



## Generative AI in Secondary STEM Classrooms: Teachers' Conditional Acceptance

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### Article Info

#### Article history:

Received Dec 27, 2025

Revised Feb 7, 2026

Accepted Apr 2, 2026

Online First Jun 12, 2026

#### Keywords:

Generative AI  
Institutional Governance  
Secondary Education  
STEM Education  
Teacher Perceptions

### ABSTRACT

**Purpose of the study:** This study examines how secondary STEM teachers perceive and engage with generative artificial intelligence (GenAI) in instructional practice and identifies the institutional conditions influencing its responsible integration in public secondary schools. The study aims to understand how teachers regulate the use of GenAI within classroom instruction and professional decision-making.

**Methodology:** A qualitative exploratory design was employed using a focus group discussion involving thirteen secondary STEM teachers from a public secondary school. Data were collected using a semi-structured discussion guide informed by the Technology Acceptance Model (TAM). Thematic analysis following Braun and Clarke's six-phase framework was conducted, with NVivo qualitative analysis software supporting coding and data organization.

**Main Findings:** The findings show that teachers' engagement with generative artificial intelligence is characterized by partial familiarity, productivity-oriented use, and strong ethical concern. GenAI is primarily used for lesson preparation and instructional planning. Concerns regarding student overreliance, academic integrity, and learning authenticity limit unrestricted use, resulting in selective and regulated integration within classroom practice.

**Novelty/Originality of this study:** This study contributes qualitative evidence on secondary STEM teachers' engagement with generative artificial intelligence, a context underrepresented in AI-in-education research. It introduces the concept of conditional acceptance, explaining how teachers selectively adopt GenAI through professional judgment and institutional constraints, extending technology acceptance perspectives beyond binary adoption models.

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## 1. INTRODUCTION

The rapid emergence of generative artificial intelligence (GenAI) has intensified scholarly attention to its applications, opportunities, and risks in educational contexts. Recent studies indicate that GenAI can support instructional design, automate routine academic tasks, provide adaptive explanations, and enhance instructional efficiency across disciplines [1]–[4]. At the same time, growing concerns have been raised regarding academic integrity, ethical use, student overreliance, and the authenticity of learning outputs, particularly in formal

assessment contexts [5]–[7]. As a result, generative artificial intelligence has become a central topic in contemporary educational technology research and policy discourse worldwide [8]–[10].

Despite the expanding body of literature, much of the existing research remains largely descriptive and technology-centered. Prior studies frequently focus on tool capabilities, perceived usefulness, or general attitudes toward adoption, often relying on survey-based acceptance models and broad perception measures [11]–[13]. While such approaches provide useful insights into adoption trends, they offer limited understanding of how educators actually negotiate the use of GenAI within real instructional environments shaped by ethical responsibility, institutional expectations, and governance constraints [14]. Consequently, technology adoption is often framed as a binary outcome acceptance or resistance overlooking the complex professional judgments that guide teachers' everyday instructional decisions. Understanding these dynamics requires closer attention to how teachers interpret, regulate, and integrate emerging technologies within their professional practice.

This limitation is particularly evident in research on GenAI use in secondary education. While studies on artificial intelligence in higher education have expanded rapidly, relatively few empirical investigations have explored how secondary school teachers experience, interpret, and regulate GenAI use in daily classroom practice [15]–[17]. Secondary teachers operate within structured curricula, heightened accountability for student learning outcomes, and stricter supervision of instructional and assessment processes compared with their higher education counterparts [18], [19]. In contexts where formal policies and governance frameworks for GenAI remain limited or under development, teachers are often required to make situational decisions that balance instructional productivity, pedagogical responsibility, and ethical accountability [6], [20]. These conditions highlight the need for research that moves beyond generalized narratives of promise and risk to examine teachers' lived instructional experiences and the professional negotiation involved in integrating emerging technologies.

Although previous studies have examined teachers' attitudes toward artificial intelligence using models such as the Technology Acceptance Model (TAM), these investigations typically emphasize intention, perceived usefulness, or perceived ease of use [21]–[23]. Such approaches provide limited insight into how teachers' familiarity with GenAI, productivity considerations, ethical concerns, and institutional conditions interact over time to shape professional judgment, particularly in secondary education settings [12], [14]. Furthermore, empirical research from the Global South and Southeast Asia remains relatively underrepresented, with much of the existing literature concentrated in higher education or technologically mature contexts [15], [24]. This imbalance restricts understanding of how GenAI is conditionally accepted, regulated, or constrained in resource-variable and policy-ambiguous educational environments.

