教學中人工智慧應用的系統性障礙：以東臺灣學校教師為對象的混合方法研究

黃振豊、*柯佳伶

國立臺東大學教育學系

*teach576@mail.tscvs.ttct.edu.tw

摘要

在教育領域日益重視人工智慧（AI）的背景下，AI 於課堂教學的實質運用仍有限，特別是在東臺灣地區。本研究採用匯聚式混合方法設計，結合主題分析與推論統計，探討教師在教學中採用 AI 工具時所面臨的障礙。研究對象為東臺灣 121 位在職教師，分析結果歸納出六項主要障礙：AI 素養不足、教學法不契合、對學生學習之負面影響的預期、學校制度與資源支持不足、情感抗拒，以及倫理疑慮。卡方檢定顯示，教師的人口與專業背景（性別、學歷、教學年資、AI 能力程度）與其陳述的障礙間皆無顯著差異，顯示此問題具系統性而非個別特質所致。研究結果點出推動 AI 融入教學需從系統面著手，包括提供明確的專業發展課程、加強倫理與負責任 AI 的訓練、以及完善學校層級的基礎建設與支持。本研究之發現對教育決策者、學校行政人員與師資培育機構具有重要參考價值，有助於推動更有效且具公平性的 AI 教育應用。

關鍵詞：人工智慧教育、教師 AI 素養、科技融入障礙、混合方法研究、東臺灣

Systemic Barriers to Artificial Intelligence Integration in Teaching: A Mixed-Methods Study of Teachers in Eastern Taiwan

Chen-Li Huang, *Chia-Ling Ko

Department of Education, National Taitung University

Abstract

Integrating artificial intelligence (AI) into teaching remains a significant challenge in many educational contexts, including Eastern Taiwan. This study examines the barriers that prevent teachers from incorporating AI tools into their instructional practices using a convergent mixed-methods design that combines thematic analysis with inferential statistics. Data were collected from 121 in-service teachers in Eastern Taiwan to explore both qualitative perspectives and quantitative patterns. Six major barriers emerged: lack of AI competency, pedagogical misalignment, perceived negative effects on student learning, insufficient institutional and resource support, emotional resistance, and ethical concerns. Chi-square tests revealed no statistically significant associations between teachers' demographic or professional characteristics—including gender, educational degree, teaching experience and AI competency level—and the identified barriers, suggesting that these challenges are systemic rather than attributable to individual characteristics. These findings underscore the need for comprehensive strategies, including targeted professional development, training in the ethical and responsible use of AI, and strengthened school-level infrastructure support, to enable meaningful and equitable AI integration in schools. The study provides timely insights for policymakers, school administrators, and teacher education programs seeking to advance AI readiness in Taiwan's education system.

Keywords: Artificial Intelligence in education, Teacher AI competency, Technology integration barriers, Mixed-methods study, Eastern Taiwan

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Corresponding author: .C-L. Ko, Department of Education, National Taitung University, Taitung 950309, Taiwan.

I. Introduction

1. Background

Artificial Intelligence (AI) has emerged as a transformative force in contemporary education (Jain et al., 2025; Kavitha & Joshith, 2024), significantly reshaping teaching methodologies and learning processes (Karataş et al., 2025; Holmes et al., 2019; Makarenko et al., 2024; UNESCO, 2021). Educational institutions around the world increasingly recognize AI's potential to personalize learning (Zohuri & Mossavar-Rahmani, 2024), streamline routine administrative work (Parycek et al., 2024), and enhance learning outcomes through intelligent adaptive systems (Esakkiammal & Kasturi, 2024; Luckin et al., 2016; OECD, 2021).

Despite these rapid developments, the successful integration of AI in education depends heavily on teachers' competencies and their readiness to employ innovative instructional practices (Hattie & Timperley, 2007; Mishra & Koehler, 2006; Rajapakse et al., 2024; Zou et al., 2025). International organizations such as UNESCO and OECD have emphasized the importance of AI literacy for educators, advocating for systematic and accessible professional development to support equitable and effective AI adoption in diverse contexts (Mutawa & Sruthi, 2025; OECD, 2021; UNESCO, 2019, 2024a, 2024b). Effective use of AI in teaching not only improves instructional quality but also aligns with Sustainable Development Goal 4, which calls for inclusive and equitable quality education and lifelong learning opportunities for all (United Nations, 2015).

2. Problem Statement

Although interest in using AI for educational purposes continues to grow, its practical implementation in classrooms remains relatively limited (Huang et al., 2025; Lin & Chen, 2024; Selwyn, 2019). Numerous studies have identified a variety of barriers—ranging from technical challenges and insufficient institutional support to pedagogical and ethical concerns—that contribute to teachers' hesitancy toward AI adoption (Ertmer & Ottenbreit-Leftwich, 2013; Filiz et al., 2024; Howard & Mozejko, 2015).

In Taiwan, despite the existence of a strong technological infrastructure and ongoing government initiatives to promote digital learning, the integration of AI into classroom instruction remains inconsistent and sporadic (Kuo et al., 2024; Wong et al., 2024). Identifying the reasons behind this gap between interest and practice is essential for designing targeted interventions and professional development models to support teachers in meaningfully incorporating AI tools into their teaching (Huang et al., 2025).

