

HUMAN-CENTERED AI INTEGRATION IN VOCATIONAL EDUCATION IN THAILAND: CLASSROOM REALITIES AND EDUCATION ADAPTATION

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ABSTRACT

This research aimed to explore the implementation of generative AI within Thai vocational education classrooms, assess its impact on students' learning outcomes and behavioral engagement, and identify critical success factors and practical challenges for effective AI integration. Employing an explanatory sequential mixed-methods design grounded in human-centered AI integration theory, the study involved 200 vocational students selected via cluster random sampling and 5 teachers selected using a purposive sampling technique. Data were collected using questionnaires, observation forms, student reflections, and semi-structured interviews, then analyzed through descriptive statistics and content analysis. The findings revealed that generative AI was primarily integrated into three main instructional activities: brainstorming, project preparation, and presentation design, functioning strictly as a learning facilitator rather than a replacement for cognitive processing. Regarding the impacts on learners, quantitative results demonstrated the highest level of overall student engagement and perceived learning outcomes (Overall Mean = 4.66, S.D. = 0.47). However, qualitative data indicated that participant experiences remained inconsistent due to disparities in digital readiness, necessitating a pedagogical shift prioritizing teacher guidance. Furthermore, the investigation identified significant contextual factors and practical challenges acting as high-level constraints (Overall Mean = 4.48, S.D. = 0.68), including unequal digital access, internet instability, and students' overreliance on automated content. Ultimately, the study highlights that meaningful educational transformation involving AI is not driven by technology alone, but requires a complex negotiation of human relationships, active teacher facilitation, learner diversity, and institutional realities.

Keywords: Human-Centered AI, Thai Vocational Education, AI-Supported Learning, Digital Readiness, Teacher Facilitation

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INTRODUCTION

The rapid growth of digital technologies has continued to influence educational systems globally. More recently, the expansion of generative artificial intelligence (AI) has intensified conversations about the changing role of educational institutions. As Holmes et al. (2019) note, while AI offers promising opportunities for learning support, it also raises critical implications regarding student dependency and the necessity to redefine, rather than replace, the role of educators. Schools and colleges are increasingly experimenting with AI-supported tools for lesson preparation and learning support. As highlighted by Luckin et al. (2016), the ultimate goal of these tools should be to 'unleash' educational potential by assisting educators, not replacing the essential human interactions they provide. Yet concerns regarding student dependency and the long-term role of teachers remain visible (Kasneci et al., 2023). This gap in understanding classroom realities is further highlighted by Zawacki-Richter et al. (2019), whose systematic review notes that while educational AI tools are rapidly expanding, research often overlooks the critical pedagogical implications and the evolving responsibilities of human educators.

In many countries, we are seeing a clear shift in education: it is no longer just about adopting new technology, but about how our systems respond to digital inequality and changing workforce expectations. This transition presents significant challenges in technical and vocational education (TVET), where students need to build hands-on occupational competencies alongside digital literacy and adaptability. As the World Economic Forum (2023) points out, core analytical skills and digital proficiency are now the actual currency of the modern workforce, meaning vocational training must move far beyond teaching basic automation. While this digital shift opens up exciting new trends for skill development, it also brings heavy systemic challenges that schools have to navigate (UNESCO, 2021; UNESCO-UNEVOC, 2021). That is why putting these tools into actual classrooms is always much more complicated than the theory suggests; gaps in digital literacy and a lack of institutional support heavily dictate how AI is used in practice (OECD, 2021). This reality strongly supports Selwyn (2016) warning against being over-optimistic about digital education, reminding us that technology in schools is always shaped and limited by the messy, everyday realities of institutional life.

Thailand provides a compelling context for examining these dynamics. While vocational institutions are under increasing pressure to modernize in response to national educational reform and digital transformation policies (Ministry of Education, 2024), practical adaptation remains highly fragmented. A pervasive digital divide persists across Thai vocational colleges, characterized by profound inequalities in access to adequate computing devices and reliable internet connectivity, particularly between well-resourced urban centers and provincial institutions. Furthermore, the integration of advanced tools like generative AI is severely constrained by systemic teacher burnout. Thai vocational educators are frequently

