



TEACHERS' COMPETENCE IN AI FACILITATION AND ITS INFLUENCE ON STUDENT LEARNING EFFICIENCY

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ABSTRACT

This study examined the competence of teachers in facilitating Artificial Intelligence tools and its influence on student learning efficiency at Trinidad Municipal College. Specifically, it aimed to identify the common AI tools used by teachers and students, determine the challenges encountered in AI integration, assess the level of teachers' competence in AI facilitation, evaluate students' learning efficiency, and determine whether a significant relationship exists between teachers' AI competence and student learning efficiency. The study utilized a quantitative descriptive-correlational research design involving 49 BSOA instructors and 294 BSOA students for all year level as respondents. Data were gathered using a researcher-made survey questionnaire validated through pilot testing and reliability analysis. Descriptive statistics such as frequency, percentage, weighted mean, and standard deviation were used, while Pearson Product-Moment Correlation was employed to test the relationship between variables. Findings revealed that ChatGPT was the most commonly used AI tool among respondents. Teachers experienced challenges related to time constraints, preparedness, ethical concerns, and limited technological resources. Results showed that teachers were generally competent in knowledge of AI tools, integration skills, and ethical AI practices. Students, meanwhile, demonstrated a high level of learning efficiency in terms of quality outputs, engagement, and independent application of learning. However, the correlation analysis revealed no statistically significant relationship between teachers' competence in AI facilitation and students' learning efficiency. The study recommends continuous professional development for teachers, improved institutional support and policies on AI integration, enhanced access to technological resources, and further research exploring other factors that may influence student learning efficiency.

Keywords: *Artificial Intelligence, AI Facilitation, AI Tools, Learning Efficiency, Student Learning, Teacher's Competence*

INTRODUCTION

Artificial Intelligence (AI) has become an important component of contemporary education because it has been a widely used tool in supporting personalized learning, improving instructional efficiency, and enhancing student engagement. However, the successful integration of AI into teaching largely depends on teachers' competence in facilitating its effective and ethical use. Recognizing this, the researchers of this study examined the relationship between teachers' competence in AI facilitation and student learning efficiency at Trinidad Municipal College. Specifically, the study focused on teachers' knowledge of AI tools, AI integration skills, and ethical AI practices, and how these competencies influence students' learning accuracy, engagement, and independent learning.

Several literatures indicate that AI technologies such as ChatGPT, Grammarly, and QuillBot have become widely used educational tools that improve instructional delivery, provide personalized learning experiences, and support student engagement (Alkhawaja et al., 2025; Surendhranatha & Leelavathi, 2025). Nevertheless, several studies emphasize that these benefits can only be maximized when teachers possess adequate AI-related knowledge, pedagogical integration skills, and ethical competence (Azahar et al., 2025; Chiu et al., 2024). Previous research also identified challenges including limited teacher preparedness, insufficient institutional support, and the absence of clear AI implementation policies (Ren & Wu, 2025). Furthermore, studies have consistently shown that teachers' competence in integrating AI positively influences instructional effectiveness, student engagement, and learning outcomes, highlighting the important role of teacher competence in successful AI-supported education (Tan et al., 2025; Surendhranatha & Leelavathi, 2025).

The researchers of this study recognized a significant research gap in the existing literature. While numerous studies have examined the applications, benefits, and challenges of AI in education, relatively few have directly investigated the relationship between teachers' competence in AI facilitation and student learning efficiency, particularly in higher education institutions. Existing studies have primarily focused on teachers' perceptions, AI adoption, or student outcomes independently, with limited empirical evidence linking teacher competence to measurable learning efficiency (Chiu et al., 2024; Sharmin et al., 2026).

AI technologies are rapidly becoming integrated into educational practices, requiring teachers to develop competencies that support effective and ethical AI-assisted instruction, making this topic suitable for a study. Despite the increasing availability of AI tools, many educators continue to experience inadequate training, limited confidence in using AI, insufficient institutional support, and the absence of clear policies for AI integration (Ren & Wu, 2025). These issues may result in the ineffective use of AI,

overreliance on AI-generated outputs, reduced development of students' critical thinking skills, and inconsistent learning experiences.

At the local level, there is limited evidence regarding teachers' competence in AI facilitation and its influence on student learning efficiency at Trinidad Municipal College. This lack of localized empirical data limits the institution's ability to formulate evidence-based professional development programs, curriculum enhancements, and AI integration policies. To address these concerns, the researchers of this study proposed examining the relationship between teachers' AI competence and student learning efficiency. The findings are expected to provide an empirical basis for strengthening teacher training, promoting ethical and effective AI integration, and supporting data-informed institutional policies and instructional innovations that enhance student learning outcomes.

Research Questions

This study determined the level of teachers' competence in facilitating Artificial Intelligence (AI) tools, examine its influence on students' learning efficiency, and address the research questions by identifying the AI tools commonly used, the challenges encountered in AI integration, the levels of teachers' competence and students' learning efficiency, and the relationship between these variables.

This study explored the following research questions in depth:

1. What are the common AI tools used by teachers and students?
2. What challenges do teachers encounter in facilitating AI in the classroom?
3. What is the level of teachers' competence in AI facilitation in terms of:
 - 3.1. Knowledge of AI Tools
 - 3.2. Skills in integrating AI into lessons
 - 3.3. Ethical and responsible use of AI-supported activities
4. What is the level of student learning efficiency in terms of:
 - 4.1. Accuracy and quality of outputs
 - 4.2. Engagement and participation
 - 4.3. Ability to apply learning independently
5. Is there a significant relationship between teachers' competence in AI facilitation and the level of students' learning efficiency?
6. What recommendations may be proposed based on the findings of the study?