3. Purpose of the Study

This mixed-methods study aims to investigate the specific barriers preventing school teachers in Eastern Taiwan from adopting AI technologies in their teaching practices. The study seeks to understand both teachers' personal perceptions of AI-related challenges and whether demographic or professional characteristics influence their reported barriers.

4. Research Questions

This study addresses the following research questions:

RQ1: What are the perceived barriers preventing teachers from integrating AI into their teaching practices?

RQ2: Are there significant associations between teachers' demographic or professional characteristics (gender, academic degree, career stage, AI competency level) and their reported barriers to AI use?

II. Literature Review

1. Technology Adoption in Education

The integration of technology into educational settings has long been shaped by a combination of first-order and second-order barriers. First-order barriers refer to structural and resource-related challenges such as inadequate infrastructure, insufficient access to devices, and limited technical support (Ertmer, 1999; Ertmer & Ottenbreit-Leftwich, 2010; Kokoç, 2024). These barriers are often more visible and can be mitigated through policy initiatives, funding, and administrative action. In contrast, second-order barriers encompass teachers' beliefs, attitudes, and resistance to pedagogical change, representing deeper and more persistent obstacles to effective technology integration (Howard et al., 2015). Because these internal barriers are rooted in values and instructional preferences, they are more difficult to address and require sustained professional development and institutional support.

With the emergence of artificial intelligence (AI), new layers of complexity have been added to the technological landscape. AI integration introduces ethical considerations such as transparency and fairness (Youssef et al., 2024), the need for pedagogically aligned implementation (AlAli & Wardat, 2024), and heightened expectations for teachers' digital competencies (Luckin et al., 2016; Selwyn, 2019). Unique AI-related barriers also include data privacy concerns (Yadav & Ansari, 2025), risks associated with data protection (Ivchyk, 2024), and biases embedded in AI algorithms that may influence instructional decision-making (Holmes et al., 2019). Collectively, these challenges highlight the need for educators to be equipped not only with technological skills but also with the ability to engage critically with AI systems and their implications for teaching and learning.

2. AI Literacy and Teacher Readiness

As AI becomes increasingly embedded in educational contexts, teacher AI literacy has emerged as a foundational requirement for responsible and effective AI-supported teaching. AI literacy extends beyond traditional digital skills, encompassing conceptual understanding of AI, awareness of ethical and legal considerations, and the pedagogical capacity to meaningfully integrate AI tools into instruction (Zou et al., 2025). UNESCO's Digital Competency Framework underscores the importance of developing teachers' capacity to utilize digital tools effectively in their pedagogical practices (UNESCO, 2018). Additionally, UNESCO (2024b) emphasizes AI competency as essential for enabling educators to navigate evolving digital ecosystems, uphold ethical standards, and ensure data protection.

Teachers with higher AI literacy demonstrate greater readiness to incorporate AI tools into lesson planning, formative assessment, and feedback processes (Kohnke et al., 2025; Zhang & Zhang, 2024). However, despite these promising trends, a gap persists between familiarity with technology and pedagogical application. This gap reinforces the importance of targeted professional development grounded in frameworks such as TPACK and UNESCO's AI Competency Framework (Mutawa & Sruthi, 2025), which highlight the need to integrate technology, pedagogy, content, and knowledge holistically (Mishra & Koehler, 2006). Without sufficient AI literacy, teachers may feel unprepared to interpret AI-generated outputs or confront issues related to fairness, bias, and student overreliance on automated systems (Liu, 2025).

Prior research reveals notable variability in teachers' attitudes and readiness toward AI, shaped by individual experiences, perceptions of usefulness, and the degree of institutional support available (Howard & Mozejko, 2015; Liu, 2025; OECD, 2021). Teachers with stronger digital literacy tend to be more confident and proactive in using AI technologies, underscoring the need for ongoing professional learning opportunities (Huang et al., 2025; Kohnke et al., 2025; Luckin et al., 2016). Therefore, cultivating AI literacy is a strategic priority for promoting ethical, meaningful, and equitable AI integration in contemporary classrooms.

3. Research Gap

Although interest in AI integration continues to grow, existing research often examines either qualitative perspectives on teacher attitudes or quantitative assessments of adoption barriers in isolation. Few studies adopt a comprehensive mixed-methods approach capable of capturing the multifaceted nature of teachers' experiences with AI in classroom settings. This lack of integrated research limits understanding of how diverse barriers interact to shape AI adoption (Creswell & Plano Clark, 2018; Zhou et al., 2024). Consequently, there is a clear need for studies that combine qualitative insights with robust statistical analyses to explore the complex factors influencing teachers' resistance to or acceptance of AI in educational environments. Addressing this gap will strengthen the evidence base for designing effective professional development, policy interventions, and institutional support structures.