overwhelmed by excessive administrative duties and high teaching loads, leaving them with limited temporal and cognitive capacity to master or meaningfully integrate novel pedagogical technologies. This friction highlights a deeper mismatch between institutional ambitions and actual teacher readiness. As Nguyen et al. (2022) point out, variations in technological familiarity heavily shape how Thai students adapt to these digital environments. In the TVET sector, this translates to a complex landscape of learner readiness: while students may exhibit high fluency in basic mobile technology and social media, their critical digital literacy regarding academic or occupational AI applications remains substantially underdeveloped. Furthermore, educators on the ground react differently to AI; some embrace it as an instructional aid, while others express valid concerns over plagiarism and student dependency. This divide underscores the need for a human-centered AI perspective—one that views technology as a tool to enrich, rather than replace, human educational relationships, while ensuring equity and contextual relevance as recommended by Miao and Holmes (2023). Moving past purely technological optimism, this article explores the nuanced realities of generative AI within Thai vocational classrooms. By examining the tension between digital opportunities and practical constraints—such as unequal access and diverse learner readiness—we argue that meaningful educational transformation is fundamentally a human process. While AI can catalyze engagement and efficiency, its true educational value depends on deliberate teacher guidance and continuous adaptation to local conditions. Ultimately, the Thai experience serves as a critical case study for developing societies, proving that sustainable technological change must always prioritize human relationships and pedagogical reflection over automation alone.

Despite the growing adoption of generative AI in education, existing studies have primarily focused on learning achievement, technology acceptance, or general applications of AI in higher education. Relatively few studies have examined how generative AI is implemented within Thai vocational education from a human-centered perspective that considers the interaction among learners, teachers, and contextual classroom conditions. Furthermore, limited empirical evidence is available regarding the practical challenges, digital readiness, and teacher facilitation required for successful AI-supported learning in vocational classrooms. This study addresses these gaps by investigating the implementation of generative AI in Thai vocational education using a convergent mixed-methods approach that integrates quantitative and qualitative evidence.

RESEARCH OBJECTIVES

This study aims to:

1. Explore how generative AI was implemented within Thai vocational education classrooms.
2. Assess the impact of technology-supported learning activities on students' learning

outcomes and behavioral engagement

3. Identify the critical success factors and enabling conditions required for effective AI integration within vocational education settings.

LITERATURE

Human-Centered AI Approach

The integration of AI in educational settings must prioritize human interaction over technological automation. Ultimately, the educational value of AI hinges entirely on a teacher's deliberate emotional investment and ability to keep human relationships at the center of the lesson. A human-centered approach ensures that technology serves merely as a supportive tool rather than a replacement for genuine human connection, empathy, and collaborative learning within the classroom.

Generative AI in Education

Generative AI offers significant opportunities to support student learning when applied with clear pedagogical intent. AI scaffolding effectively reduces initial task anxiety during brainstorming and project preparation by providing immediate cognitive support (Sweller, 1988). By assisting learners in organizing preliminary ideas and structuring their work, generative AI tools can help overcome initial learning barriers and stimulate creative workflows.

TVET and Digital Readiness

The introduction of advanced technologies fundamentally redefines the learner's role, particularly within Technical and Vocational Education and Training (TVET). Navigating AI-supported environments requires a high baseline of digital readiness, technical literacy, and adaptive confidence. TVET students must develop these critical competencies to effectively transition from passive consumers of technology to adaptable, digitally literate professionals equipped for the modern workforce.

Teacher Facilitation

The success of AI integration relies heavily on the educator's active and evolving role. A teacher's pedagogical agility and real-time instructional decisions are crucial for guiding students through complex digital landscapes. Meaningful learner adaptation requires students to engage in critical, ethical, and reflective dialogue with AI tools, a process that can only be sustained under the continuous and intentional guidance of a teacher (Miao & Holmes, 2023).

Digital Divide

Addressing infrastructural and technological inequalities is a fundamental prerequisite for equitable AI integration. Meaningful learner adaptation depends not on mere technology access, but on the comprehensive capacity to utilize these tools effectively (OECD, 2021). Closing the digital divide in developing contexts means going beyond providing hardware and

internet connectivity; it necessitates ensuring that all students have equal opportunities to develop the digital skills required to benefit from AI innovations.

Academic Integrity

While AI provides valuable cognitive support, it also introduces severe academic and cognitive risks if left unmonitored. Without sufficient digital literacy, students easily succumb to cognitive passivity and over-reliance on automated outputs, which obscures actual comprehension and threatens academic integrity (Kasneci et al., 2023). Consequently, educational institutions must foster a culture of critical evaluation, ensuring that students use AI to enhance their reasoning rather than bypass the learning process.