Related Literature

This section presents a review of relevant literature and empirical studies that provide the theoretical and conceptual foundation for the present research. The integration of Artificial Intelligence (AI) into educational settings presents both transformative opportunities and significant challenges, particularly in relation to teachers' competence in AI facilitation and its influence on student learning efficiency (Surendhranatha & Leelavathi, 2025). As AI continues to reshape teaching and learning,

research consistently emphasizes the need for educators to develop the knowledge, skills, and ethical competencies necessary to effectively integrate AI tools into classroom instruction and improve educational outcomes (Azahar et al., 2025). Accordingly, this will examine local and foreign literature and studies on AI in education, including the common AI tools used by teachers and students, the challenges encountered in AI integration, teachers' competence in terms of knowledge, instructional skills, and ethical AI practices, as well as students' learning efficiency in relation to AI-supported instruction. The reviewed literature establishes the basis for the study's theoretical and conceptual framework, identifies existing research gaps, and demonstrates the relevance of the present investigation in contributing to the expanding body of knowledge on Artificial Intelligence in education.

Common AI Tools Used by Teachers and Students

Artificial Intelligence (AI) tools are increasingly prevalent in education, assisting with various aspects of teaching and learning. For teachers, AI can streamline administrative tasks, provide real-time feedback on instructional strategies, and aid in designing educational content tailored to learning objectives (Surendhranatha & Leelavathi, 2025) (Tanvir & Shahzadi, 2024). Examples of AI tools commonly used or perceived as beneficial by teachers include language models like ChatGPT, writing aids such as Quillbot and Grammarly, and other AI-assisted learning robots that offer personalized learning facilities (Alkhawaja et al., 2025). Specifically, in a study involving 86 teachers, AI was less frequently used but often employed for tutoring, with ChatGPT being a prominent example (Leonillo, 2025). Surveys indicate that approximately 40% of teachers possess some familiarity with AI tools, though confidence in their effective use remains lower (Roshan et al., 2024).

Students also utilize a range of AI tools to enhance their learning experiences, improve engagement, and boost academic performance. Tools like ChatGPT, QuillBot, and Grammarly are perceived by students as beneficial for improving writing quality, comprehension, and overall learning efficiency (Alkhawaja et al., 2025). These tools contribute to improved efficiency and comprehension, although concerns exist regarding potential over-reliance and reduced critical thinking (Hasin et al., 2025).

Challenges Faced by Teachers in facilitating AI in the Classroom

Despite the potential benefits, teachers encounter numerous challenges when integrating AI into their pedagogical practices. A primary challenge is the lack of teacher readiness and sufficient knowledge regarding AI integration (Azahar et al., 2025). Many educators feel inadequate due to a lack of knowledge or struggle to keep pace with AI-oriented tools (Çelenk & Büyükahıska, 2025). This readiness gap extends to insufficient awareness and understanding of how to effectively employ AI tools in preparing educational content and integrating them into classroom practices (Abdulummin, 2025).

Beyond individual readiness, systemic issues contribute to these challenges. The absence of clear guidelines, policies, and adequate resources to assist instructors in

efficiently and ethically integrating AI is a significant barrier (Ren & Wu, 2025). Teachers also express concerns about AI's potential impact on students' critical thinking skills, the risk of over-dependence on automated systems, and the pressing need for comprehensive training and ongoing professional support to maximize AI's benefits (Hasin et al., 2025).

Level of Teachers' Competence in AI Facilitation

Teachers' competence in AI facilitation is multifaceted, encompassing their knowledge of AI tools, their skills in integrating these tools into lessons, and their understanding and application of ethical and responsible AI use. While educators acknowledge the transformative potential of AI, many still face challenges related to AI literacy and proficiency, resulting in varying levels of familiarity and preparedness for integrating rapidly advancing AI tools into educational practice (Bohara & Rana, 2024; Ding et al., 2024). The development and validation of scales like the Teacher AI Competence Self-efficacy (TAICS) are crucial for evaluating these competence levels, especially for fostering effective human-machine cooperation in K-12 educational environments (Chiu et al., 2024).

Effective integration of AI into lessons necessitates specific pedagogical skills, requiring teachers to adapt their roles and enhance their abilities to leverage AI as an instructional aid. This involves designing AI-supported learning activities and shifting from mere tool-focused training to professional development that cultivates a mindset for responsible AI use (Huynh et al., 2025). The Intelligent Technological Pedagogical Content Knowledge (I-TPACK) framework is emerging as a critical model, synthesizing technological, pedagogical, content, and ethical knowledge essential for AI integration. An empirical study involving 401 teachers confirmed that digital proficiency significantly impacts teachers' AI-TPACK competencies (Hava & Babayiğit, 2024).

Furthermore, ethical considerations are paramount in AI integration, demanding that teachers possess ethical, reflective, and collaborative competencies for meaningful AI application (Azahar, 2025). This includes critically addressing issues such as data privacy, algorithmic bias, and ensuring that AI tools do not compromise critical thinking or academic integrity. AI literacy for K-12 teachers increasingly focuses on key dimensions including awareness, ethics, evaluation, and practical use, highlighting the necessity for a comprehensive grasp of AI's societal implications (Al-Abdullatif, 2025).

Significant Relationship Between Teachers' Competence in AI Facilitation and Student Learning Efficiency

A growing body of literature suggests a significant positive relationship between teachers' competence in AI facilitation and the level of students' learning efficiency. When teachers effectively integrate AI, delivering tailored learning experiences and streamlining administrative tasks, student engagement and academic performance can be enhanced (Surendhranatha & Leelavathi, 2025). The ability of teachers to create relevant

educational content and provide feedback on instructional strategies using AI tools directly contributes to improved student outcomes (Tanvir et al., 2024).

Furthermore, teachers' AI competency, particularly their Technological Pedagogical Content Knowledge (TPACK) related to AI, plays a mediating role in their teaching performance (Tan et al., 2025). This improved teaching performance, characterized by innovative pedagogical practices and personalized learning approaches, directly correlates with enhanced student learning experiences. re-service teachers' perceived AI competencies are also linked to their intentions to use AI, which, when translated into practice, would benefit student learning (Sadaf et al., 2025). The effective use of AI tools by teachers, including their ability to audit AI literacy and ensure ethical use, can lead to better student outcomes by fostering a more effective and responsible learning environment (AI-Abdullatif, 2025).

The presence of well-trained teachers who can thoughtfully integrate AI into their pedagogy is crucial for maximizing AI's positive impact on student learning and mitigating potential drawbacks such as over-reliance or ethical concerns (Huynh et al., 2025). Studies emphasizing the importance of teacher training and professional development consistently highlight improved teacher confidence and effective utilization of AI tools, which in turn benefits student learning.