Responding to these gaps, this study advances a perspective that conceptualizes teachers' engagement with generative artificial intelligence as a process of conditional acceptance rather than a simple outcome of adoption or resistance. As generative AI tools increasingly enter school environments without clear governance frameworks or institutional guidance, understanding how teachers regulate their use has become an important educational concern [25]–[27]. Rather than treating acceptance as a static attitudinal state, this study examines how secondary STEM teachers' engagement with GenAI is dynamically negotiated through partial familiarity, perceived productivity benefits, ethical considerations, and institutional conditions [28]–[30]. By focusing on teachers' instructional experiences, the study extends acceptance-oriented frameworks by emphasizing the role of professional judgment, ethical responsibility, and governance ambiguity in shaping how and under what conditions GenAI is integrated into classroom practice [6], [14], [20]. Empirically, the study contributes qualitative evidence from a secondary education context in Southeast Asia, addressing a notable gap in predominantly higher-education-focused and Global North-oriented research [15], [23].

The study draws on the Technology Acceptance Model (TAM) as a sensitizing theoretical framework rather than as a predictive or causal model of technology adoption. Although TAM has been widely used to explain teachers' acceptance of educational technologies based on perceived usefulness and ease of use [21], [22], the model alone does not fully capture the ethical, professional, and institutional complexities associated with GenAI use in formal schooling [5], [6], [14]. These challenges extend beyond usability and efficiency to issues of academic integrity, professional responsibility, and institutional governance [7], [9]. In this study, TAM functions as an interpretive lens that helps contextualize teachers' early engagement with generative artificial intelligence, while qualitative analysis enables deeper exploration of how acceptance is shaped, negotiated, and constrained within specific instructional and institutional contexts. This approach moves beyond intention-based explanations and provides insight into how secondary STEM teachers exercise professional judgment when integrating GenAI in ethically sensitive and policy-ambiguous educational environments.

Overall, this study contributes to emerging scholarship on generative artificial intelligence in education by conceptualizing teachers' engagement with GenAI as a process of conditional acceptance rather than a binary outcome of adoption or resistance. By examining the lived instructional experiences of secondary STEM teachers, the research demonstrates how GenAI integration is negotiated through the interaction of professional judgment, ethical responsibility, and institutional conditions. In doing so, it extends technology acceptance perspectives and provides contextually grounded insights that may inform policy development, professional learning initiatives, and governance strategies for responsible AI integration in secondary education.

## 2. RESEARCH METHOD

### 2.1. Research Design

This study employed a qualitative exploratory research design to examine how secondary STEM teachers engage with generative artificial intelligence (GenAI) within instructional contexts. An experience-oriented qualitative approach was adopted to capture how teachers perceive, interpret, and regulate the use of GenAI in everyday classroom practice. Qualitative exploratory designs are particularly suitable for investigating emerging educational technologies where meanings, professional judgments, and instructional practices are still evolving and shaped by ethical considerations and institutional conditions [31]–[33].

The study was guided by an interpretivist research orientation, which views teachers' engagement with educational technologies as socially constructed through professional experience, institutional expectations, and classroom realities. From this perspective, understanding teachers' interaction with generative artificial intelligence requires attention to how they interpret its instructional value, ethical implications, and practical constraints within their professional responsibilities. This orientation allowed the study to examine teachers' engagement with GenAI as a context-dependent and evolving instructional practice, rather than as a purely measurable adoption outcome [34].

The Technology Acceptance Model (TAM) was used as a sensitizing theoretical framework to inform the focus of inquiry, particularly with respect to perceived usefulness and perceived ease of use, without functioning as a predictive or causal model of technology adoption [20], [21]. Rather than quantitatively testing TAM variables, the framework served as an interpretive lens that helped contextualize teachers' early engagement with generative artificial intelligence. Using TAM in this interpretive manner aligns with qualitative research that adapts established theoretical constructs to support sense-making and thematic interpretation in complex educational environments [13], [35].

### 2.2. Participants and Data Collection

The participants consisted of thirteen (13) secondary STEM teachers from a public secondary school. A purposive sampling strategy was employed to select participants who had prior exposure to, experience with, or awareness of generative artificial intelligence in instructional contexts. Purposive sampling is commonly used in qualitative exploratory research to identify information-rich participants capable of providing detailed insights into professional experiences and decision-making processes [36], [37]. The selected teachers represented different STEM subject areas and shared a common instructional environment, allowing the study to examine how educators collectively interpret and respond to the emergence of generative artificial intelligence in classroom practice.