III. Research Method

1. Research Design

This study employed a convergent parallel mixed-methods design (Creswell & Plano Clark, 2018), integrating qualitative thematic analysis with quantitative inferential statistics to obtain a comprehensive understanding of the barriers teachers face in adopting AI tools. This design was chosen because it enables the simultaneous collection and analysis of qualitative and quantitative data, allowing different forms of evidence to complement one another and strengthen the overall interpretation (Tashakkori & Teddlie, 2010).

A convergent design was particularly appropriate for this study because the two research questions required both an exploratory qualitative understanding of teachers' perceived barriers and a quantitative examination of whether such barriers differed across demographic groups. Collecting both strands concurrently allowed the qualitative themes to explain the meanings behind the barriers, while the quantitative results tested potential subgroup patterns. Integrating the two strands during interpretation provided a more holistic and valid understanding of the systemic nature of AI adoption challenges (Creswell & Plano Clark, 2018).

Qualitative data were collected through open-ended responses, offering rich insights into teachers' subjective experiences and perceptions. In parallel, quantitative analyses using descriptive statistics and Chi-square tests identified associations among categorical variables. The integration of both strands yields methodological triangulation, enhancing the validity of findings and providing a multi-dimensional perspective on teachers' AI adoption challenges (Creswell & Plano Clark, 2018).

2. Participants

A total of 121 in-service teachers from various educational institutions in Eastern Taiwan participated in this study through convenience sampling. The sample included diverse demographic and professional backgrounds to capture a broad range of perspectives: (1) Gender–79 female (65.29%) and 42 male (34.71%); (2) Academic qualifications–75 university degree holders (61.98%) and 46 master's degree holders (38.02%); (3) Career stages–Novice teachers (49, 40.50%), developing teachers (33, 27.27%), and expert teachers (39, 32.23%); and (4) Self-reported AI competency– Basic AI competency (100, 82.64%), advanced AI competency (12, 9.92%), and no AI competency (9, 7.44%).

Ethical protocols were rigorously followed. Participant anonymity was ensured, and informed consent was obtained in accordance with the ethical guidelines established by the British Educational Research Association (BERA, 2018).

3. Data Collection

Data were collected through a single open-ended survey question administered via Google Forms: "Why don't you use AI tools in your teaching?” This format allowed participants to freely articulate their perspectives, yielding detailed qualitative responses suitable for exploratory research (Patton, 2015). Additionally, demographic variables—including gender, degree, career stage, and self-reported AI competency—were collected to support subsequent quantitative analysis.

4 Data Analysis

Qualitative Analysis: The qualitative responses underwent thematic analysis following Braun and Clarke’s (2006) guidelines, involving a rigorous and iterative coding process: (a) familiarization with data and initial code generation, (b) code categorization into themes, (c) review and refinement of themes, and theme naming and definition. This method identified six major themes: Lack of AI Competency, Pedagogical Misalignment, Negative Effect, Insufficient Support, Emotional Resistance, and Ethics Concern. Each theme was substantiated with direct quotations from participants, preserving authenticity and depth of insight.

Quantitative Analysis: Quantitative analysis comprised descriptive statistics to summarize demographic data and thematic frequencies, along with Chi-square tests to investigate associations between teachers’ demographics and their stated barriers to AI integration. The Chi-square test, a robust non-parametric method, was used due to its appropriateness for analyzing categorical data relationships (Field, 2013). A significance threshold was set at $p < .05$.

5. Trustworthiness and Rigor

Qualitative rigor was ensured through investigator triangulation, with coding independently reviewed by two researchers, and discrepancies resolved via consensus (Nowell et al., 2017). Quantitative analyses conducted using Python in Google Colab Notebooks underwent verification to maintain accuracy and reliability, further reinforcing the validity and trustworthiness of the mixed-methods approach (Creswell & Plano Clark, 2018).

IV. Research Results

1. Qualitative Analysis Results

To explore why school teachers refrain from incorporating AI tools into their teaching practices, a thematic analysis was conducted using responses from 121 participants. The findings revealed six overarching themes, each comprising several categories. These themes reflect a broad spectrum of technical, pedagogical, emotional, and ethical concerns. Representative quotations from participants are provided to illustrate each theme (See Table 1).

(1) Lack of AI Competency

The most frequently reported barrier to AI integration was a lack of competency in using AI tools. Within this theme, unfamiliarity with AI (Category 11) was especially prevalent. Participants commonly stated that they "can't use it" (Participant 100) or were “unfamiliar with how to use it” (Participant 12). Others admitted they "don't know how to apply it" (Participant 13) and found it “not easy to get started” (Participant 77). These responses reveal a significant technical barrier stemming from limited exposure and confidence in using AI in the classroom.

In addition, some participants cited a lack of training opportunities (Category 12), pointing to a gap in professional development. For instance, one participant remarked, “Hasn't learned AI skills” (Participant 28), while another noted the absence of “practical examples of application in teaching for reference” (Participant 63).

Further responses demonstrated misunderstandings about AI (Category 13), such as conflating unfamiliarity with unsuitability: “Hasn't been exposed to AI tools, leading to the belief that AI is not suitable for teaching” (Participant 34). This suggests that misconceptions may hinder some teachers’ openness to experimentation or innovation with AI tools.