METHODOLOGY

Research Design

This study employed a quantitative descriptive-correlational research design to examine teachers' competence in Artificial Intelligence (AI) facilitation and its influence on students' learning efficiency. The descriptive component was used to determine the common AI tools utilized by teachers and students, identify the challenges encountered in AI integration, assess teachers' competence in AI facilitation, and evaluate students' learning efficiency. The correlational component was utilized to determine whether a significant relationship exists between teachers' competence in AI facilitation and students' learning efficiency. This design was appropriate because it enabled the researchers to describe the current conditions and examine the association between the study variables without manipulating them.

Research Environment

The study was conducted in a public higher education institution in Bohol, Philippines, specifically within the Bachelor of Science in Office Administration (BSOA) program during the School Year 2025–2026. The institution has adopted digital learning initiatives that encourage the integration of Artificial Intelligence (AI) tools into teaching and learning. This setting provided an appropriate environment for examining teachers' competence in AI facilitation and its relationship with students' learning efficiency.

Research Participants

The respondents consisted of 49 BSOA instructors and 294 BSOA students from all year levels who were selected through simple random sampling. The instructor-respondents were included because they directly facilitate AI-assisted instruction, while the student-respondents were selected to assess their learning efficiency in AI-supported learning environments. Participation in the study was voluntary, and informed consent was obtained from all respondents before data collection. The scope of the study was limited to the selected instructors and students of the BSOA program; therefore, the findings may not be generalized to other academic programs or higher education institutions with different educational contexts.

Research Instruments

Data were gathered using a researcher-made survey questionnaire developed from the objectives of the study and relevant literature on AI in education. The instrument consisted of six sections: (1) respondents' profile, (2) commonly used AI tools, (3) challenges encountered in facilitating AI, (4) teachers' competence in AI facilitation, (5) students' learning efficiency, and (6) the relationship between teachers' competence and students' learning efficiency. The sections measuring AI tool utilization, teachers' competence, students' learning efficiency, and perceived challenges employed four-point Likert scales with descriptive equivalents appropriate to each construct (e.g., Very Competent to Not Competent, Very High to Very Low, Very Often to Never, and Strongly Agree to Strongly Disagree).

Table 1.
For Teachers' Competence and Student Learning Efficiency

Scale	Range	Descriptive Equivalent
4	3.25 – 4.00	Very Competent / Very High
3	2.50 – 3.24	Competent / High
2	1.75 – 2.49	Less Competent / Low
1	1.00 – 1.74	Not Competent / Very Low

Table 2.
For Frequency of AI Tool Utilization

Scale	Range	Descriptive Equivalent
4	3.25 – 4.00	Very Often
3	2.50 – 3.24	Often
2	1.75 – 2.49	Sometimes
1	1.00 – 1.74	Never

Table 3.
For Challenges and Agreement-Based Indicators

Scale	Range	Descriptive Equivalent
4	3.25 – 4.00	Strongly Agree
3	2.50 – 3.24	Agree
2	1.75 – 2.49	Disagree
1	1.00 – 1.74	Strongly Disagree

Prior to the actual data collection, the instrument underwent expert validation to establish content validity and was pilot-tested among instructors and students who were not included in the final respondents. Reliability was assessed using Cronbach's alpha, yielding coefficients ranging from 0.74 to 0.92, indicating acceptable to excellent internal consistency. These results confirmed that the instrument was valid and reliable for measuring the variables included in the study.

Data Gathering Procedure

Prior to the conduct of the study, the researchers developed a researcher-made survey questionnaire based on the study objectives and relevant literature on Artificial Intelligence (AI) facilitation and student learning efficiency. The instrument underwent expert validation and a one-week pilot test involving instructors from departments other than the Bachelor of Science in Office Administration (BSOA) program and selected students who were excluded from the actual study to assess its clarity, relevance, and reliability. Cronbach's alpha coefficients ranging from 0.74 to 0.92 confirmed the instrument's acceptable to excellent internal consistency. After establishing the validity and reliability of the questionnaire, the researchers secured the necessary approvals from the appropriate institutional authorities before administering the survey. Ethical standards were strictly observed by obtaining informed consent, ensuring voluntary participation, and maintaining the confidentiality of all responses. Data were then collected from 49 randomly selected BSOA instructors and 294 randomly selected BSOA students through Google Forms distributed via email and Facebook Messenger, supplemented by face-to-face administration to maximize the response rate. Upon retrieval, the responses were checked, encoded, tabulated, and collated before undergoing appropriate descriptive and inferential statistical analyses to address the research objectives and examine the relationship between teachers' competence in AI facilitation and students' learning efficiency.

Data Analysis

The data gathered in this study were analyzed using both descriptive and inferential statistical techniques to address the research questions and examine the relationship between teachers' competence in AI facilitation and students' learning efficiency. The collected responses were encoded, organized, tabulated, and processed using appropriate statistical software to ensure accuracy, reliability, and consistency in data interpretation. Descriptive statistics were employed to summarize the data and determine the extent of teachers' competence, students' learning efficiency, the common

AI tools used, and the challenges encountered in AI integration. Inferential statistics were utilized to determine the significance of the relationship between the variables, providing a sound basis for the presentation of findings, formulation of conclusions, and development of recommendations.

To facilitate the interpretation of the weighted mean, standardized four-point rating scales were adopted for the different variables. Teachers' competence and students' learning efficiency were interpreted using a scale ranging from 1 (Not Competent/Very Low) to 4 (Very Competent/Very High). The frequency of AI tool utilization was measured using a scale from 1 (Never) to 4 (Very Often), while challenges and other agreement-based indicators were interpreted using a scale from 1 (Strongly Disagree) to 4 (Strongly Agree). These standardized scales ensured consistency in interpreting the respondents' perceptions and provided a uniform basis for analyzing and comparing the study variables.

