SI-002)

Beyond efficiency, ChatGPT functioned as an exploratory learning tool that supported conceptual clarification and idea generation:

> ChatGPT is used to submit assignments, analyse difficult questions, and assist in understanding challenging topics. (QQ-KI-003)

Together, these findings indicate that ChatGPT operates as a form of cognitive scaffold, supporting learners in constructing understanding rather than simply retrieving ready-made answers.

Finding 3: Advantages and Challenges in Using ChatGPT

Main Theme: Benefits and limitations of ChatGPT

Students emphasised ChatGPT's ability to provide clear and detailed explanations:

> ChatGPT is highly beneficial for assignments due to its simple, clear, and detailed explanations. (QQ-KI-005)

However, participants also highlighted concerns related to response accuracy and completeness:

> Not all answers are always available or entirely accurate. (QQ-KI-006)

From a technical perspective, access-related barriers were reported to be minimal:

> Generally, there are no obstacles since network connectivity is stable. (QQ-SI-003)

These findings suggest that while technical infrastructure may not represent a major constraint in this context, cognitive and epistemic challenges remain central to ChatGPT-assisted learning.

Finding 4: Positive Effects on Motivation and Independent Learning

Main Theme: ChatGPT enhances learning motivation

Students reported increased confidence, initiative, and engagement in academic tasks:

> I acquire more knowledge, work harder on assignments, and boost my confidence. (QQ-KI-007)

Teachers similarly observed practical benefits in task completion:

> ChatGPT makes doing homework and solving problems easier. (QQ-SI-004)

These responses indicate that ChatGPT supports self-directed learning behaviours, although the nature and sustainability of this motivation require further critical examination, which is addressed in the discussion section.

Finding 5: Potential Dependency and Ethical Challenges

Main Theme: Negative impacts of ChatGPT usage

Teachers expressed concern regarding students' growing dependence on ChatGPT:

> Many students become reliant on it and stop thinking independently. (QQ-SI-005)

Issues related to information accuracy further complicated usage:

> Some answers are incorrect, requiring students to verify them through other sources. (QQ-SI-006)

More critically, misuse through direct copying was observed:

> It diminishes critical thinking skills and fosters an instant-results mentality. (QQ-KI-010)

These findings highlight ethical risks associated with uncritical consumption of ChatGPT content and underscore the importance of guiding its use in educational settings.

Finding 6: The Role of Teachers in Guiding Students

Main Theme: Teacher mediation as a critical regulatory mechanism

Teachers were widely perceived as central actors in guiding responsible ChatGPT use:

> Teachers play an essential role in providing guidance so that students do not rely solely on ChatGPT. (QQ-SI-001)

Teacher mediation emerged as a key factor in transforming ChatGPT from a shortcut-oriented tool into a structured learning aid that supports critical engagement.

Finding 7: Recommendations for ChatGPT Development

Main Theme: Enhancing ChatGPT's features to improve learning effectiveness

Participants suggested several improvements to enhance ChatGPT's educational value:

> ChatGPT should provide more detailed explanations, include images, and offer evaluation tools to enhance student understanding. (QQ-KI-012)

These recommendations reflect users' expectations for pedagogically oriented ChatGPT design rather than purely content-generating functionality.

Integrative Finding: Towards a Conceptual Model of ChatGPT-Enhanced Learning

Taken together, the findings reveal patterns that extend beyond isolated benefits or challenges. They point to a broader pedagogical dynamic in which learning emerges through interaction among students, teachers, and ChatGPT. In this context, ChatGPT functions not merely as a technological tool but as a co-constructive agent whose educational value depends on instructional guidance, learner engagement, and reflective use.

In response, this study proposes a ChatGPT-enhanced learning conceptual model grounded in empirical evidence and informed by established educational theory. Rather than separating cognitive, motivational, and technological dimensions, the model integrates these elements to reflect the lived realities of learners in resource-constrained educational contexts.

Development of the ChatGPT-Enhanced Learning Conceptual Model

The ChatGPT-enhanced learning model developed in this study is not a direct adoption of existing theoretical frameworks but rather a result of empirical synthesis derived from field data, analysed both inductively and deductively.

1. Empirical Integration of Constructivism and ChatGPT Technology

Students actively constructed understanding through questioning, exploration, and reflection, positioning ChatGPT as a cognitive scaffold rather than a passive information source.