Table 1
The Theme and Category Distribution of Why Not Use AI

Six Themes	Categories	Times	Percentages	Ranking
1 Lack of AI Competency		56	46.28	Top 1 Theme
	11 Unfamiliar	51	61.71	1
	12 Lack of Training	3	3.63	
	13 Misunderstanding	2	2.42	
2 Pedagogical Misalignment		8	6.62	
	21 Learners Misaligned	3	3.63	
	22 Learning Content Misaligned	2	2.42	
	23 Subject Misaligned	3	3.63	
3 Negative Effect		13	10.74	
	31 Over Reliance	7	8.47	3
	32 Losing Competency	7	8.47	3
	33 Digital Discipline	3	3.63	
4 Insufficient Support		16	13.22	Top 2 Theme
	41 Infrastructure	0	0	
	42 Resources	4	4.84	
	43 Time	12	19.36	2
5 Emotional Resistance		10		
	51 Lack of Motivation	2	2.42	
	52 Preference	5	6.05	6
	53 Digital Resistance	3	3.63	
6 Ethics Concern		14	8.26	Top 3 Theme
	61 Inaccuracy	3	3.63	
	62 Dehumanization	7	8.47	3
	63 Misuse	4	4.84	

(2) Pedagogical Misalignment

Some teachers expressed skepticism about the relevance or suitability of AI tools in their particular educational contexts. This theme of pedagogical misalignment includes issues related to learner characteristics (Category 21), content appropriateness (Category 22), and subject matter fit (Category 23). For example, a preschool teacher stated, "Preschool children should focus on family and life education, without excessive AI intervention" (Participant 47). Others believed AI was "not helpful for improving basic skills and techniques that require constant practice" (Participant 102) or "not applicable to certain performing arts" (Participant 60).

(3) Negative Effect

Teachers also voiced concerns about the negative consequences of AI on students' learning processes and skill development. A prominent concern was student overreliance on AI (Category 31), which could undermine independent thinking and core skills. One teacher observed, "Students will always want to use AI to solve problems" (Participant 2), and another warned, "Tool application and basic literacy and numeracy are intertwined; students may become overly reliant and lack self-production practice” (Participant 30).

The potential for decline in essential learning competencies (Category 32), such as creativity, oral expression, and critical thinking, was another concern. For instance, one participant stated, “Afraid that students will lack creativity” (Participant 113), while another expressed, “The thinking skills required for learning cannot be fully developed when using AI” (Participant 80).

Teachers also noted digital discipline issues (Category 33), fearing distractions or improper use of technology: “Students may secretly play games or not participate in class” (Participant 23).

(4) Insufficient Support

This theme encompasses the lack of institutional support needed to facilitate AI integration. Participants cited infrastructure limitations (Category 42), including “lack of school hardware” (Participant 24) and the challenge that “student use requires devices (no time to solve equipment problems)” (Participant 104).

Additionally, many teachers highlighted time constraints (Category 43) as a barrier. One participant noted, “Learning new tools takes time, but teachers don't have much time to learn new knowledge” (Participant 116). Another explained, “Not enough time to become proficient and verify that AI can improve student learning effectiveness” (Participant 70). These structural constraints suggest a need for administrative support, time allocation, and access to streamlined training.

(5) Emotional Resistance

Some teachers revealed emotional or psychological resistance to adopting AI, particularly those less comfortable with technology. This theme includes low motivation (Category 51), such as that expressed by one participant: “There is a lower willingness to try incorporating new information like computers and internet technology into teaching” (Participant 29).

Other responses reflected a preference for traditional methods (Category 52): “Used to the old successful models” (Participant 53). A few teachers demonstrated digital resistance (Category 53), citing “fear of change” (Participant 99) and “worry about learning new knowledge” (Participant 42).

(6) Ethics Concern

The final theme involved ethical concerns regarding AI use in educational contexts. Some participants raised issues about inaccuracy in AI-generated information (Category 61), stating, “The information may be incorrect or false” (Participant 120).

Concerns about dehumanization and loss of interpersonal connection (Category 62) were also prominent. One participant remarked, “AI leads to loss of educational essence and teaching warmth” (Participant 85), while another feared students might “forget proper etiquette over time” (Participant 94).

Lastly, the theme of misuse (Category 63) emerged, particularly around plagiarism and privacy: “Students therefore copy and plagiarize to deal with learning tasks” (Participant 91) and “Worried about the misuse of personal data” (Participant 51).

2. Descriptive Results

To contextualize the qualitative findings, descriptive statistical analyses were conducted to summarize the demographic and professional characteristics of the 121 participating teachers, along with the primary themes identified as reasons for not using AI tools in their teaching practice. The demographic distributions are listed in table 2.