Context of Thai Vocational Education

Driven by the "Thailand 4.0" policy, Thailand's TVET sector aims to develop a digital-ready workforce (Office of the Vocational Education Commission, 2022). However, integrating generative AI faces challenges due to a pervasive digital divide, marked by unequal access to devices and internet connectivity across urban and provincial colleges (Ministry of Education, 2024). Furthermore, despite frequent social media use, students' critical digital literacy for academic and occupational tasks remains uneven (Nguyen et al., 2022). Consequently, effective AI adoption demands pedagogical strategies that address infrastructural gaps and actively scaffold students' digital competencies to ensure equitable learning.

CONCEPTUAL FRAMEWORK

Based on a comprehensive review of existing literature, this study develops a human-centered conceptual framework for integrating generative AI into Thai vocational classrooms. The reviewed literature suggests that the success of AI in education does not rely on technology alone; rather, it hinges on a dynamic interplay between learner readiness, teacher adaptation, and institutional conditions within real-world classrooms. Prior research highlights digital literacy, technological familiarity, and adaptability as core learner-related factors. Meanwhile, the literature underscores that teachers must evolve into instructional facilitators who provide reflective practice and responsible AI guidance. Furthermore, critical studies remind us that these human elements are always bounded by contextual realities, such as infrastructure limits and local classroom constraints. By synthesizing these interconnected streams of literature, our framework maps out how these variables collectively shape educational outcomes, including engagement, flexibility, and overall learning effectiveness. Ultimately, the literature positions generative AI integration not as a quick technical fix, but as a gradual, context-sensitive journey driven by human interaction within developing-country environments.

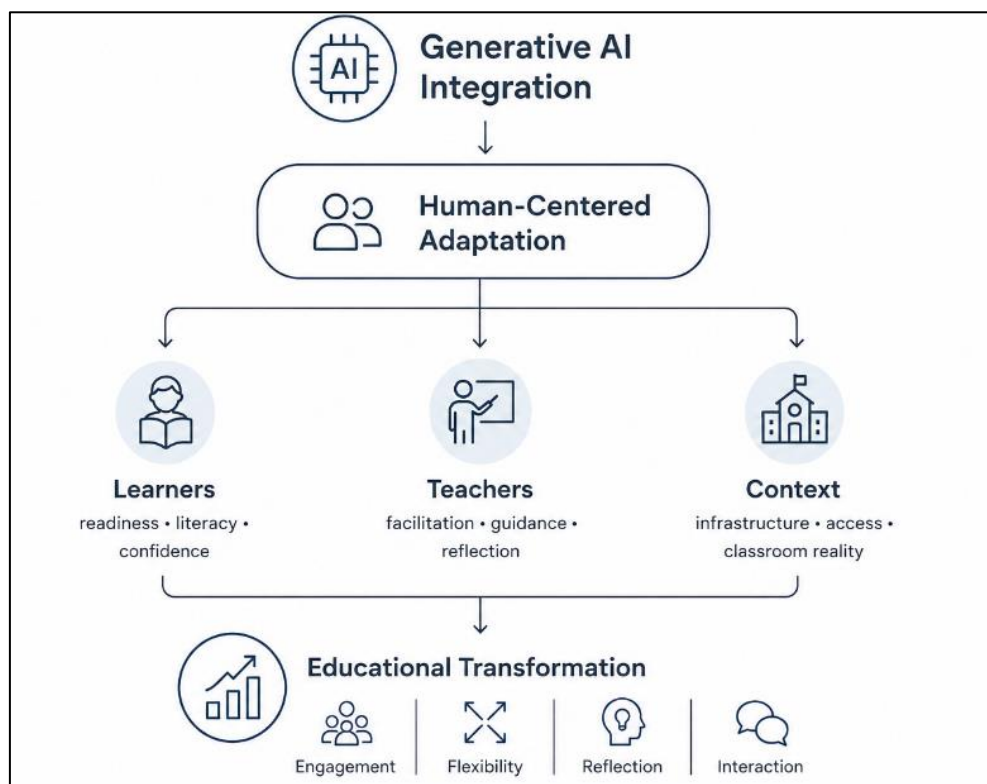


Figure 1 Human-Centered AI Integration Framework for Vocational Education in Thailand Developed by the authors based on Bruner (1966) and Vygotsky (1978).