Data were collected through a single focus group discussion (FGD) involving all participants and conducted for approximately one hour. The use of a single FGD was appropriate because participants belonged to the same professional community and had comparable levels of exposure to generative artificial intelligence within their teaching environment. Conducting the discussion collectively enabled participants to reflect on shared experiences, respond to one another's perspectives, and generate interactive insights regarding GenAI use in instructional contexts. Focus group discussions are widely used in educational research to capture shared meanings, collective reflection, and interactional dynamics surrounding emerging practices and technologies [38]–[40].

The discussion was conducted in a public secondary school located in a rural context, characterized by limited technological resources and the absence of formal institutional policies governing emerging educational technologies. This context provided an appropriate setting for examining teachers' engagement with generative artificial intelligence under conditions of policy ambiguity and resource variability. A semi-structured focus group discussion guide was used to elicit participants' experiences related to GenAI familiarity, instructional use, perceived productivity benefits, ethical concerns, and institutional conditions shaping classroom practice. Semi-structured discussion guides allow researchers to maintain consistency across participants while providing flexibility to explore emerging perspectives and unanticipated insights during interaction [38]–[40]. The discussion was audio-recorded with participants' informed consent and subsequently transcribed verbatim to ensure accuracy and completeness of the data for analysis.

### 2.3. Data Analysis

Data analysis followed the six-phase thematic analysis procedure proposed by Braun and Clarke, consisting of data familiarization, initial code generation, theme development, theme review, theme definition, and reporting [41]. Thematic analysis was selected because of its flexibility in identifying patterns of meaning across qualitative datasets while remaining sensitive to the contextual and experiential dimensions of participants' accounts [42]. Following transcription, the data were repeatedly read to achieve familiarity with the dataset. Initial coding was conducted by systematically identifying meaningful segments related to teachers' familiarity with

GenAI, instructional use, perceived productivity benefits, ethical concerns, and institutional constraints. Although the Technology Acceptance Model (TAM) informed the conceptual orientation of the study, coding was conducted inductively, allowing themes to emerge directly from participants' accounts.

Codes were iteratively refined through constant comparison across the dataset, allowing patterns of similarity and variation among participants' experiences to be identified. This iterative process supported the development of broader thematic categories that reflected shared meanings while preserving contextual nuances [37], [43]. To enhance analytic rigor, emerging codes and themes were reviewed through peer debriefing with co-researchers [44], [45]. Qualitative data management and coding were supported using NVivo qualitative analysis software [46]. Analytic memos were maintained throughout the process, and final themes were reviewed to ensure coherence, consistency, and analytic distinctiveness.

#### 2.4. Ethical Considerations

Ethical approval for the study was obtained from the appropriate institutional ethics review body prior to data collection. Participants were informed about the purpose of the study, the voluntary nature of participation, and their right to withdraw at any stage. Written informed consent was obtained in accordance with established ethical standards for educational research involving human participants [47]. To ensure confidentiality and anonymity, identifying information was removed and anonymized codes were used in reporting. Data were stored in secure, password-protected files accessible only to the research team and handled in accordance with established data protection and ethical research guidelines [48], [49].

### 3. RESULTS AND DISCUSSION

This section presents the findings and discussion derived from thematic analysis of focus group discussion data involving secondary STEM teachers' engagement with generative artificial intelligence in instructional contexts. The analysis identifies four interrelated themes: partial and informal familiarity, productivity-oriented engagement, ethical concerns and professional responsibility, and conditional acceptance.

#### 3.1. Perceiving Generative AI Through Partial and Informal Familiarity

The findings indicate that secondary STEM teachers' engagement with generative artificial intelligence is characterized by partial and informal familiarity rather than comprehensive or systematic understanding. Participants demonstrated general awareness of GenAI tools and reported occasional use for instructional preparation tasks such as generating lesson outlines, presentation materials, or assessment items. However, their familiarity was largely limited to surface-level functionalities and developed primarily through self-directed exploration, peer sharing, or incidental exposure, rather than through structured professional development initiatives [39], [7]. One participant explained:

*“Before attending the AI orientation and training workshop, I was familiar with AI, but not fully confident in using it for teaching.” (T2–STEM Science)*

This pattern reflects a form of early-stage engagement with generative artificial intelligence in which teachers recognize the presence and potential usefulness of the technology but have not yet developed systematic knowledge or pedagogical confidence in its application. Similar patterns of partial familiarity have been reported in studies examining educators' early encounters with artificial intelligence technologies [14], [18]. In the present study, however, this condition appears to be shaped not only by individual uncertainty but also by institutional and systemic constraints influencing how familiarity with GenAI develops.