Table 2

Distribution of Gender, Degree, Career Stage, and AI Competency level

Demographic	Character	Times	Percentage
Gender	Female	79	65.29%
	Male	42	34.71%
Degree Level	Bachelor	75	61.98%
	Graduates	46	38.02%
Career Stage	Novice	49	40.50%
	Developing	33	27.27%
	Expert	39	32.23%
AI Competency Level	Non	9	7.44%
	Basic	100	82.64%
	Advanced	12	9.92%

(1) Gender Distribution

Among the respondents, 65.29% were female (n = 79) and 34.71% were male (n = 42). This gender distribution reflects the typical demographic pattern of the teaching workforce in Taiwan. The predominance of female participants may also intersect with broader trends in technology adoption, where prior research suggests gender-based differences in technological acceptance and digital self-efficacy.

(2) Academic Qualifications

In terms of educational attainment, 61.98% of teachers held a university degree (n = 75), while 38.02% had obtained a master's degree (n = 46). Although the sample is generally well-educated, the qualitative data indicate that higher academic qualifications do not necessarily translate into higher AI competency. This gap highlights the distinction between formal education and digital literacy, especially regarding emerging technologies like AI.

(3) Career Stage

Participants represented a range of professional experience levels. Novice teachers accounted for the largest group at 40.50% (n = 49), followed by expert teachers at 32.23% (n = 39), and developing teachers at 27.27% (n = 33). This spread allows for an inclusive understanding of how teachers across the career spectrum perceive and respond to AI integration.

(4) AI Competency Levels

The majority of participants self-identified as having basic AI competency (82.64%, n = 100). A smaller portion reported advanced AI competency (9.92%, n = 12), while 7.44% (n = 9) indicated they had no AI competency at all. Despite this relatively high level of basic familiarity, the qualitative findings suggest that teachers often lack the confidence or pedagogical strategies needed to apply AI meaningfully in the classroom. This gap points to a critical need for more practical, instructional AI training.

(5) Primary Reasons for Not Using AI Tools

When responses were categorized into thematic codes(See Table 1), the most frequently cited reason for not using AI was Lack of AI Competency (n = 56, 46.28%). This theme encapsulates unfamiliarity, limited training, and misunderstandings regarding AI functions and applications.

Other reported reasons included: Negative Effect (n = 17, 14.05%), reflecting concerns about overreliance on AI, reduced student creativity, and loss of critical skills. Insufficient Support (n = 15, 12.40%), including inadequate infrastructure, limited resources, and time constraints. Ethics Concern (n = 14, 11.57%), addressing worries about misinformation, dehumanization, and student misuse of AI. Emotional Resistance (n = 11, 9.09%), often stemming from discomfort with technology or resistance to pedagogical change. Pedagogical Misalignment (n = 8, 6.61%), referring to perceived incompatibility between AI tools and specific subjects, student groups, or curriculum goals.

These descriptive results confirm that resistance to AI use is multi-dimensional, involving not only technical limitations but also emotional, ethical, and contextual considerations that span all teacher subgroups.

3. Inferential Statistics of Gender and Reasons for Not Using AI

To examine whether teachers' gender was associated with their stated reasons for not using AI tools in teaching, a cross-tabulation analysis was performed followed by a Chi-square test of independence.

Table 3 presents the distribution of reasons for not using AI tools, categorized by gender. Among female teachers (n = 79), the most frequently cited reason was Lack of AI Competency (n = 36), followed by Negative Effect (n = 13) and Insufficient Support (n = 9). Among male teachers (n = 42), Lack of AI Competency was also the most common reason (n = 20), with other categories reported less frequently.

A Chi-square test of independence was conducted to assess whether the observed distribution of reasons for not using AI differed significantly by gender. The result was not statistically significant, $\chi^2(5, N = 121) = 1.90, p = .8623$. This indicates that there is no significant association between teachers' gender and their reasons for not using AI tools in teaching.

Table 3

Distribution of Reasons for Not Using AI by Gender

Reason for Not Using AI	Female (n=79)	Male (n=42)
Lack of AI Competency	36	20
Pedagogical Misalignment	6	2
Negative Effect	13	4
Insufficient Support	9	6
Emotional Resistance	7	4
Ethics Concern	8	6

These findings suggest that gender does not meaningfully influence the types of barriers teachers experience regarding AI integration. Both male and female teachers most frequently cited a lack of AI competency, indicating that the need for professional development in AI literacy spans across gender lines.

4. Inferential Statistics of Degree and Reasons for Not Using AI

To determine whether teachers' academic degree level influenced their stated reasons for not incorporating AI tools into their teaching, a cross-tabulation analysis was conducted, followed by a Chi-square test of independence.

Table 2 displays the distribution of reasons for not using AI tools according to teachers' academic qualifications. Among participants with a university degree (n = 75), the most commonly reported reason was Lack of AI Competency (n = 33), followed by Insufficient Support (n = 12) and Negative Effect (n = 10). Teachers holding a master's degree (n = 46) also most frequently cited Lack of AI Competency (n = 23), followed by Negative Effect (n = 7) and Ethics Concern (n = 7).