The conceptual framework served as the foundation for the overall research design. It guided the development of the research objectives, the selection of research instruments, the organization of quantitative and qualitative data collection, and the interpretation of the findings. Specifically, the framework explains how instructional implementation, learner and teacher experiences, and contextual factors collectively contribute to understanding the implementation of generative AI in Thai vocational education.

RESEARCH METHODOLOGY

The explanatory sequential mixed-methods design was selected because it enabled the quantitative findings to be explained and elaborated through qualitative evidence obtained during the second phase of the study. The initial quantitative data identified overall patterns and trends, whereas the subsequent qualitative data provided deeper explanations of learners' experiences, teacher facilitation, and contextual factors influencing the implementation of generative AI in Thai vocational classrooms. The integration of both phases allowed for a more comprehensive understanding of the research problem than either approach alone.

Research Area: The study was conducted at Suphanburi College of Agriculture and Technology during regular classroom instruction in the first semester of the 2025 academic year.

Population and Sample: **Population:** The population of this study comprised two groups from Suphanburi College of Agriculture and Technology: 1) vocational education students enrolled in courses related to communication, digital learning, and vocational skill development, and 2) teachers who instruct these courses or actively integrate digital technologies into their classrooms.

Sample: This study utilized two distinct participant groups from Suphanburi College of Agriculture and Technology. The first group consisted of 200 first- to third-year vocational students from the Agricultural Product Processing, Fisheries, Crop Production, and Animal Production programs, who were selected via cluster random sampling. The second group included 5 teachers selected using a purposive sampling technique for the qualitative phase. This dual-group approach ensured a holistic understanding of the AI integration process.

Research Instruments Development and Content Validation:

The research instruments were developed based on the Human-Centered AI Integration framework. All tools underwent content validation by a three-expert panel to ensure conceptual alignment and language suitability for vocational students.

1. **Student Perception Questionnaire:** Designed to measure learner engagement, confidence, digital readiness, and perceived AI usefulness using a 5-point Likert scale and open-ended items. Items achieving an IOC ≥ 0.70 were retained. A pilot test with 30 non-sample students yielded a Cronbach's alpha of 0.84, indicating high internal consistency.

2. **Classroom Observation Form:** A structured tool used to assess pedagogical and contextual variables, including classroom engagement, student-teacher interaction, and technological challenges. A trial session with two synchronous observers achieved a Cohen's Kappa score of 0.85, confirming strong inter-rater reliability.

3. **Student Reflection Form and Interview Protocol:** Semi-structured, open-ended tools aimed at eliciting qualitative insights into student learning pathways, information evaluation, and AI over-reliance. The protocol was pilot-tested with 3 to 5 non-sample students to ensure clarity and descriptive responses. Qualitative trustworthiness was systematically maintained through peer debriefing and data triangulation.

Each research instrument was developed to address specific research objectives and to provide complementary evidence within the explanatory sequential mixed-methods design. The questionnaire generated quantitative data regarding students' perceptions of generative AI-supported learning, while the classroom observation form, student reflection form, and semi-structured interview protocol provided qualitative evidence explaining classroom implementation, learner and teacher experiences, and contextual factors

influencing AI integration. The combined use of these instruments enabled data triangulation and strengthened the credibility of the research findings.

Prior to formal data collection, all research instruments were pilot-tested with non-sample participants to ensure reliability and practical feasibility. The student questionnaire ($n = 30$) demonstrated high internal consistency (Cronbach's $\alpha = 0.84$) and allowed for language refinement. The observation form achieved strong inter-rater reliability (Cohen's $Kappa = 0.85$) through a dual-observer trial session. Finally, the interview protocol was piloted with five non-sample students to simplify academic jargon, refine probing techniques, and ensure the elicitation of descriptive responses.

Data Collection: Data collection was conducted during the first semester of the 2025 academic year over an eight-week classroom implementation period.

Data Analysis: Quantitative: Data from the 5-point Likert scale questionnaires were analyzed using means and standard deviations. Following Best (1981), a 0.80 class interval was applied to interpret the mean scores, categorizing the results into five levels: Highest (4.50–5.00), High (3.50–4.49), Moderate (2.50–3.49), Low (1.50–2.49), and Lowest (1.00–1.49). (Best, 1981)

Qualitative: Data from interviews, student reflections, classroom observations, and teacher notes were evaluated via systematic content analysis. This process progressed from open coding to categorization and overarching themes, with data triangulation applied to ensure trustworthiness and validity (Creswell & Poth, 2018; Flick, 2018).