Participants consistently described limited institutional guidance regarding the use of generative artificial intelligence in classroom instruction. Teachers reported the absence of clear school-level policies, formal training programs, or curricular frameworks addressing the integration of GenAI into instructional practice. As a result, teachers often relied on informal experimentation and peer exchange to explore the technology. This situation contributed to fragmented and uneven knowledge about GenAI, reinforcing uncertainty regarding appropriate pedagogical use, ethical boundaries, and professional responsibility. Comparable findings have been reported in research showing that policy ambiguity and limited institutional support can constrain teachers' confidence in adopting emerging educational technologies [13].

The findings also contrast with patterns commonly observed in higher education contexts, where faculty members often have greater instructional autonomy, institutional resources, and opportunities for professional development related to emerging technologies [11]. Secondary school teachers operate within more structured curricular frameworks and face heightened accountability for student learning outcomes. These conditions limit opportunities for experimentation and encourage cautious engagement with new technologies. As one teacher noted:

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*“I know AI can help, but I am careful because we don’t have clear rules yet, and I don’t want to misuse it in class.”* (T1–STEM Science)

From an analytical perspective, partial and informal familiarity represents an initial stage in teachers’ negotiated engagement with generative artificial intelligence rather than a stable endpoint of adoption. Participants’ accounts reveal early recognition of GenAI’s potential usefulness alongside uncertainty regarding its pedagogical legitimacy and institutional acceptance. This finding extends acceptance-oriented research by demonstrating that familiarity alone does not directly translate into technology adoption; instead, it becomes meaningful only when supported by organizational guidance, policy clarity, and professional accountability [14], [3].

Within the analytic framework of this study, partial familiarity therefore functions as the starting condition shaping subsequent patterns of engagement, including productivity-oriented use, ethical concern, and professional judgment. These dynamics ultimately influence how teachers evaluate the appropriate role of generative artificial intelligence in their instructional practice.

### 3.2. Perceiving Generative AI as a Practical Instructional and Productivity Resource

Participants consistently described generative artificial intelligence as a productivity-enhancing instructional resource, particularly for routine and time-intensive teaching tasks. Teachers reported using GenAI to assist with lesson planning, preparation of instructional materials, generation of assessment items, and development of presentation content. These applications were perceived as reducing cognitive and administrative workload, allowing teachers to allocate more time to classroom interaction and instructional delivery [46], [47]. One participant explained:

*“Since I’ve used AI tools, I’ve saved more time, especially in preparing lesson plans and presentations.”* (T4–STEM Mathematics)

These findings align with prior research identifying productivity and efficiency as key motivations driving educators’ interest in artificial intelligence-supported tools [1], [2]. However, in the present study, productivity was not interpreted as an unconditional benefit. Participants’ accounts suggest that efficiency gains were valued primarily as a pragmatic response to institutional pressures, including heavy teaching loads, limited preparation time, and increasing administrative responsibilities. Within this context, generative artificial intelligence was often perceived less as a transformative pedagogical innovation and more as a practical mechanism for managing workload demands. Similar patterns have been reported in studies suggesting that AI-supported tools are frequently adopted as compensatory strategies enabling teachers to cope with structural constraints within educational systems [13].

At the same time, participants expressed ambivalence regarding the long-term pedagogical implications of relying on GenAI for instructional preparation. While acknowledging its practical benefits, several teachers raised concerns that habitual dependence on automated content generation could gradually weaken instructional creativity, reflective lesson design, and professional skill development. As one teacher noted:

*“AI helps us work faster, but I worry that if we depend on it too much, we might stop thinking deeply about how to design our lessons.”* (T3–STEM Technology)

Such concerns are consistent with recent research cautioning that efficiency-driven uses of artificial intelligence may contribute to forms of pedagogical deskilling if they are not accompanied by reflective teaching practices and ongoing professional learning opportunities [14], [47].

Importantly, productivity-oriented uses of GenAI in this study were largely confined to behind-the-scenes instructional preparation rather than direct classroom implementation. This boundary-setting illustrates teachers’ efforts to balance efficiency with pedagogical responsibility, particularly in the absence of explicit institutional guidelines governing the appropriate use of generative artificial intelligence. In secondary education contexts—where accountability for student learning outcomes is high and instructional practices are closely monitored—teachers appeared reluctant to extend GenAI use into activities that directly influence student learning processes or assessment integrity [15].