2. Bidirectional Interaction between Active Inquiry and Learning Motivation

Active inquiry stimulated motivation, while motivated learners engaged more deeply with ChatGPT, revealing a reciprocal dynamic not fully captured by existing theories.

3. Extending TAM in Adaptive Learning Contexts

Perceived usefulness and ease of use evolved dynamically through repeated interaction and learning outcomes, extending TAM beyond static adoption models.

4. Strengthening the AIED Framework through Adaptive-Reflective Learning

ChatGPT enabled not only adaptive support but also reflective comparison and revision, adding a cognitive-reflective dimension to AIED.

Figure 1 shows that learning outcomes are not final or linear end points. Instead, they act as reflective feedback that encourages students to revisit questions, refine their understanding, and engage in self-regulated learning, all within ongoing teacher guidance.

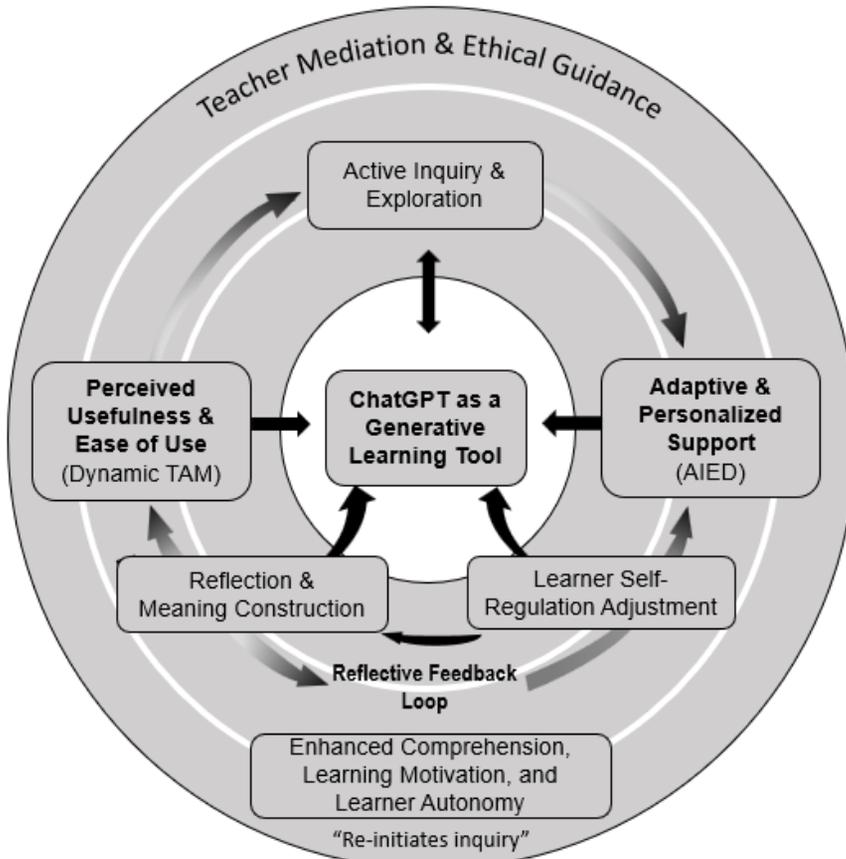A Teacher-Mediated and Reflective ChatGPT-Enhanced Learning Model

Figure 1: ChatGPT-enhanced learning model

Narrative Explanation of the ChatGPT-Enhanced Learning Model

The ChatGPT-enhanced learning model proposed in this study conceptualises learning as a dynamic, cyclical, and teacher-mediated process, rather than a linear outcome of technology adoption. Grounded in empirical findings and informed by constructivist learning theory, the technology acceptance model, and the artificial intelligence in education framework, the model reflects how generative AI functions within real classroom practices in a developing country context.

At the centre of the model, ChatGPT functions as a generative learning tool that supports explanation, idea generation, and conceptual clarification. However, meaningful learning emerges only when ChatGPT interaction is combined with active inquiry and cognitive scaffolding, where learners test, refine, and reinterpret knowledge.

A critical component of the model is reflection, which enables learners to evaluate ChatGPT responses, compare them with prior knowledge or authoritative sources, and reconstruct meaning. This reflective dimension extends traditional constructivist approaches by situating ChatGPT not merely as an information provider, but as a catalyst for metacognitive engagement.

The model further integrates technology acceptance as a dynamic condition rather than a static prerequisite. Consistent with TAM, perceived usefulness and ease of use influence students' willingness to engage with ChatGPT. However, the findings indicate that these perceptions evolve over time, shaped by learning outcomes, task success, and teacher feedback. This positions technology acceptance as an adaptive process, continuously reshaped by educational experience.