RESULTS

The results are presented according to the three research objectives. Quantitative findings are reported using descriptive statistics, whereas qualitative evidence from classroom observations, student reflections, and semi-structured interviews is presented to explain and support the quantitative results.

Results for Objective 1; The findings are presented in two sections. Table 1 summarizes the demographic characteristics of the respondents, whereas Table 2 presents the instructional implementation of generative AI supported by classroom observations and interview evidence.

1. **Demographic Information of the Respondents** the sample for this study comprised 200 first- to third-year vocational certificate students from Suphanburi College of Agriculture and Technology. The demographic characteristics of the respondents are presented in Table

Table 1 Demographic characteristics of the respondents (n = 200)

Demographic Variables	Frequency (n)	Percentage (%)
1. Year of Study		
1.1 First-Year Vocational Certificate	66	33.00
1.2 Second-Year Vocational Certificate	75	37.50
1.3 Third-Year Vocational Certificate	59	29.50
Total	200	100
2. Major of Study		
2.1 Agricultural Product Processing	25	12.50
2.2 Fisheries	20	10.00
2.3 Crop Production	78	39.00
2.4 Animal Production	77	38.50
Total	200	100

2. The qualitative findings from classroom observations and semi-structured interviews provide additional evidence regarding the instructional implementation of generative AI. As presented in Table 2, three major classroom activities were consistently identified: brainstorming, project preparation, and presentation design.

Table 2 Instructional Implementation and Activities of Generative AI Integration in Thai Vocational Classrooms

Core Activities	Practical Classroom Applications & Student Evidence	Observed Pedagogical Scaffolding & Teacher Evidence
1. Brainstorming	Students used generative AI to explore diverse project topics and overcome initial task anxiety "At first, I didn't know where to start. Asking the AI for ideas related to agriculture gave my group a clear direction."	Teachers monitored prompt construction to ensure students developed initial concepts before using AI
2. Project Preparation	Learners employed AI to outline project frameworks, organize technical data, and structure reports. "The AI helped us break down a massive project into weekly tasks, making it much easier to divide the workload."	Instructors provided ongoing facilitation to verify the accuracy of information and prevent automated over-reliance.

Core Activities	Practical Classroom Applications & Student Evidence	Observed Pedagogical Scaffolding & Teacher Evidence
3. Presentation Design	Students utilized tools to translate concepts into slide structures and refine vocational terminology. " It spit out some big words, making us look like we actually know what we're talking about."	Classroom dynamics emphasized interactive defense of content rather than passive copying.

Results for Objective 2; The findings are presented in Tables 3, 4, and 5. Quantitative data on students' perceptions (Table 4) are complemented by qualitative observations (Table 3) and emerging themes (Table 5). Together, they provide a comprehensive view of learner experiences, teacher facilitation, and contextual factors influencing classroom implementation.

Table 3 Learner and Teacher Experiences in AI-Supported Learning Activities Based on Classroom Observations and Student Reflections

Learning Experience	Reflective Classroom Observation
Classroom Engagement	Many students became more willing to participate during brainstorming and discussion activities, particularly when AI tools helped reduce hesitation at the beginning of tasks.
Learning Confidence	Some learners reported feeling more comfortable starting assignments when digital support was available during classroom activities.
Idea Development	AI tools were often used to organize ideas, prepare presentations, and support project-related tasks during lessons.
Information Evaluation	Several students experienced uncertainty when evaluating the reliability or accuracy of generated information.
Prompt Construction	Some learners required repeated teacher guidance when attempting to create effective prompts or refine AI-generated responses.
Independent Learning	A small number of students relied heavily on generated content and occasionally demonstrated limited reflective engagement during activities.
Teacher Facilitation	Classroom interaction continued to depend strongly on teacher explanation, monitoring, and reflective discussion throughout implementation.
Technological Challenges	Internet instability and differences in digital readiness occasionally interrupted classroom continuity and participation patterns.