RESULTS

The study sought to determine the teachers' competence in Artificial Intelligence (AI) facilitation and its influence on students' learning efficiency. A quantitative descriptive-correlational research design was employed to examine the variables of the study. Data were collected through a researcher-made survey questionnaire using a four-point Likert scale to obtain the respondents' perceptions regarding the common AI tools used by teachers and students, the challenges encountered in AI facilitation, teachers' competence in terms of knowledge of AI tools, skills in integrating AI into lessons, and ethical and responsible use of AI-supported activities, as well as students' learning efficiency in terms of accuracy and quality of outputs, engagement and participation, and the ability to apply learning independently. Descriptive statistics, including frequency, percentage, weighted mean, and standard deviation, were used to summarize and interpret the data, while the Pearson Product-Moment Correlation Coefficient was employed to determine the significance of the relationship between teachers' competence in AI facilitation and students' learning efficiency. The findings are presented according to the sequence of the research questions and are interpreted in relation to relevant literature to provide a comprehensive understanding of AI integration in teaching and learning.

Table 1.
Common AI tools used by the teachers and students

AI Tools	Frequency	Percent (%)
ChatGPT	295	86
Meta AI	18	5
Grammarly	13	4
Google Gemini	13	4
Microsoft Copilot	3	1
Quilbot	1	0
Total	343	100

Table 2.
Challenges do teachers encounter in facilitating AI in the classroom

INDICATORS	MEAN	LEVEL
Time constraints limits my ability to effectively AI-assisted learning activities.	3.00	SA
I feel unprepared to manage and monitor AI-assisted classroom activities.	3.00	SA
Ethical concerns limit my use of AI	2.88	SA
Limited access to devices among students affects my ability to facilitate AI integration.	2.67	SA
I struggle to align AI tools with lesson objectives.	2.61	SA
Students' misuse of AI for academic dishonesty makes facilitation difficult.	2.59	SA
I find AI tools difficult to use.	2.57	SA
Internet connectivity issues hinder my facilitation of A-based activities.	2.53	SA
I lack sufficient training to effectively facilitate students' use of AI tools.	2.33	A
The absence of a clear school policy on AI use affects how I facilitate AI integration.	2.06	A
Total	2.62	SA

Table 3.
Knowledge in AI tools

Indicators	Mean	Level
I understand the strengths and limitations of AI tools when facilitating student learning.	3.24	Competent
I understand how to facilitate students' use of different AI tools in learning activities.	3.12	Competent
I know which AI tools are most appropriate to facilitate learning in my subject area.	3.08	Competent
I can explain to students how AI tools generate response and content.	3.08	Competent
I can guide students in evaluating the accuracy and reliability of AI-generated outputs.	3.04	Competent
Total	3.11	Competent

Table 4.
Skills in integrating AI into lessons

Indicators	Mean	Level
I facilitate the use of AI to enhance students' understanding of lessons.	3.10	Competent
I facilitate AI use to support differentiated instruction for diverse learners.	3.06	Competent
I can effectively facilitate the integration of AI tools into my class discussions.	3.02	Competent
I design and facilitate classroom activities that meaningfully incorporate AI tools.	2.98	Competent

I can effectively manage and monitor AI-assisted learning activities in the classroom.	2.98	Competent
Total	3.03	Competent

Table 5.
Ethical and responsible use of AI-supported activities

Indicators	Mean	Level
I ensure that AI use in my class aligns with school policies and ethical standards.	3.12	Competent
I promote academic integrity when facilitating AI-assisted tasks.	3.10	Competent
I address and manage students' overdependence on AI tools.	3.08	Competent
I facilitate students' ethical and responsible use of AI tools.	3.03	Competent
I can guide students in properly citing and acknowledging AI-generated content.	3.03	Competent
Total	3.07	Competent

Table 6.
Level of students learning efficiency in terms of accuracy and quality outputs

Indicators	Mean	Level
Students submit high-quality academic work with appropriate AI assistance.	3.13	High
Students show improvement in the clarity and organization of their outputs when using AI.	3.13	High
Students demonstrate improved understanding of lessons through AI-supported activities.	3.10	High
Students produce accurate outputs when using AI as a learning support tool.	3.08	High
Students are able to verify and refine AI-generated responses to improve accuracy.	3.06	High
Total	3.10	high

Table 7.
Level of students learning efficiency in terms of engagement and participation

Indicators	Mean	Level
Students are actively engaged during AI-supported lessons.	2.93	High
Students collaborate effectively with peers during AI-assisted activities	2.91	High
Students show increased interest and motivation when learning with AI tools.	2.89	High
Students participate more actively in discussions when AI tools are integrated.	2.88	High
Students complete AI-supported tasks with enthusiasm and focus.	2.87	High
Total	2.90	High

Table 8.
Level of students learning efficiency in terms of ability to apply learning independently

Indicators	Mean	Level
Students can apply what they have learned without relying on AI tools	3.23	High
Students are able to complete tasks using their own understanding and knowledge.	3.21	High
Students can transfer learned concepts to new situations without AI assistance.	3.13	High
Students show confidence in making decisions independently after using AI-supported learning.	3.06	High
Students demonstrate independently problem-solving skills beyond AI suggestions.	3.02	High
Total	3.13	High

Table 9.
Correlation between teachers' competence in AI facilitation and the level of students' learning efficiency

Variables	r - value	Computed t	Critical t	Result	Decision
KAT & AQO	0.21	1.472	2.021	Not significant	Fail to reject H_0
SIAL & EP	-0.08	-0.550	2.021	Not significant	Fail to reject H_0
ERUAA & AALI	0.25	1.770	2.021	Not significant	Fail to reject H_0

Legend:

KAT means Knowledge of AI Tools
 AQO means Accuracy and Quality Output
 SIAL means Skills in Integrating AI into Lessons
 EP means Engagement and Participation
 ERUAA means Ethical and responsible use of AI support
 AALI means Independent Application

DISCUSSION

Table 1 presents the common AI tools used by teachers and students. The data indicate that ChatGPT obtained the highest frequency of 295 or 86%, making it the most widely utilized AI tool among respondents. This suggests that both teachers and students heavily depend on ChatGPT for various academic tasks, including idea generation, answering queries, and supporting instructional and learning activities. Its widespread use can be attributed to its accessibility, user-friendly interface, and versatility in addressing diverse educational needs. In contrast, tools such as Meta AI, Microsoft Copilot, Google Gemini, Grammarly, and QuillBot registered significantly lower frequencies, reflecting minimal utilization among respondents. This indicates that while multiple AI tools are available, their adoption remains limited compared to ChatGPT, possibly due to differences in familiarity, functionality, and user preference.