From an analytical perspective, productivity and efficiency therefore emerge as a double-edged dimension of teachers’ engagement with generative artificial intelligence. On one hand, efficiency provides a practical rationale for initial engagement, reinforcing perceptions of usefulness emphasized in technology acceptance frameworks [20], [21]. On the other hand, concerns about overreliance and potential pedagogical erosion introduce caution and restraint, preventing productivity from translating into unrestricted adoption. Within the progression identified in this study, productivity functions as an intermediate stage of engagement,

simultaneously encouraging experimentation with GenAI while prompting reflective evaluation of its appropriate role in teaching practice.

### 3.3. Perceiving Generative AI as an Ethical Risk Requiring Careful Regulation

Ethical considerations emerged as a central dimension shaping teachers' engagement with generative artificial intelligence. Participants expressed concerns related to student overreliance on GenAI, the potential weakening of critical thinking and problem-solving skills, academic dishonesty, and the authenticity of student-generated work. These concerns were grounded not in abstract speculation but in teachers' direct experiences with classroom instruction, student assessment, and accountability for learning outcomes [39], [41]. One participant explained:

*“My concern is that students might rely too much on AI and their critical thinking and problem-solving skills may decrease.” (T1–STEM Science)*

Although ethical risks associated with artificial intelligence in education have been widely discussed in recent literature [5], [7], the findings suggest that teachers' ethical judgments are closely connected to their sense of professional responsibility, particularly within secondary education contexts. Unlike higher education instructors, secondary school teachers play a critical role in developing students' foundational skills, learning discipline, and responsible learning behaviors. This responsibility appears to heighten ethical sensitivity, prompting teachers to evaluate not only whether generative artificial intelligence can be used, but whether its use remains consistent with pedagogical goals and broader educational values [3].

Participants' ethical concerns also extended beyond classroom practice to include issues of institutional accountability and governance. Teachers frequently described uncertainty resulting from the absence of clear school-level policies, formal guidelines, or shared standards regulating the use of generative artificial intelligence in teaching and learning. In this context of policy ambiguity, ethical decision-making was largely delegated to individual teachers, increasing the burden of professional judgment and the perceived risks associated with technology use. As one teacher stated:

*“We are expected to decide on our own, but there are no clear guidelines yet on how AI should be used in class.” (T5–STEM Mathematics)*

Similar concerns have been documented in studies indicating that institutional silence regarding artificial intelligence governance can intensify uncertainty and ethical anxiety among educators [18].

These findings highlight an important distinction between individual ethical awareness and institutional ethical responsibility in the adoption of emerging educational technologies. While teachers demonstrated strong ethical reflexivity in their classroom decision-making, their ability to act with confidence was constrained by the absence of coherent governance structures. Ethical concern therefore functioned not merely as personal hesitation but as a response to systemic ambiguity regarding responsibility, accountability, and acceptable practice. This interpretation aligns with broader calls for educational institutions to take proactive roles in establishing ethical frameworks, policy guidance, and governance mechanisms for artificial intelligence in education [9], [18]. These findings suggest that ethical concern functions not simply as resistance to technology but as a professional safeguard guiding responsible instructional decision-making.

From an analytical perspective, ethical concern operates as a regulatory mechanism within teachers' engagement with generative artificial intelligence. It moderates productivity-driven engagement and reframes technology acceptance as a matter of professional responsibility rather than technical feasibility alone. Within the progression identified in this study, ethical considerations represent a critical turning point that prompts teachers to reassess the boundaries of GenAI use and to seek conditions under which its integration can be ethically justified and institutionally supported.

### 3.4 Conditional Acceptance of Generative AI Anchored in Professional Judgment and Institutional Context

The findings indicate that secondary STEM teachers' engagement with generative artificial intelligence is best characterized as conditional acceptance rather than straightforward acceptance or resistance. Participants neither fully embraced nor categorically rejected GenAI. Instead, they described a carefully regulated mode of engagement shaped by professional judgment, ethical responsibility, and institutional context. As one participant explained:

*“AI should only assist teachers; it should not replace us because the teacher still guides the learning process.” (T5–STEM Technology)*

*AI should only assist teachers; it should not replace us because the teacher still guides the learning process*

This perspective reflects a cautious and bounded approach to technology use in which teachers maintain primary responsibility for instructional decision-making. Similar patterns of moderated engagement have been documented in studies examining teachers' responses to emerging artificial intelligence technologies in formal schooling environments [13], [11].

Conditional acceptance emerged as a contextually negotiated professional stance in which teachers actively defined boundaries regarding how, when, and for what purposes generative artificial intelligence could be used. Participants expressed willingness to employ GenAI for preparatory and supportive tasks, such as lesson planning and instructional material development, while deliberately restricting its use in activities that directly influence student learning processes, assessment practices, or skill development. This selective engagement illustrates teachers' efforts to balance technological efficiency with pedagogical responsibility. Similar patterns have been reported in research indicating that teachers' adoption of AI technologies is mediated by professional norms, pedagogical values, and accountability structures, rather than technological capability alone [11], [3].