Table 4 Means and Standard Deviations of Students' Perceptions of Generative AI-Supported Learning

Items	$\bar{x}$	<i>S.D.</i>	Level of Constraint
1.Behavioral Engagement			
1.1 AI-supported learning enhanced my enthusiasm and active participation in classroom activities	4.87	0.34	Highest
1.2 Using AI as a learning tool stimulated me to ask more questions and engage in knowledge-sharing discussions with peers and teachers	4.74	0.44	Highest
2.Learning Outcomes			
2.1 Having AI technology as a support tool reduced my anxiety when starting tasks and increased my overall learning confidence	4.82	0.39	Highest
2.2 Using Generative AI supported the improvement of the quality and attractiveness of my work and presentation designs	4.43	0.50	High
2.3 AI tools helped me gather ideas, organize my thoughts, and plan my projects more effectively	4.45	0.50	High
Total Average	4.66	0.47	Highest

Table 5 Emerging Themes from Classroom Implementation and Student Reflections

Theme	Reflective Interpretation
Enhanced Engagement	AI-supported interaction significantly enhanced active participation by lowering learning anxiety and increasing instructional flexibility.
Digital Readiness	Learners exhibited significant variance in technological self-efficacy, digital literacy, and adaptive readiness throughout the implementation phase.
Continuing Teacher Role	Teacher mediation proved essential for scaffolding information interpretation, maintaining student focus, and driving critical engagement with AI-generated content.
Responsible Technology Use	Classroom interactions increasingly drove critical information verification, reflective learning, and ethical engagement with AI-generated outputs.
Practical Classroom Constraints	Infrastructural constraints—specifically unstable internet, limited device availability, and variable classroom conditions—directly moderated the implementation outcomes.

Theme	Reflective Interpretation
Learner Reflection	AI integration presented a clear trade-off: it effectively reduced assignment anxiety for some students, while inducing critical concerns regarding information reliability and cognitive overdependence among others.

The qualitative findings presented in Table 5 further illustrate the major themes emerging from classroom observations, student reflections, and semi-structured interviews. Together, these findings suggest that learners generally perceived generative AI as a supportive learning tool while emphasizing the continuing importance of teacher guidance, responsible AI use, and appropriate technological support during classroom implementation

Results for Objective 3; the research reveals that the practical challenges and contextual factors influencing AI integration revolve around three main themes: (1) technological infrastructure constraints, such as internet instability and limited device accessibility; (2) learner behaviors characterized by an overreliance on automated content and a lack of critical evaluation; and (3) disparities in student digital readiness. These intertwined factors directly disrupted instructional continuity, thereby necessitating ongoing pedagogical adjustments by teachers to maintain effective classroom management, as presented in Table 6

Table 6 Means and Standard Deviations of Student Perceptions Regarding Contextual Factors and Practical Challenges Influencing AI Integration (n = 200)

Contextual Factors and Practical Challenges	$\bar{x}$	<i>S.D.</i>	Level of Constraint
1.Contextual Factors and Readiness			
1.1 Instability of institutional internet infrastructure	4.06	0.65	High
1.2 Inequality in students' access to digital devices	4.73	0.45	Highest
1.3 Lack of financial budget to support premium AI software	4.38	0.72	High
2.Practical Challenges			
2.1 Students' overreliance on AI-generated content, leading to a lack of critical thinking skills	4.49	0.74	High
2.2 Instructors' difficulties in adapting pedagogical methods to keep pace with technology	4.68	0.58	Highest
2.3 Difficulties in detecting academic dishonesty or AI-plagiarized assignments	4.52	0.69	Highest
Total Average	4.48	0.68	High

The overall mean score for contextual factors and practical challenges was 4.48 (S.D. = 0.68), indicating a high level of perceived influence among the participating students.

The qualitative findings from classroom observations, student reflections, and semi-structured interviews complemented the quantitative results by providing additional evidence regarding the implementation of generative AI in vocational classrooms. Four recurring themes were identified from the qualitative data.

1. Infrastructure and Connectivity. Classroom observations and student reflections consistently identified internet connectivity and device availability as recurring challenges during AI-supported learning activities. Participants described interruptions to classroom continuity when internet access was unstable, while limited access to suitable digital devices occasionally reduced participation in AI-supported tasks.

2. Digital Readiness. The qualitative findings indicated differences in digital readiness among students during AI-supported learning activities. Variations in technological confidence, digital literacy, and prompt construction skills were observed, resulting in different levels of participation and engagement during classroom activities.

3. Responsible AI Use. Classroom observations and student reflections indicated that some students relied heavily on AI-generated content during learning activities. Participants also described the importance of verifying AI-generated information, explaining their own ideas, and using generative AI responsibly when completing classroom tasks.