The findings highlight the strong preference for ChatGPT as the dominant AI platform in educational contexts. This implies that respondents are more comfortable using conversational and generative AI tools that provide immediate, interactive, and context-based responses. Such preference may also reflect the increasing integration of AI-assisted learning strategies in both teaching and academic work.

Furthermore, the results suggest that ChatGPT has emerged as the most accessible and practical AI tool for educational purposes. Its extensive functionality supports a wide range of learning activities, making it a valuable resource in both classroom instruction and independent study. However, the limited use of other AI tools may indicate a need to improve awareness, training, and accessibility to diversify AI integration in education. Supporting this, Nikolopoulou (2024) emphasizes that ChatGPT is an effective tool for enhancing pedagogical practices through personalized learning and automated support, although it still requires proper human evaluation and guidance to ensure accuracy and responsible use.

Table 2 presents the challenges teachers encounter in facilitating AI integration in the classroom, with an overall mean of 2.62, interpreted as Strongly Agree, indicating that respondents generally experience notable challenges in AI facilitation. The highest-rated indicators were “Time constraints limit my ability to effectively facilitate AI-assisted learning activities” and “I feel unprepared to manage and monitor AI-assisted classroom activities”, both with a mean of 3.00 (Strongly Agree). This was followed by “Ethical concerns limit my use of AI” with 2.88, and “Limited access to devices among students affects my ability to facilitate AI integration” with 2.67, both interpreted as Strongly Agree. The lowest indicators were “I lack sufficient training to effectively facilitate students’ use of AI tools” with 2.33 (Agree) and “The absence of a clear school policy on AI use affects how I facilitate AI integration” with 2.06 (Agree).

The findings indicate that teachers face multidimensional challenges in facilitating AI, including time-related, technical, pedagogical, and institutional factors. The most prominent issues—time constraints and lack of preparedness—suggest insufficient support for effectively designing and managing AI-assisted activities, reflecting a gap between the demand for AI integration and teachers’ readiness. Ethical concerns and student misuse further emphasize the need for clear guidelines and monitoring. Infrastructural limitations, such as limited device access and poor internet connectivity, also hinder implementation, while lower-rated concerns like training and policy gaps still point to weak systemic support. These results align with prior research, as Mudgal (2024) identified similar constraints, including limited resource accessibility, lack of training, ethical concerns, and data privacy issues. Overall, although teachers recognize AI’s potential, effective integration requires targeted interventions such as professional development, improved resources, workload adjustments, and clear institutional policies.

Table 3 presents the teachers’ level of knowledge in AI tools. The overall mean score of 3.11, interpreted as “Competent,” indicates that respondents generally possess a solid understanding of AI tools in the context of teaching and learning. Among the indicators, the highest mean score is 3.24, which reflects teachers’ understanding of the

strengths and limitations of AI tools. This is followed by their ability to facilitate students' use of AI tools (Mean = 3.12). Other indicators, such as knowing the appropriate AI tools for specific subject areas (Mean = 3.08) and the ability to explain how AI generates responses (Mean = 3.08), also fall within the competent level. The lowest mean, though still within the same level, is 3.04, which refers to teachers' ability to guide students in evaluating the accuracy and reliability of AI-generated outputs.

The results indicate that teachers generally demonstrate an adequate level of knowledge regarding AI tools, including their applications, the ability to select appropriate tools, and the capacity to explain their functions to students, suggesting that they have developed the foundational competencies needed for AI-assisted learning. This is supported by several studies involving 515 pre-service teachers and 253 Chinese EFL teachers (Dayagbil et al., 2025), which found that teachers possess moderate to adequate levels of general AI knowledge. However, findings from Carruba et al. (2025), based on 67 middle and high school teachers, reveal difficulties in distinguishing AI-generated outputs from student-created work, indicating inconsistencies in critical evaluation skills. The slightly lower ratings in evaluating AI outputs further highlight the need to strengthen teachers' critical assessment abilities. These results reinforce that technological knowledge alone is insufficient for effective AI integration; rather, as emphasized by Celik (2002), teachers must combine pedagogical and technological knowledge—consistent with the TPACK framework—to ensure that AI tools are used effectively, responsibly, and in ways that enhance student learning.

Table 4 reveals that teachers demonstrate a “competent level” of skill in integrating Artificial Intelligence (AI) into their lessons, as reflected by the overall mean of “3.03”. The results indicate that teachers are generally capable of using AI to support instruction, particularly in enhancing students' understanding (3.10) and addressing diverse learning needs through differentiated instruction (3.06). This suggests a strong foundation in utilizing AI as a tool for improving comprehension and personalization in the classroom. These findings are consistent with studies by Purwati et al. (2026), which highlight that teachers perceive AI as beneficial for enhancing understanding and providing individualized support, and Sibug et al. (2026), who found that teachers are highly aware of the potential of AI tools to meet students' learning needs. Furthermore, the integration of AI into class discussions (3.02) indicates that teachers can incorporate AI into interactive and participatory learning environments.

However, the findings also show comparatively lower mean scores (2.98) in designing meaningful AI-integrated activities and in managing and monitoring AI-assisted learning, although both remain within the “Competent” level. This suggests that teachers may encounter challenges when applying AI in more complex instructional tasks, such as activity design and classroom management. The results imply that while teachers are proficient in basic AI facilitation, there is still a need to strengthen their higher-order integration skills. Supporting this interpretation, Aravantinos et al. (2026) emphasize that effective AI integration extends beyond technical skills and requires strong pedagogical knowledge, institutional support, and continuous professional development. Overall, the

findings highlight the importance of targeted training programs to further enhance teachers' ability to fully utilize AI in teaching and learning processes.

Table 5 presents teachers' competence in ethical and responsible use of AI-supported activities, yielding an overall mean of 3.07, interpreted as Competent. The highest indicator was ensuring that AI use aligns with school policies and ethical standards with 3.12, while the lowest means of 3.03 were noted in facilitating responsible AI use and guiding students in citing AI-generated content.