Importantly, conditional acceptance was not determined solely by individual attitudes toward technology. Instead, it emerged through the interaction of multiple factors identified across the preceding themes. Partial and informal familiarity limited teachers' confidence to engage extensively with GenAI, while productivity considerations encouraged cautious experimentation. At the same time, ethical concerns particularly those related to student learning, academic integrity, and overreliance on automated outputs served as moderating influences that prompted teachers to critically evaluate the appropriateness of GenAI use in instructional contexts [5], [41]. In the absence of clear institutional policies or governance frameworks, teachers assumed responsibility for regulating the use of generative artificial intelligence within their classrooms, reinforcing a conditional rather than unrestricted mode of acceptance. Comparable dynamics have been observed in studies showing that governance gaps often shift regulatory responsibility to individual educators [13].

This finding contributes to the technology acceptance literature by challenging the commonly assumed acceptance–resistance dichotomy associated with models such as the Technology Acceptance Model (TAM). While TAM explains technology adoption primarily through perceived usefulness and perceived ease of use [19], [20], it does not fully capture the ways in which educators actively negotiate acceptance under conditions of ethical uncertainty, professional accountability, and policy ambiguity. The concept of conditional acceptance advanced in this study reframes teacher technology engagement as a dynamic and reflective process, shaped by continuous evaluation of pedagogical responsibility, institutional expectations, and governance conditions. This interpretation aligns with recent critiques of intention-based adoption models in artificial intelligence in education research [13].

Within the broader analytic pattern identified in this study, conditional acceptance represents the culmination of a progressive trajectory beginning with partial familiarity, followed by productivity-oriented engagement, and subsequently moderated by ethical reflection and institutional considerations. This progression suggests that teachers' acceptance of generative artificial intelligence is not a fixed endpoint but rather a situated professional judgment that remains open to revision as professional development opportunities expand, institutional policies evolve, and governance frameworks for artificial intelligence in education become more clearly articulated [4], [15].

### 3.5. Synthesis

Taken together, the four themes identified in this study reveal a progressive and interconnected pattern in secondary STEM teachers' engagement with generative artificial intelligence. Teachers' experiences begin with partial and informal familiarity, shaped primarily by self-directed exploration rather than structured institutional preparation. While such exposure introduces teachers to the potential capabilities of GenAI, it simultaneously limits deeper pedagogical experimentation and confident instructional integration due to the absence of systematic training, institutional policies, or formal guidance, a pattern also observed in studies on early-stage AI adoption in education [53].

As familiarity develops, teachers begin to engage with generative artificial intelligence primarily as a practical instructional and productivity resource, using it to support lesson preparation, the generation of instructional materials, and the management of professional workload. Under conditions of heavy teaching responsibilities and expanding administrative demands, these productivity-oriented uses provide tangible efficiency benefits that make GenAI an appealing supplementary tool. However, productivity-driven engagement does not translate into uncritical adoption. Instead, increasing interaction with GenAI prompts ethical reflection and professional evaluation, particularly as teachers confront concerns related to student overreliance, academic integrity, and the potential erosion of critical thinking, consistent with emerging research on AI-related pedagogical risks [53].

To clarify the analytic structure of these findings, Table 1 summarizes the four major themes, the corresponding participant perspectives, and representative verbatim evidence illustrating each stage of teachers' engagement with generative artificial intelligence.

Table 1. Summary of Themes on Teachers' Engagement with Generative Artificial Intelligence

Theme	Participants (n = 13)	Core Meaning / Analytic Focus	Representative Verbatim Evidence
Partial and Informal Familiarity with GenAI	Majority of participants	Teachers possess surface-level awareness of GenAI developed through self-directed exploration rather than structured training; uncertainty persists due to lack of institutional guidance.	"Before attending the AI orientation and training workshop, I was familiar with AI, but not fully confident in using it for teaching." (T2 – STEM Science)
GenAI as a Practical Instructional and Productivity Resource	Most participants	GenAI is used primarily to support lesson preparation, material generation, and workload management rather than direct classroom instruction.	"Since I've used AI tools, I've saved more time, especially in preparing lesson plans and presentations." (T4 – STEM Mathematics)
Ethical Concerns and Professional Responsibility	Nearly all participants	Teachers express strong concern about student overreliance, academic integrity, and erosion of critical thinking, intensified by accountability pressures in secondary education.	"My concern is that students might rely too much on AI and their critical thinking and problem-solving skills may decrease." (T1 – STEM Science)
Conditional Acceptance Anchored in Professional Judgment and Context	All participants	Teachers selectively adopt GenAI under clearly defined boundaries, balancing productivity benefits with ethical responsibility in the absence of institutional policy.	"AI should only assist teachers; it should not replace us because the teacher still guides the learning process." (T5 – STEM Technology)