Table 4

Distribution of Reasons for Not Using AI by Academic Degree

Reason for Not Using AI	University Degree	Master’s Degree
Lack of AI Competency	33	23
Pedagogical Misalignment	7	1
Negative Effect	10	7
Insufficient Support	12	3
Emotional Resistance	6	5
Ethics Concern	7	7

A Chi-square test of independence was performed to assess the relationship between degree level and reasons for not using AI. The result was not statistically significant, $\chi^2(5, N = 121) = 5.68$, $p = .3384$. This suggests that the distribution of reasons does not differ significantly between university and master's degree holders.

These results indicate that formal academic qualification does not significantly influence teachers’ reported barriers to AI use. Regardless of educational background, the most cited obstacle remained a lack of AI competency, reinforcing the need for targeted training that bridges both theoretical and applied digital literacy.

Here is the polished and academically enhanced version of Section 4.5: Inferential Statistics of Career Stage and Reasons for Not Using AI, following APA formatting and academic journal standards:

5. Inferential Statistics of Career Stage and Reasons for Not Using AI

To examine whether teachers’ career stage was associated with their stated reasons for not adopting AI in teaching, a cross-tabulation and Chi-square test of independence were conducted.

Table 5 presents the distribution of reasons for not using AI across three career stages: Novice Teachers ($n = 49$), Developing Teachers ($n = 33$), and Expert Teachers ($n = 39$). Across all groups, the most frequently cited reason was Lack of AI Competency, reported by novice ($n = 22$), expert ($n = 18$), and developing teachers ($n = 16$). Other reasons, such as Negative Effect, Insufficient Support, and Ethics Concern, were distributed relatively evenly among the career stages.

Table 5

Distribution of Reasons for Not Using AI by Career Stage

Reason for Not Using AI	Novice (n=49)	Developing (n=33)	Expert (n=39)
Lack of AI Competency	22	16	18
Pedagogical Misalignment	3	2	3
Negative Effect	6	5	6
Insufficient Support	6	5	4
Emotional Resistance	4	2	5
Ethics Concern	8	3	3

The Chi-square test of independence indicated that the association between career stage and reasons for not using AI was not statistically significant, $\chi^2(10, N = 121) = 3.31$, $p = .9731$. This suggests that the reasons teachers reported for not using AI were consistent across all career stages.

These findings demonstrate that barriers to AI integration are experienced uniformly, regardless of teachers’ level of experience. Whether novice, developing, or expert, teachers consistently cited a lack of AI competency as the principal reason for non-adoption. This highlights a system-wide need for structured AI training and support at all professional levels.

6. Inferential Statistics of AI Competency Level and Reasons for Not Using AI

To investigate whether teachers' self-reported AI competency level influenced their reasons for not using AI tools in teaching, a cross-tabulation and Chi-square test of independence were performed.

Table 6 presents the distribution of reasons for not using AI across three competency levels: No AI Competency (n = 9), Basic AI Competency (n = 100), and Advanced AI Competency (n = 12). Across all levels, the most frequently cited reason was Lack of AI Competency—reported by participants with basic (n = 43), advanced (n = 10), and even no AI competency (n = 3). Other reasons, such as Negative Effect and Insufficient Support, were more frequently noted by teachers with basic AI competency.

Table 6

Distribution of Reasons for Not Using AI by AI Competency Level

Reason for Not Using AI	No Competency (n=9)	Basic Competency (n=100)	Advanced Competency (n=12)
Lack of AI Competency	3	43	10
Pedagogical Misalignment	1	7	0
Negative Effect	2	14	1
Insufficient Support	1	14	0
Emotional Resistance	1	9	1
Ethics Concern	1	13	0

The Chi-square test revealed no statistically significant relationship between AI competency level and reasons for not using AI, $\chi^2(10, N = 121) = 9.24$, $p = .5095$. This indicates that self-perceived AI competency does not significantly affect the types of barriers teachers report when deciding not to use AI in the classroom.

Notably, even teachers with advanced AI competency cited "Lack of AI Competency" as a barrier. This paradox may reflect a distinction between technical knowledge and pedagogical application, or it may indicate a broader concern about institutional and contextual readiness. These findings reinforce the importance of comprehensive professional development that not only enhances technical proficiency but also supports effective, curriculum-aligned AI integration in practice.

V. Research Discussion

1. The Key Findings

This study identified several barriers that inhibit teachers from integrating AI into their instructional practice. Across all demographic groups, "Lack of AI Competency" emerged as the primary and most frequently cited barrier. This aligns with existing literature emphasizing that teachers require adequate digital literacy and systematic professional development to adopt technological innovations effectively (Huang et al., 2025; Mishra & Koehler, 2006; UNESCO, 2021, 2024b). Teachers' limited confidence, insufficient knowledge of AI, and difficulty applying AI tools pedagogically reflect a broader need for AI-related capacity-building in education.

Other key barriers included pedagogical misalignment, ethical concerns, insufficient institutional support, potential negative effects on students, and emotional resistance toward new technologies. These findings are consistent with theoretical frameworks distinguishing first-order barriers (external constraints) and second-order barriers (internal beliefs and attitudes) (Ertmer, 1999; Ertmer & Ottenbreit-Leftwich, 2010). Teachers in this study described both tangible obstacles—such as limited resources—and intangible ones, including entrenched pedagogical beliefs and reluctance to change familiar teaching practices.