The results indicate that teachers are generally competent in fostering ethical AI practices, upholding academic integrity, and guiding responsible AI use in the classroom. This suggests that they possess a solid awareness of ethical considerations in AI facilitation; however, there is still a need to further strengthen practices related to proper citation and responsible student engagement with AI tools. Supporting this, the study of Acquiatan and Plaza (2026), involving 15 teachers, revealed that educators demonstrated strong foundational competencies in facilitating AI-driven learning, with greater emphasis on transparency and risk awareness compared to students.

Table 6 indicates that students demonstrate a "High" level of learning efficiency in terms of accuracy and quality of outputs, with an overall mean of 3.10. This suggests that the use of AI as a learning support tool contributes positively to students' academic performance. The highest means (3.13) show that students are particularly effective in producing high-quality work and improving the clarity and organization of their outputs with AI assistance. Additionally, students exhibit enhanced understanding of lessons (3.10) and are able to generate accurate outputs (3.08), indicating that AI supports both comprehension and performance. Although slightly lower, the ability to verify and refine AI-generated responses (3.06) still falls within the high level, suggesting that students are developing critical thinking skills when using AI.

The findings demonstrate that AI-supported learning significantly enhances students' output quality, organization, and overall understanding. This is supported by Ali et al. (2025), who identified a strong positive correlation between the use of AI tools and the quality of assessments among 200 postgraduate students, reinforcing the effectiveness of AI in academic tasks. These results suggest that AI tools play a vital role in improving the accuracy, coherence, and overall quality of student outputs, highlighting their value as powerful and reliable learning support tools.

Table 7 shows that students demonstrate a "High" level of engagement and participation in AI-supported learning, with an overall mean of 2.90. The highest rating indicates that students are actively engaged during AI-supported lessons (2.93), followed closely by their ability to collaborate with peers and increased interest in learning through AI tools. Although slightly lower, the remaining indicators still reflect high levels of participation, suggesting that AI integration effectively fosters motivation, interaction, and active involvement among students.

The findings indicate that AI integration effectively promotes students' active participation, collaboration, and motivation in the learning process. Supporting this, Rad (2025) reported that 77% of students highlighted the effectiveness of an AI-based platform in fostering engagement and self-regulated learning, with increased attentiveness and enhanced motivation frequently emerging as key themes, while Moussa et al. (2024), in a study of 355 students, found a significant positive relationship between students' perceptions of AI and their level of classroom engagement. These results suggest that AI-supported instruction not only enhances students' interest in learning but also encourages greater involvement and interaction in academic activities.

Table 8 shows that students demonstrate a "High" level of learning efficiency in terms of their ability to apply learning independently, with an overall mean of 3.13. The highest mean (3.23) indicates that students are most capable of applying what they have learned without relying on AI tools, followed closely by their ability to complete tasks using their own understanding and knowledge (3.21). Students also show competence in transferring learned concepts to new situations without AI assistance (3.13), as well as exhibiting confidence in independent decision-making (3.06) and problem-solving beyond AI suggestions (3.02). Overall, the results suggest that students are able to internalize learning from AI-supported activities and apply it effectively on their own.

The findings suggest that AI integration supports rather than hinders students' independence, helping develop their ability to learn autonomously. The consistently high results indicate that students use AI as a complementary tool to enhance their understanding and performance, rather than becoming overly dependent on it. Supporting this, studies by Rashed et al. (2026) and Singhachotsukpat et al. (2025) show that AI-assisted learning can strengthen critical thinking and problem-solving skills, with students who possess higher-order thinking abilities more likely to use AI as support instead of a substitute. However, slightly lower performance in decision-making and problem-solving beyond AI suggestions suggests the need for further improvement in these areas. This highlights the importance of instructional strategies that promote critical thinking, reflection, and independent application of knowledge, ensuring that AI remains a supportive tool in the learning process.

Table 9 shows the correlation between teachers' competence in AI facilitation and students' learning efficiency across selected domains. The relationship between knowledge of AI tools (KAT) and accuracy and quality of outputs (AQO) yielded an r-value of 0.21 with a computed t of 1.472, which is lower than the critical t-value of 2.021, indicating a weak positive but not statistically significant relationship. Similarly, the correlation between skills in integrating AI into lessons (SIAL) and engagement and participation (EP) produced an r-value of -0.08 and a computed t of -0.550, reflecting a very weak negative and non-significant relationship. Lastly, ethical and responsible use of AI (ERUAA) and ability to apply learning independently (AALI) showed an r-value of 0.25 with a computed t of 1.770, which also falls below the critical value, indicating a weak positive but still non-significant relationship. In all cases, the computed t-values do not exceed the critical t-value, leading to the decision to fail to reject the null hypothesis.

The findings indicate that although teachers are generally competent in facilitating AI, this competence does not necessarily result in direct or measurable improvements in students' learning efficiency across the identified domains. The weak and non-significant relationships suggest that other variables—such as students' abilities, motivation, learning environment, and access to technology—may have a stronger influence on learning outcomes. Moreover, the effects of teachers' AI competence may be indirect or may require sustained and consistent implementation before meaningful results become evident. Supporting this, Bauer et al. (2025) highlight that the success of AI integration is influenced by moderating factors such as teachers' pedagogical approaches and the quality of implementation. Overall, these findings underscore the importance of considering broader educational conditions and support systems when assessing the impact of AI on student learning efficiency.

The null hypothesis stating that there is no significant relationship between teacher's competence in AI facilitation and the level of students' learning efficiency was not rejected. All computed values were lower than the critical value of 2.021 at the 0.05 significance level, indicating that none of the tested variable pairs showed statistically significant relationships.

Conclusions

Based on the results of the study, the researchers concluded that teachers are prepared to include AI tools into teaching procedures since they have a typically competent level of AI facilitation throughout the domains of knowledge, abilities, and ethical practices. At the same time, students show a high degree of learning efficiency in terms of output quality and accuracy, participation and engagement, and independent application of learning, indicating that AI-supported education improves learning outcomes. However, the lack of a statistically significant correlation between teachers' competence in AI facilitation and students' learning efficiency indicates that such competence alone does not directly predict or determine student performance. This implies that a wider range of factors such as learner characteristics, access to technology resources, classroom atmosphere, and pedagogical strategies influence student learning efficiency in addition to instructor ability. Moreover, the existence of significant obstacles like time restraints, restricted device access, and inadequate training highlights the necessity of institutional and systemic support to improve the successful application of AI in education. Overall, AI integration has the potential to enhance teaching and learning, but its effects are complex and dependent on both contextual and individual factors.