Within this progression, ethical concerns function as a critical turning point in teachers' engagement with generative artificial intelligence. As teachers recognize both the benefits and potential risks of GenAI use, ethical considerations prompt them to reassess the boundaries of acceptable instructional practice. Concerns regarding student dependency, academic integrity, and the authenticity of learning outputs become particularly salient in contexts where institutional policies, ethical guidelines, and governance frameworks for GenAI use remain underdeveloped, reinforcing findings from recent work on AI governance gaps in education [55].

The interaction of partial familiarity, perceived productivity benefits, ethical concern, and institutional ambiguity ultimately culminates in conditional acceptance, a form of engagement characterized by selective, cautious, and professionally mediated use rather than unrestricted integration. This process-oriented relationship among themes is illustrated in Figure 1, which conceptualizes teachers' engagement with generative artificial intelligence as a negotiated progression rather than a linear or binary decision.

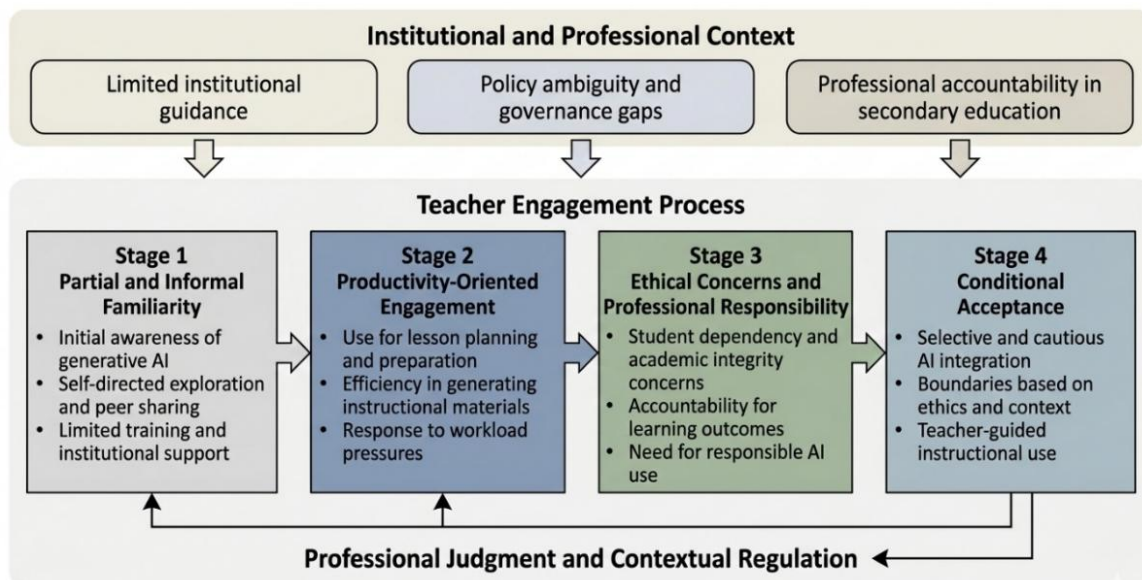


Figure 1. Process Model of Secondary STEM Teachers' Conditional Acceptance of Generative Artificial Intelligence

Figure 1 presents a process model of secondary STEM teachers' conditional acceptance of generative artificial intelligence, highlighting how institutional and professional contexts shape teachers' evolving engagement with the technology. The model illustrates how teachers move from initial awareness toward

productivity-oriented engagement, followed by ethical reflection and professional evaluation that ultimately shape conditional acceptance. Rather than representing a fixed endpoint, conditional acceptance reflects an ongoing evaluative process through which teachers continuously assess the pedagogical appropriateness, ethical implications, and institutional legitimacy of GenAI use, aligning with process-oriented perspectives on teacher decision-making in technology integration [56].

Overall, this synthesis demonstrates that secondary STEM teachers' acceptance of generative artificial intelligence is neither linear nor dichotomous, but rather represents a dynamic and revisable form of professional judgment shaped by experiential learning, ethical responsibility, and institutional context. By foregrounding this progression, the study extends acceptance-oriented frameworks beyond intention-based explanations and highlights how professional judgment and governance conditions play decisive roles in shaping how GenAI is integrated into secondary education practice [8], [9], [10], [31].