From an AIED perspective, ChatGPT provides adaptive and personalised support, yet its effectiveness depends on how learners interpret and regulate ChatGPT assistance. Importantly, the model foregrounds teacher mediation as a regulatory and ethical layer that surrounds the entire learning process. Teachers guide students in interpreting ChatGPT outputs, discourage uncritical copying, prompt explanation in students' own words, and foster ethical awareness in ChatGPT use. This mediation ensures that ChatGPT enhances rather than undermines critical thinking and learner autonomy.

Therefore, learning outcomes manifested as improved comprehension, increased motivation, and greater learning autonomy are not end points, but feedback inputs that reinitiate inquiry and exploration. The cyclical nature of the model highlights that meaningful ChatGPT-enhanced learning emerges through iterative interactions among students, teachers, and generative technology, embedded within contextual and ethical considerations.

Classroom Observation Findings: Patterns of Student Engagement and Teacher Intervention

To complement the interview-based findings and strengthen methodological triangulation, classroom observation data were analysed as a separate empirical layer. Classroom observations provided important insights into how ChatGPT was actually used during learning activities and how teachers intervened in practice. Observational data revealed that students primarily accessed ChatGPT through personal smartphones, often during independent or group-based tasks rather than during direct instruction.

Students commonly used ChatGPT to clarify unfamiliar concepts, rephrase explanations from textbooks, and generate initial ideas for assignments. In several instances, students compared ChatGPT responses with textbook materials or notes provided by teachers, indicating exploratory rather than purely consumptive use. However, observations also showed moments where students tended to accept ChatGPT answers without questioning their accuracy or relevance.

Teacher intervention played a critical moderating role. Teachers were observed prompting students to explain ChatGPT answers in their own words, questioning the logic of responses, and encouraging cross-checking with trusted learning resources. In some cases, teachers explicitly instructed students not to copy responses verbatim and instead use ChatGPT as a reference or starting point for discussion.

These observations corroborate interview findings that teacher guidance is essential in preventing over-reliance on ChatGPT. They also demonstrate that responsible ChatGPT use does not occur automatically but emerges through active pedagogical mediation, reinforcing the importance of teacher presence in ChatGPT-supported learning environments.

Discussion

This study provides empirical insight into how ChatGPT is experienced, negotiated, and pedagogically regulated within secondary education in a developing country context. Rather than portraying ChatGPT as a deterministic or universally transformative solution, the findings reveal a dynamic, teacher-mediated, and reflective learning process, as conceptualised in the ChatGPT-enhanced learning model (Figure 1). This perspective aligns with critical scholarship in educational technology and emphasises the social, pedagogical, and contextual conditions shaping technology use in education (Selwyn et al. 2023). The discussion below integrates the thematic findings with this model to explain how learning emerges through the interaction of inquiry, motivation, technology acceptance, and teacher-mediated ethical guidance.

ChatGPT as a Cognitive Scaffold within Constructivist Learning

The findings indicate that ChatGPT primarily functions as a cognitive scaffold that supports students in clarifying concepts, exploring ideas, and initiating problem-solving processes. This pattern is consistent with constructivist learning theory, particularly Vygotsky's concept of the zone of proximal development, which emphasises that learning occurs through guided interaction and supported meaning-making (Sage 2022). Rather than passively consuming ChatGPT-generated responses, students used ChatGPT to extend inquiry, reinterpret learning materials, and construct preliminary understandings that were subsequently refined.

Unlike earlier conceptualisations that positioned AI tools as supplementary digital aids (Krakowski, Luger, and Raisch 2023), the present model conceptualises ChatGPT as embedded within a cyclical interaction between inquiry, scaffolding, and reflection. This finding challenges simplistic narratives that frame generative AI as replacing cognitive effort. Instead, ChatGPT operates as a provisional support whose educational value depends on learners' active engagement and interpretive agency.

Motivation and Inquiry as Reciprocal Processes

Although students reported increased motivation and confidence when using ChatGPT, the findings do not allow for a definitive distinction between intrinsic motivation and instrumental motivation driven by task efficiency. This distinction is important, as short-term gains in productivity do not necessarily translate into sustained deep learning or long-term cognitive engagement.