Recommendations

Based on the findings and conclusions of the study, the recommendations are proposed:

1. Teachers may participate in continuous professional development programs which focuses on AI integration in order to improve their skills related in lesson planning, managing classrooms, and evaluating AI-generated outputs. They also have to strengthen their ability to mentor students in the ethical and critical use of AI tools.

2. School administrators may create and enforce clear policies and guidelines regarding the integration of AI in education. They may also set up training programs, provide adequate resources, such as dependable internet connectivity and sufficient digital equipment to enhance teacher's competence in AI facilitation.
3. Curriculum planners may include AI-supported learning methodologies to guarantee that AI technologies are integrated in an organized and significant way. They may also encourage the adoption of a variety of AI applications to broaden both teachers' and students' exposure to various technologies.
4. Teachers may guide students to use AI tools in an ethical and responsible manner. When using AI-generated content, they should be encouraged to develop critical evaluation abilities, independent thought, and proper citation practices.
5. Future researchers may explore other variables including motivation, digital literacy, and the learning environment that could influence student learning efficiency. Researchers are invited to carry out similar studies using larger samples or alternative research approaches to further validate the findings of this study.

Compliance with ethical standards

This study was conducted in accordance with established ethical principles governing educational research. Prior to data collection, formal permission to conduct the study was obtained from the Chairman of the Board of Trustees, through the College Administrator and the College President of the institution. Participation in the study was entirely voluntary, and all respondents were provided with sufficient information regarding the purpose, procedures, and significance of the research before giving their informed consent. Participants were informed of their right to decline participation or withdraw from the study at any stage without penalty or negative consequences. To protect their privacy, respondents' identities were kept anonymous, and all information gathered was treated with strict confidentiality. The data were presented only in aggregated form and were used solely for academic and research purposes. The researchers ensured that the rights, dignity, safety, and well-being of all participants were safeguarded throughout the conduct of the study. Furthermore, the researchers declare that no conflict of interest existed in the conduct of this research. All sources of information were properly acknowledged to avoid plagiarism, and the collection, analysis, interpretation, and presentation of the findings were carried out objectively, honestly, and without bias to preserve the integrity and credibility of the study.

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REFERENCES

- Abdulmumin, A. I. (2025). The Educator's Guide to AI: What You Can't Afford Not to Know. *Al-Wazan: Journal of Arabic Education*, 3(1), 48–67. <https://doi.org/10.58223/al-wazan.v3i1.337>
- Acquiatan, E. S. V. B., & Plaza, R. C. O., EdD. (2026). The evolving roles of academic community in the age of artificial intelligence. *International Journal of Social Science and Human Research*, 09(01). <https://doi.org/10.47191/ijsshr/v9-i1-97>
- Alkhawaja, L., Idris, M., Al-Sayyed, S., & Al Jaber, A. M. (2025). Exploring the impact of Artificial Intelligence on students' skills for sustainable development in education. *Frontiers in Education*, 10. <https://doi.org/10.3389/feduc.2025.1691148>
- Al-Abdullatif, A. M. (2025). Auditing AI Literacy Competency in K–12 Education: The Role of Awareness, Ethics, Evaluation, and Use in Human–Machine Cooperation. *Systems*, 13(6), 490. <https://doi.org/10.3390/systems13060490>
- Aravantinos, S., Lavidas, K., Komis, V., Karalis, T., & Papadakis, S. (2026). Artificial Intelligence in K-12 Education: A Systematic Review of Teachers' Professional development Needs for AI integration. *Computers*, 15(1), 49. <https://doi.org/10.3390/computers15010049>
- Azahar, R., Hilhamsyah, H., Nuzuliana, S., Oktavianti, N., & Jannah, M. (2025). The Role of Artificial Intelligence in the Future of the Teaching Profession: Analysis of Competencies, Challenges, and Development Directions. *Lembaran Ilmu Kependidikan*, 54(2), 285–298. <https://doi.org/10.15294/lik.v54i2.32452>
- Bauer, E., Greiff, S., Graesser, A. C., Scheiter, K., & Sailer, M. (2025). Looking beyond the hype: Understanding the effects of AI on learning. *Educational Psychology Review*, 37(2). <https://doi.org/10.1007/s10648-025-10020-8>
- Bohara, D. K., & Rana, K. (2024). Unmasking teachers' proficiency in harnessing Artificial Intelligence (AI) for transformative education. *SN Social Sciences*, 4(11). <https://doi.org/10.1007/s43545-024-01003-7>
- Carruba, M. C., Caiazzo, A., Scuotto, C., Savioni, L., & Triberti, S. (2025). A Grade for Artificial Intelligence: A study on school teachers' ability to identify assignments written by generative artificial intelligence. *Cyberpsychology Behavior and Social Networking*, 28(7), 489–496. <https://doi.org/10.1089/cyber.2024.0524>
- Çelenk, S., & Büyükahıska, D. (2025, September). An Examination of The Artificial Intelligence Self-Efficacy of Foreign Language Teachers: Sample Of K12 Education. *Full Text Proceedings Book. IX. International Academic Studies Congress Spring 2025*. <https://doi.org/10.71284/Asc.2025153>