Contrary to initial expectations, demographic and professional characteristics—including gender, degree, career stage, and AI competency level—did not significantly influence the types of barriers reported. This widespread uniformity echoes prior research suggesting that challenges related to technology integration are systemic rather than restricted to specific subgroups (Howard et al., 2015; Howard & Mozejko, 2015).

Importantly, this systemic pattern is significant in the Taiwanese context, where national digital education initiatives and the 12-Year Basic Education Curriculum guide teachers toward competency-based learning (Ministry of Education, 2019, 2022), yet uneven school resources and regional disparities—especially in Eastern Taiwan—continue to shape teachers' capacity to adopt emerging technologies (Huang et al., 2025).

Taken together, these findings highlight the ongoing need for comprehensive professional development, improved digital infrastructure, and sustained organizational support to reduce teachers' barriers and to bridge the gap between willingness and practice in AI adoption, as also emphasized by UNESCO (2024b).

2. Interpretation of Findings

The predominance of "Lack of AI Competency" across all teacher demographics aligns directly with the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006). Effective technology integration requires simultaneous mastery of technological, pedagogical, and content domains. The study's qualitative findings—especially those involving uncertainty about AI tools and pedagogical misalignment—indicate a significant TPACK gap for many teachers. This reinforces the importance of targeted professional development that emphasizes classroom application rather than solely technical knowledge. As Kohnke et al. (2025) and Zhang & Zhang (2024) argue, higher teacher AI competency supports more advanced and effective integration of AI into educational practices.

Teachers' concerns regarding pedagogical appropriateness, ethical risks, and data protection also align with global discussions on the responsible use of AI in education. UNESCO (2021) highlights the necessity of incorporating data privacy, algorithmic fairness, and ethical awareness into AI-related training programs. The findings of this study therefore support a dual focus in teacher preparation: developing both technical proficiency and ethical competence.

Additionally, insufficient institutional support and limited AI experiences appear to undermine teachers' confidence and perceived usefulness of AI. As noted by Liu (2025), teachers' engagement with AI tools directly influences their perceptions of AI's instructional value. Without opportunities for guided practice or supportive learning environments, even teachers with foundational AI knowledge may feel unprepared to integrate AI meaningfully.

Interestingly, even teachers who self-identified as having "advanced" AI competency still reported barriers related to insufficient knowledge. This pattern may reflect not only the gap between technical skill and pedagogical application but also a heightened awareness of AI's complexity, in which more experienced users become increasingly conscious of their own limitations—an interpretation consistent with psychological tendencies such as a reverse Dunning–Kruger effect or feelings resembling impostor syndrome (Dunning, 2011; Kruger & Dunning, 1999). Integrating this perspective provides a more nuanced understanding of why higher competency does not always translate into higher confidence in practice.

Furthermore, Taiwan's teacher professional development system—characterized by mandatory annual training hours, school-based workshops, and subject-based learning communities—tends to focus on digital tools rather than AI-specific pedagogical strategies. This may partially explain why even technologically capable teachers still experience uncertainty when applying AI tools in authentic classroom contexts.

In Eastern Taiwan, where schools often face smaller teaching staffs and fewer technology coaches compared with Western metropolitan regions, teachers may have fewer opportunities to engage in collaborative experimentation or peer-supported AI learning (Huang et al., 2025). This contextual factor deepens the interpretation that barriers are not only individual but structurally embedded in regional educational ecosystems.

The absence of significant demographic differences further suggests that barriers are deeply embedded within the broader educational ecosystem. Prior research similarly indicates that technology integration challenges are pervasive at the institutional level (Ertmer & Ottenbreit-Leftwich, 2010; Howard & Mozejko, 2015). System-wide approaches are therefore necessary to address these obstacles effectively, rather than relying solely on teacher-specific or subgroup-targeted interventions.

3. Practical Implications

The findings offer several implications for educational practice, policy, and teacher training: First, Strengthen Taiwan-Specific AI Professional Development: Educational administrators should design sustained, localized training programs aligned with Taiwan's 12-Year Basic Education Curriculum's emphasis on digital literacy and problem-solving competence (Ministry of Education, 2022). Workshops should contextualize AI tools for Mandarin-medium classrooms, Indigenous education, multi-grade teaching, and rural school needs—contexts highly relevant in Eastern Taiwan.

Second, Address Infrastructural and Institutional Barriers: Schools should invest in robust technological infrastructure, including adequate hardware, network capacity, and accessible AI tools. As Ertmer and Ottenbreit-Leftwich (2010) note, successful technology integration requires institutional cultures that value innovation and provide continuous support for teachers. UNESCO (2024b) similarly underscores the importance of ongoing professional development as a core dimension of teachers' AI competency.

Third, Integrate AI Ethics and Data Governance into Teacher Education: Given Taiwan's Ministry of Education initiatives on digital citizenship and data protection, AI ethics training should be embedded into pre-service and in-service teacher education. Clear guidelines regarding transparency, fairness, and student privacy will better support teachers' ethical decision-making.