Within the proposed model, motivation is conceptualised not as a static outcome but as a reciprocal process that both shapes and is shaped by inquiry. As illustrated in Figure 1, learning outcomes feed back into renewed exploration, reinforcing learner autonomy and engagement. However, this study adopts a cautious interpretation of self-reported motivation, recognising that increased confidence may partly reflect the convenience afforded by AI assistance rather than enduring intrinsic learning motivation (Santini et al. 2025). This finding highlights the need for pedagogical strategies that channel ChatGPT-supported efficiency towards deeper conceptual engagement.

Dynamic Technology Acceptance in ChatGPT-Supported Learning

Consistent with the technology acceptance model (Davis and Granić 2024), students' engagement with ChatGPT was shaped by perceptions of usefulness and ease of use. However, the findings extend TAM by demonstrating that technology acceptance is not static, but evolves through ongoing learning experiences. As students interacted with ChatGPT and observed its impact on task performance and comprehension, their perceptions shifted in response to both success and instructional feedback.

In the proposed model, perceived usefulness and ease of use are embedded within the learning cycle rather than treated as preconditions for adoption. Technology acceptance thus emerges as an outcome of reflective engagement and pedagogical context. This insight contributes to current debates on AI adoption by highlighting how acceptance develops within authentic classroom practices rather than controlled experimental settings.

Adaptive and Reflective Learning through AIED

From an artificial intelligence in education (AIED) perspective, ChatGPT provided adaptive and personalised support by responding to students' questions and learning needs. However, the findings indicate that adaptivity alone is insufficient to ensure educational value. The effectiveness of ChatGPT support depended on students' capacity for reflection and self-regulation, as well as on teacher mediation.

Unlike studies from high-income contexts that often assume uniform access and digital fluency (Van de Werfhorst, Kessenich, and Geven 2022), the present model foregrounds reflection as a central mediating mechanism. As illustrated in Figure 1, reflective meaning-making and self-regulation play critical roles in transforming adaptive ChatGPT responses into meaningful learning outcomes. This represents a shift from

algorithm-centred adaptivity towards human-centred, reflective ChatGPT-supported learning.

Teacher Mediation and Ethical Regulation as Systemic Conditions

One of the most significant contributions of this study lies in demonstrating that teacher mediation and ethical guidance are not peripheral supports but systemic conditions of ChatGPT-enhanced learning. While ChatGPT offers substantial cognitive and motivational affordances, the findings show that its educational value emerges only when student engagement is actively guided and regulated by teachers. Classroom observations and teacher interviews consistently indicated that responsible ChatGPT use did not occur spontaneously, but was shaped through deliberate pedagogical intervention. Teachers encouraged students to explain ChatGPT-generated responses in their own words, discouraged direct copy-paste practices, and required verification through trusted learning resources.

These findings resonate with broader concerns in the literature regarding the ethical risks of generative AI in education, particularly tendencies towards cognitive offloading, surface learning, and the normalisation of digital shortcuts (Hadi Mogavi et al. 2024; Oates and Johnson 2025). Without instructional regulation, students may prioritise task completion over conceptual understanding, leading to diminished critical thinking and reflective engagement. In this sense, teacher mediation functions as a counterbalance to the automation of thought, ensuring that AI serves as a learning support rather than a substitute for intellectual effort (Razak, Abdul Razak, and Krish 2022).

From an artificial intelligence in education perspective, these findings further support the argument that effective AI integration requires hybrid pedagogical models that combine machine intelligence with human judgement and ethical oversight. Prior studies emphasise that AI systems must be embedded within instructional designs that foreground teacher agency, digital citizenship, and reflective learning practices (Seo et al. 2025). In the present study, teachers were not displaced by ChatGPT but repositioned as ChatGPT integrators and ethical moderators, guiding students to engage with generative tools responsibly, critically, and purposefully.

This systemic role of teachers is explicitly represented in the ChatGPT-enhanced learning model (Figure 1), where teacher mediation and ethical guidance form the outer regulatory layer surrounding the entire learning cycle. This visualisation reinforces the idea that ethical ChatGPT use is not an individual responsibility alone, but a collective pedagogical practice embedded within classroom norms, instructional strategies, and professional judgement. Without such mediation, the risks of over-reliance, superficial learning, and ethical misuse increase substantially, particularly in secondary education contexts where learners are still developing self-regulation and critical digital literacy skills.