This study offers a novel contribution by conceptualizing teachers' engagement with generative artificial intelligence as a process of conditional acceptance, rather than a binary adoption rejection outcome. Unlike prior studies that primarily explain technology acceptance through intention-based models, this study demonstrates that teachers' decisions are dynamically shaped by the interplay of experiential familiarity, perceived productivity benefits, ethical considerations, and institutional uncertainty. By integrating a process-oriented perspective with qualitative evidence from a Southeast Asian secondary STEM context, this study extends existing technology acceptance frameworks and highlights the central role of professional judgment and governance conditions in shaping AI integration in educational practice.

This study has several important practical implications. First, educational institutions should establish clear governance frameworks and institutional policies to regulate the responsible use of generative artificial intelligence in teaching and learning. The absence of structured guidance identified in this study suggests an urgent need for formalized ethical standards and usage boundaries. Second, teacher education programs and professional development providers should design targeted training initiatives that not only enhance teachers' technical competence in using GenAI, but also strengthen their pedagogical judgment and ethical awareness. Third, policy makers should consider developing context-sensitive regulatory frameworks that balance innovation with academic integrity, ensuring that AI integration supports rather than undermines meaningful learning processes. This study is limited by its focus on a single institutional context and reliance on focus group data, which may reflect shared perspectives.

#### **4. CONCLUSION**

This study examined how secondary STEM teachers perceive and engage with generative artificial intelligence in classroom contexts, focusing on pedagogical use, ethical considerations, and institutional conditions. The findings reveal a progressive pattern of engagement characterized by partial familiarity, productivity-oriented use, ethical reflection, and ultimately conditional acceptance, wherein teachers selectively integrate GenAI while maintaining professional responsibility for instructional decisions. Rather than uncritical adoption or outright resistance, teachers regulate GenAI use by balancing perceived instructional usefulness with concerns related to student dependency, academic integrity, and the authenticity of learning outcomes. Theoretically, the study extends the Technology Acceptance Model (TAM) by showing that technology acceptance in educational settings is not solely driven by perceived usefulness and ease of use, but is also shaped by ethical considerations, professional accountability, and institutional context. The concept of conditional acceptance contributes to AI-in-education literature by framing adoption as a dynamic and contextually negotiated process, particularly in formal schooling environments. Future research should examine multiple contexts and employ longitudinal designs to explore how teachers' conditional acceptance evolves, as well as investigate the effects of GenAI on student learning outcomes and perspectives.

#### **ACKNOWLEDGEMENTS**

The authors express their sincere appreciation to the school administrators and STEM teachers who generously shared their time and experiences during the conduct of this study. The authors also acknowledge the support provided by the institution in facilitating data collection and professional development activities related to this research.

#### **AUTHOR CONTRIBUTIONS**

This research followed the Contributor Roles Taxonomy (CRediT) to accurately represent the contributions of each author. Conceptualization, methodology, software, formal analysis, data curation, visualization, and writing – original draft preparation were undertaken by Mary Cris J. Go. Validation and investigation were conducted by Mary Cris J. Go and Helen B. Ajon. Resources were provided by Mary Cris J. Go, Helen B. Ajon, Rowena E. Bagongon, Alven L. Gomez, and Anna Marie D. Genita. Writing – review and

editing were carried out by Mary Cris J. Go, Mary Koren Witting-Acuesa, and Jovelyn G. Delosa. Supervision was performed by Mary Cris J. Go and Helen B. Ajon. Project administration was managed by Mary Cris J. Go, Helen B. Ajon, Mary Koren Witting-Acuesa, and Jovelyn G. Delosa. Funding acquisition was secured by Mary Cris J. Go.

### INFORMED CONSENT STATEMENT

Informed consent was obtained from all participants involved in the study prior to data collection. Participants were provided with a clear explanation of the study's objectives, procedures, and voluntary nature, including their right to withdraw from participation at any stage without penalty. Consent was also obtained for audio recording during the focus group discussion and for the use of anonymized data for research and publication purposes.

### CONFLICTS OF INTEREST

The authors declare no conflict of interest. The funding institution had no role in the design of the study; in the collection, analysis, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

### USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that artificial intelligence (AI)-assisted tools were used solely for language refinement, formatting support, and organizational editing during manuscript preparation. No AI tools were used in data collection, data analysis, interpretation of results, or decision-making processes. All analyses, interpretations, and conclusions presented in this manuscript were conducted by the authors, who retain full responsibility for the content, accuracy, and integrity of the work.

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