4. Teacher Facilitation. The qualitative findings consistently highlighted the continuing role of teachers throughout AI-supported classroom implementation. Teachers guided prompt construction, verified AI-generated information, encouraged reflective discussion, and supported students in explaining and justifying their learning processes during classroom activities.

Overall, the qualitative findings complement the quantitative results by providing additional evidence regarding the experiences of learners and teachers during AI-supported learning. Together, these findings suggest that the successful implementation of generative AI depended not only on technological resources but also on teacher facilitation, learner readiness, and appropriate classroom support.

DISCUSSION

4.1. AI-Supported Classroom Implementation. The first objective of this study was to explore how generative AI was implemented within Thai vocational education classrooms. The findings suggest that generative AI was primarily integrated into brainstorming, project preparation, and presentation design activities within the participating vocational classrooms. Rather than functioning as a substitute for student thinking, AI served as a classroom support tool that assisted learners in organizing initial ideas and beginning learning tasks.

Classroom observations further suggested that AI-supported activities appeared to reduce hesitation for some learners during the early stages of project development. However, the observed benefits varied across students and depended on individual confidence, digital

familiarity, and classroom participation. These findings are broadly consistent with previous studies, which suggest that AI may provide cognitive support during learning activities while remaining dependent on appropriate instructional guidance (Kasneci et al., 2023; Miao & Holmes, 2023). From a human-centered educational perspective, the educational value observed in this study appeared to arise not from the technology itself but from the interaction between AI-supported activities and teacher facilitation during classroom implementation. This interpretation is also consistent with Vygotsky's (1978) concept of instructional support, in which external resources may assist learners as they engage with increasingly complex classroom tasks.

4.2. Learner and Teacher Experiences During AI-Supported Learning. The second objective of this study was to explore learner and teacher experiences during AI-supported learning activities in Thai vocational classrooms. The findings reflected considerable variation among learners throughout classroom implementation. Some students appeared more willing to participate in brainstorming, classroom discussion, and project preparation when AI-supported tools reduced initial uncertainty during learning tasks. However, learner adaptation remained uneven, with several students continuing to experience difficulty evaluating generated information, constructing effective prompts, and balancing AI-supported responses with independent thinking.

These observations suggest that learner confidence, technological familiarity, and prior learning experience influenced classroom participation during AI-supported activities. Students who appeared more comfortable using digital tools generally adapted more readily, whereas others continued to require additional classroom guidance and reflective support. Similar observations have been reported in previous studies emphasizing the importance of learner readiness and digital literacy during technology-supported learning environments (OECD, 2021; Miao & Holmes, 2023).

The findings also suggest the continuing importance of teacher facilitation throughout classroom implementation. Although AI-supported tools assisted brainstorming, idea development, and project preparation, meaningful classroom interaction continued to depend heavily on teacher guidance, reflective discussion, and contextual explanation. Rather than reducing the instructional role of teachers, classroom implementation appeared to reinforce their responsibility in helping students evaluate generated information, develop critical thinking, and use AI responsibly during learning activities. This interpretation is consistent with the human-centered educational perspective and the TPACK framework, which emphasize that effective technology integration depends on pedagogical decision-making rather than technology alone (Mishra & Koehler, 2006; Fullan, 2013).

4.3. Contextual Factors and Practical Challenges. The third objective of this study was to examine the contextual factors influencing the implementation of generative AI within Thai vocational education classrooms. The findings suggest that classroom implementation was

influenced not only by the availability of AI-supported tools but also by practical educational conditions. Uneven digital readiness, differences in technological familiarity, limited device accessibility, and unstable internet connectivity occasionally affected classroom continuity and learner participation during instructional activities.

Classroom observations further indicated that some learners relied heavily on AI-generated responses without sufficient critical evaluation, whereas others remained hesitant to use AI because of limited technological confidence. These differences reflected the diverse educational backgrounds and digital experiences of the participating students rather than the technology itself.

The findings are broadly consistent with previous educational discussions, which suggest that successful AI integration involves more than technological availability alone. Effective classroom implementation appeared to depend on the interaction among learner readiness, teacher facilitation, institutional support, and contextual educational conditions (Selwyn, 2016; UNESCO-UNEVOC, 2021). Within the participating vocational classrooms, technology represented only one component of the learning environment, while instructional practice and reflective classroom interaction continued to play important roles throughout implementation.