Lastly, Foster Communities of Practice: Developing communities of practice can help reduce emotional resistance, encourage peer learning, and create a collaborative environment for exploring AI tools. As suggested by Howard & Mozejko (2015) and Kohnke et al. (2025), such communities can enhance teacher confidence and motivation, making AI integration more sustainable.

4. Limitations

This study presents several limitations that should be recognized: First, Convenience Sampling and Self-Selection Bias: The use of convenience sampling limits the generalizability of the findings to the broader teacher population in Taiwan. Additionally, the study is subject to self-selection bias, where teachers with strong positive or negative opinions regarding AI may have been more inclined to participate. This potential overrepresentation of extreme views could skew the perceived prevalence of specific barriers compared to the general teaching population.

Second, Reliance on Self-Reported Data and Question Framing: Self-reported responses may be susceptible to social desirability or recall bias. Furthermore, the use of a single, negatively framed open-ended question ("Why don't you use AI tools...") may have primed participants to focus exclusively on obstacles and deficits. This framing potentially limits the richness of the data by obscuring instances of partial adoption or the nuanced benefits teachers might perceive despite existing barriers.

Third, Cross-Sectional Design: The cross-sectional nature of this study restricts its ability to examine changes over time. Longitudinal approaches could provide deeper insights into how teacher perceptions and competencies evolve.

Fourth, Subjectivity in Qualitative Interpretation: Although investigator triangulation was employed, thematic analysis remains interpretive. Different researchers may derive slightly different themes or interpretations from the same qualitative data.

Fifth, Limited Consideration of Taiwanese Structural Factors: This study did not quantitatively analyze the influence of Taiwan's teacher training system, regional resource disparities, or curriculum policy implementation, which may shape AI integration readiness. Recognizing these limitations can guide the refinement of future research and improve the methodological rigor of studies on AI integration in education.

Sixth, Statistical Power Limitations: The sample size of 121 participants, while sufficient for exploratory analysis, may be underpowered to detect small-to-medium effect sizes in the Chi-square analyses. Consequently, the lack of statistically significant associations between demographic variables and reported barriers should be interpreted with caution, as it may reflect a Type II error rather than a definitive absence of relationship.

5. Recommendations for Future Research

Future research should build on the present findings by using more rigorous methodological approaches and broader sampling strategies. First, Conduct Longitudinal Studies: Longitudinal designs can track changes in teachers' AI adoption behaviors, competency development, and perceptions over time, providing more robust insights into how barriers shift and how interventions influence practice.

Second, Use Representative Sampling: Stratified or random sampling techniques can increase generalizability and help capture diverse teacher populations more accurately.

Third, Employ Mixed and Multi-Method Approaches: Combining surveys, interviews, classroom observations, and digital interaction logs can yield richer and more precise understandings of technology integration dynamics.

Fourth, Examine Taiwanese Curriculum, Policy, and Regional Factors: Future research should explore how Taiwan's national curriculum reforms, school resource allocations, and rural–urban differences influence AI adoption. Such contextual analyses will deepen the understanding of structural and regional influences on teachers' readiness.

Lastly, Conduct Comparative International Studies: Given the systemic nature of AI integration challenges, cross-national comparisons could help identify global trends and highlight policy approaches that support effective AI adoption across cultural and educational contexts.

VI. Conclusion

This study investigated the barriers teachers face in integrating AI into their instructional practices. Across all demographic groups, "Lack of AI Competency" consistently emerged as the most significant barrier. Participants also identified several additional obstacles, including pedagogical misalignment, ethical concerns, insufficient institutional support, perceived negative effects on student learning, and emotional resistance to adopting new technologies.

These findings underscore the multifaceted nature of technology integration in educational contexts. They align with theoretical frameworks highlighting the interplay between external barriers (such as resources and infrastructure) and internal barriers (such as beliefs, confidence, and attitudes). Notably, demographic characteristics—including gender, academic degree, career stage, and self-reported AI competency—did not significantly influence teachers' perceptions. This suggests that the challenges associated with AI adoption are systemic, affecting teachers broadly rather than specific subgroups.

From a practical standpoint, the results point to several key areas for improvement: targeted professional development that supports both AI technical skills and pedagogical integration, investment in educational infrastructure to ensure adequate tools, hardware, and digital resources, ethical training that addresses concerns related to data privacy, fairness, and responsible AI use, and supportive communities of practice that foster collaboration, reduce emotional resistance, and encourage shared problem-solving.

Future research directions proposed in this study aim to enhance methodological rigor and deepen understanding of AI integration in education. These include longitudinal studies to examine changes over time, representative sampling to increase generalizability, mixed-methods approaches for richer insights, comparative international analyses, and intervention-based studies to test practical solutions.

In conclusion, effectively overcoming the barriers to AI integration requires comprehensive, systemic strategies that address both the technical and human dimensions of technology adoption. Policymakers, educational leaders, and teachers must work collaboratively to cultivate environments that support AI-enhanced teaching. Such efforts have the potential to elevate instructional quality and improve student learning outcomes.

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