Integrating Findings through the ChatGPT-Enhanced Learning Model

Taken together, the findings indicate that ChatGPT-enhanced learning is not a linear outcome of technology adoption but an iterative, reflective, and socially mediated process. As illustrated in Figure 1, learning outcomes such as improved comprehension, motivation, and learner autonomy function as feedback mechanisms that reinitiate inquiry and self-regulated learning under continuous teacher guidance. This cyclical dynamic demonstrates that meaningful learning with ChatGPT emerges through sustained pedagogical interaction rather than one-time technological exposure.

This integrative model extends existing scholarship by situating ChatGPT-enhanced learning within context-sensitive educational realities, particularly in developing education systems where digital access, learner readiness, and pedagogical practices vary considerably. In contrast to studies conducted in high-income contexts that often assume stable infrastructure and high levels of digital fluency (Van de Werfhorst, Kessenich, and Geven 2022), the present findings reveal a more layered learning ecology shaped by social, infrastructural, and cognitive constraints.

While the empirical data were generated from a single public secondary school in Indonesia, the patterns observed reflect broader structural challenges faced by many secondary education systems across resource-constrained regions, including uneven digital infrastructure, limited teacher preparation for ChatGPT integration, and emerging ethical governance frameworks. Rather than aiming for statistical generalisation, this study offers analytical generalisations by demonstrating how ChatGPT is negotiated within everyday classroom practice. In this sense, the proposed model provides transferable insights into ChatGPT-supported learning processes beyond the immediate research site.

By synthesising constructivist learning theory, motivational dynamics, the technology acceptance model, and artificial intelligence in education perspectives, the ChatGPT-enhanced learning model offers a theoretically integrative and empirically grounded framework. It emphasises that inquiry, reflection, teacher mediation, and ethical regulation are not supplementary features, but central mechanisms that enable ChatGPT to function as a pedagogical support rather than as a shortcut for task completion.

Finally, this study contributes to the global discourse on AI in education by demonstrating that effective ChatGPT-enhanced learning depends not only on technological innovation, but also on contextual sensitivity, pedagogical intentionality, and ethical stewardship. Consistent with critical perspectives on educational technology, the model reinforces the view that ChatGPT does not autonomously transform learning practices; instead, its educational value emerges through social mediation, instructional design, and institutional governance (Selwyn et al. 2023).

It is important to acknowledge that this study is subject to selection bias as participants were purposively selected based on their active use of ChatGPT. Consequently, the

findings primarily reflect the experiences of early adopters and regular users, and do not capture the perspectives of students who do not use ChatGPT due to limited access, digital skills, or personal preferences. As a result, the findings should be interpreted as insights into user-mediated learning practices rather than as a comprehensive representation of ChatGPT's impact across the entire student population.

Conclusion

This study examined how ChatGPT is used and negotiated within secondary education in a developing country context. The findings indicate that ChatGPT does not operate as a deterministic learning solution, but rather as part of a dynamic, teacher-mediated, and reflective learning process. ChatGPT primarily functions as a cognitive scaffold that supports inquiry and conceptual understanding; however, its educational value is contingent upon students' reflective engagement, self-regulation, and sustained pedagogical guidance.

A key contribution of this study lies in identifying teacher mediation and ethical guidance as systemic conditions for effective ChatGPT-enhanced learning. Classroom evidence suggests that responsible use of ChatGPT does not emerge automatically, but is cultivated through deliberate instructional practices that encourage students to articulate understanding in their own words, discourage uncritical copying, and promote verification of ChatGPT-generated information. These patterns are synthesised in the ChatGPT-enhanced learning model, which conceptualises learning as a cyclical process in which comprehension, motivation, and learner autonomy function as reflective feedback mechanisms that reinitiate inquiry under continuous teacher supervision.

Several limitations should be acknowledged. First, the study is based on a single-case investigation conducted in one public secondary school, which constrains the scope of generalisation. Second, the sample focused primarily on students who actively used ChatGPT, which may limit representation of non-users or students with restricted access and digital skills. Third, the qualitative design captures perceptions and observed practices, but does not assess long-term academic outcomes. Future research is therefore encouraged to adopt comparative and longitudinal designs across diverse institutional and socio-technical contexts.

Despite these limitations, the study offers context-sensitive insights into the pedagogical and ethical integration of generative AI in secondary education, particularly in environments characterised by uneven digital infrastructure and emerging AI adoption. As an instrumental single-site case study, the findings are not intended for statistical generalisation. Instead, they provide analytically grounded insights into how ChatGPT is experienced, mediated, and embedded in everyday classroom practice, offering transferable lessons for similar resource-constrained secondary education settings.

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