Overall, the findings should be interpreted within the context of the participating Thai vocational classrooms rather than generalized to other educational settings. Although similar implementation challenges may also be observed elsewhere, further studies involving different institutions, learner groups, and instructional environments are needed before broader educational conclusions can be drawn. This contextual interpretation is consistent with the human-centered perspective adopted throughout the study, which emphasizes that educational outcomes emerge through the interaction among learners, teachers, and classroom conditions rather than technology alone.

LIMITATIONS

Several limitations should be considered when interpreting the findings of this study. First, the research was conducted within a single vocational education context and involved a relatively small group of participants over one academic semester. Consequently, the findings should not be generalized beyond educational settings with similar characteristics. Second, participants entered the study with varying levels of digital literacy, technological familiarity, and readiness to adopt AI-supported learning, which may have influenced their classroom participation and learning experiences. Third, practical constraints, including unstable internet connectivity and unequal access to digital devices, occasionally affected the continuity of classroom activities and the implementation of AI-supported learning.

These limitations should be considered alongside the study's contributions. Despite its contextual scope, the research provides empirical insights into how generative AI was

implemented within a human-centered learning approach in Thai vocational classrooms. The findings contribute to a better understanding of the interaction among technology, teacher facilitation, learner characteristics, and classroom context, while remaining specific to the educational setting in which the study was conducted. Future research involving multiple institutions, more diverse participant groups, and longer implementation periods would help strengthen the evidence base and further examine the applicability of these findings across different educational contexts.

RECOMMENDATIONS AND FUTURE RESEARCH

Based on the research findings, achieving meaningful and sustainable integration of generative AI in vocational education requires a comprehensive, human-centered approach. To address the identified challenges and leverage AI's potential, actionable recommendations are proposed across three distinct levels: the educator level, the institutional level, and the policy level.

Recommendations at the Educator Level: At the educator level, teachers must transition from traditional lecturers to active learning facilitators by focusing on the learning process rather than merely the final output. To achieve this, educators should implement process-oriented assessments, such as oral presentations, project defenses, and reflective discussions, to verify students' genuine comprehension. Furthermore, teachers should require students to submit prompt and revision logs alongside their assignments to encourage reflective practice. Integrating classroom fact-checking exercises where students critically evaluate AI-generated information will also promote responsible and ethical technology use.

Recommendations at the Institutional Level: At the institutional level, administrators must actively bridge the digital divide and foster an environment that supports pedagogical innovation. Practically, institutions must continuously invest in upgrading internet bandwidth and ensuring reliable connectivity across all vocational workspaces. To guarantee equitable hardware access, colleges should establish centralized device-lending systems for smart devices and laptops. Additionally, school leaders must support their staff by providing targeted professional development on AI-supported instruction and actively reducing excessive administrative workloads, thereby giving teachers the time and cognitive capacity needed to integrate new technologies effectively.

Recommendations at the Policy Level: At the policy level, sustainable AI integration requires robust systemic support and clear national strategies. Educational authorities must develop and enforce standardized, TVET-specific ethical guidelines for AI usage to define acceptable boundaries and prevent plagiarism. Furthermore, national policymakers should allocate targeted funding to upgrade digital infrastructure in provincial institutions, which could include providing subsidies for premium AI software licenses. Finally, it is crucial to officially embed AI literacy and human-AI collaboration skills into the core vocational

curriculum, ensuring graduates meet the modern workforce demands outlined in the Thailand 4.0 policy.

The findings of this study provide both theoretical and practical implications for AI-supported learning in vocational education. Theoretically, the study extends existing research by demonstrating how an explanatory sequential mixed-methods approach can provide a more comprehensive understanding of generative AI implementation through the integration of quantitative and qualitative evidence. Practically, the findings suggest that successful AI integration requires not only access to digital technologies but also appropriate teacher facilitation, institutional support, and responsible AI use. These findings may inform educators, curriculum developers, and educational policymakers seeking to promote the effective and ethical integration of generative AI in vocational education.

CONCLUSION

This study explored the implementation of generative AI within Thai vocational education through a human-centered learning approach. The findings suggest that generative AI supported classroom engagement, idea generation, and learning activities when implemented alongside appropriate teacher facilitation. At the same time, it highlighted the critical need for equitable digital access and ongoing pedagogical adaptation to ensure that technological advancements translate into meaningful, responsible, and inclusive educational transformation rather than merely exacerbating existing inequalities.

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