- Celik, I. (2022). Towards Intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education. *Computers in Human Behavior*, 138, 107468. <https://doi.org/10.1016/j.chb.2022.107468>
- Chiu, T. K. F., Ahmad, Z., & Çoban, M. (2024). Development and validation of teacher artificial intelligence (AI) competence self-efficacy (TAICS) scale. *Education and Information Technologies*, 30(5), 6667–6685. <https://doi.org/10.1007/s10639-024-13094-z>
- Dayagbil, F. T., Boholano, H. B., & Sumalinog, G. G. (2025). Are they in or out? Exploring pre-service teachers' knowledge, perceptions, and experiences regarding artificial intelligence (AI) in teaching and learning. *Frontiers in Education*, 10. <https://doi.org/10.3389/feduc.2025.1665205>
- Ding, L., Kim, S., & Allday, R. A. (2024). Development of an AI literacy assessment for non-technical individuals: What do teachers know? *Contemporary Educational Technology*, 16(3), ep512. <https://doi.org/10.30935/cedtech/14619>
- Hasin, H., Jamil, A., Mahat, Z., Sehat, R., & Fauzihardani, E. (2025). The Role of AI-Assisted Learning Tools in Higher Education: Balancing Efficiency, Critical Thinking and Academic Integrity. *Journal of Social and Development Sciences*, 15(1(S)), 36–46. [https://doi.org/10.22610/jsds.v15i1\(s\).4462](https://doi.org/10.22610/jsds.v15i1(s).4462)
- Hava, K., & Babayiğit, Ö. (2024). Exploring the relationship between teachers' competencies in AI-TPACK and digital proficiency. *Education and Information Technologies*, 30(3), 3491–3508. <https://doi.org/10.1007/s10639-024-12939-x>
- Huynh, L., Le, Tam. H., Dang, B., An, B. T., Vu, C. T., & Nguyen, A. (2025). Mindset matters: Fostering teachers' responsible AI use through professional development. *Journal of New Approaches in Educational Research*, 14(1). <https://doi.org/10.1007/s44322-025-00043-y>
- Leonillo, R. (2025). AI-Assisted Education: An Investigation into its Perceived Effects on Teacher Efficiency and Student Performance. *Psychology and Education: A Multidisciplinary Journal*, 35(2), 103–109. <https://doi.org/10.70838/pemj.350201>
- Moussa, N., Bentoumi, R., & Saali, T. (2023). Promoting Student Success with Neutrosophic Sets: Artificial Intelligence and Student Engagement in Higher Education Context. *International Journal of Neutrosophic Science*, 23(1), 238–248. <https://doi.org/10.54216/ijns.230121>
- Mudgal, H. P. A. (2024). AI (Artificial Intelligence) integration in education: Teachers' perspectives, professional development and policy recommendations. *Journal of Information Systems Engineering & Management*, 9(4s), 138–145. <https://doi.org/10.52783/jisem.v9i4s.10602>
- Nikolopoulou, K. (2024). Generative Artificial Intelligence in Higher Education: Exploring Ways of Harnessing Pedagogical Practices with the Assistance of ChatGPT. *International Journal of Changes in Education*, 1(2), 103–111. <https://doi.org/10.47852/bonviewijce42022489>
- Purwati, H., Rahmawansyah, R., & Nugroho, A. P. (2026). EFL Teacher's Perspectives on Integrating AI into Reading Comprehension Teaching in Papua. *ETERNAL (English Teaching Journal)*, 7(1), 72–83. <https://doi.org/10.26877/eternal.v7i1.2917>
- Rad, H. S. (2025). Reinforcing L2 reading comprehension through artificial intelligence intervention: refining engagement to foster self-regulated learning. *Smart Learning Environments*, 12(1). <https://doi.org/10.1186/s40561-025-00377-2>
- Rashed, T., Kashada, A., & Alfared, R. A. (2026). The Impact of AI on Critical Thinking and

- Problem-Solving on Student Skills in Higher Education: an Empirical study. *International Science and Technology Journal*, 38(1), 1–16. <https://doi.org/10.62341/darc1943>
- Ren, X., & Wu, M. L. (2025). Examining Teaching Competencies and Challenges While Integrating Artificial Intelligence in Higher Education. *TechTrends*, 69(3), 519–538. <https://doi.org/10.1007/s11528-025-01055-3>
- Roshan, S., Zaffar Iqbal, S., & Qing, Z. (2024). Teacher Training and Professional Development for Implementing AI-Based Educational Tools. *Journal of Asian Development Studies*, 13(2), 1972–1987. <https://doi.org/10.62345/jads.2024.13.2.154>
- Sadaf, A., Maxwell, D., Küplüce, C., & Holz, H. (2025). Relationship between pre-service teachers' perceived competencies, affective dispositions, and readiness to use artificial intelligence: A study informed by the intelligent-TPACK. *Computers and Education Open*, 9, 100305. <https://doi.org/10.1016/j.caeo.2025.100305>
- Sharmin, L., Kalima, R., Imran, M., Chauca, M., & Balladares, J. (2026). Teachers' perceptions of AI in supporting students' learning within a globally diverse digital settings. *Discover Education*, 5(1). <https://doi.org/10.1007/s44217-025-01089-y>
- Sibug, V. B., Vital, V. P., Miranda, J. P. P., Fernando, E. Q., Gamboa, A. B., Hernandez, H. E., Bansil, J. A., Penecilla, E. M., & Gonzales, D. D. (2024). Teachers' Perspectives on Integrating AI tools in Classrooms: Insights from the Philippines. *International Conference on Computers in Education*. <https://doi.org/10.58459/icce.2024.4964>
- Singhachotsukpat, R., Thiangtham, K., Wilepana, C., Yaemsawat, N., Sisaeng, P., Songkram, N., & Khlaisang, J. (2025). How Critical Thinking Shapes Student Engagement with AI Tools to Foster Self-Directed Learning. *IEEE Xplore Logo*, 1–8. <https://doi.org/10.1109/ictaect67351.2025.11391283>
- Surendhranatha Reddy, C., & Leelavathi, R. (2025). Reimagining classroom dynamics: the impact of AI-teacher collaboration on student engagement in higher education. *International Journal of Educational Management*, 1–18. <https://doi.org/10.1108/ijem-12-2024-0843>
- Tan, X., Cheng, G., & Ling, M. H. (2025). Investigating the mediating role of TPACK on teachers' AI competency and their teaching performance in higher education. *Computers and Education: Artificial Intelligence*, 9, 100461. <https://doi.org/10.1016/j.caeai.2025.100461>
- Tanvir, A., Bashir, S., & Shahzadi, S. (2024). Exploring the Role of Artificial Intelligence in Enhancing Teachers' Competencies: A Comprehensive Review. *Global Social Sciences Review*, IX(IV), 115–123. <https://doi.org/10.31703/gssr.20>

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