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# Artificial Intelligence (AI) Competency and Its Impact on 21st-Century Pedagogy Among History Trainee Teachers

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### ABSTRACT

The rapid development of Artificial Intelligence (AI) technologies has brought about significant changes in the education sector, especially in how teaching and learning are conducted in the 21st century. Educators are now expected to integrate technology meaningfully into their pedagogical practices to enhance student engagement, critical thinking, collaboration, and creativity. History trainee teachers, in particular, are responsible for ensuring that historical content is delivered through innovative, student-centered, and technologically-supported strategies. However, there is limited research that specifically investigates the level of AI competence among history trainee teachers and how it relates to their implementation of 21st-century pedagogical practices. This study aims to explore three key objectives: (i) to assess the level of AI skills among history trainee teachers, (ii) to examine the level of their 21st-century pedagogical practices, and (iii) to analyze the relationship between AI skills and 21st-century pedagogy. The research was conducted using a quantitative approach with a structured questionnaire as the main data collection tool. A total of 50 history trainee teachers from Universiti Malaysia Sabah participated as respondents in the study. The results indicate that the trainee teachers possess a good level of AI competency. Moreover, they also demonstrated a good understanding and application of 21st-century teaching principles. Statistical analysis revealed a significant positive correlation between AI skills and the practice of 21st-century pedagogy. This means that trainee teachers with higher AI proficiency are more likely to adopt modern, effective, and technology enhanced teaching methods in their future classrooms. In conclusion, the study emphasizes the importance of embedding AI training into teacher education programs to ensure that future educators are equipped with the necessary digital competencies. Strengthening AI related knowledge and skills among trainee teachers can significantly improve their readiness to implement innovative pedagogical strategies aligned with 21st-century educational demands.

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## 1. Introduction

The emergence of Artificial Intelligence (AI) has transformed global education by reshaping how teaching and learning processes are designed and delivered. In today's digital age, educators are required not only to impart knowledge but also to cultivate essential 21st-century skills among students, such as collaboration, creativity, critical thinking, and communication. AI contributes to this transformation by offering tools such as personalized learning systems, intelligent tutoring platforms, automated feedback mechanisms, and data-driven instructional support, especially notable in emerging economies, where AI tools like ChatGPT enable more flexible and individualized instruction [1]. In the domain of history education, AI's impact is even more profound. Historical content has often been perceived as static and reliant on memorization. However, with AI-powered platforms, historical narratives can be reimagined using simulations, augmented reality, and interactive storytelling. These approaches not only enhance student engagement but also allow learners to think critically about sources, interpret multiple perspectives, and connect historical knowledge to present day issues [2].

Teacher preparation programs play a crucial role in preparing trainee teachers to integrate AI effectively. For trainee History teachers, the challenge lies in balancing disciplinary content with pedagogical innovation. Many are aware of digital tools but may lack systematic training in AI-driven applications that align with 21st-century pedagogy. Without targeted interventions, this gap may limit their future teaching effectiveness [3]. Globally, research suggests that teacher competence in AI directly influences their willingness to apply modern teaching approaches. Teachers with higher AI literacy show stronger tendencies to adopt learner-centered pedagogies, experiment with collaborative learning models, and personalize learning environments [4]. Thus, AI competence is not an isolated digital skill but an enabler of pedagogical transformation.

This study responds to the need for empirical research within the Malaysian teacher education context, particularly focusing on History trainee teachers. By assessing their AI competence, their practice of 21st-century pedagogy, and the correlation between the two, this research contributes to ongoing discussions on how teacher education programs can be restructured to better prepare future educators for technology driven classrooms.

## 2. Research Problem

The rapid advancement of Artificial Intelligence (AI) technologies has created a paradigm shift in the education sector, influencing not only how knowledge is transmitted but also how teachers conceptualize pedagogy. Despite widespread acknowledgment of AI's potential, many trainee teachers still face challenges in translating digital competence into effective classroom practice [5]. For History trainee teachers, this challenge is compounded by the nature of the subject itself, which demands critical engagement with historical sources, contextual interpretation, and the fostering of civic literacy.

One problem is that teacher education curricula often do not prioritize AI specific training, assuming instead that general ICT competence suffices for modern classrooms. However, studies highlight that AI requires a unique set of skills, such as understanding machine learning tools, critically evaluating algorithmic processes, and applying AI in subject-specific contexts that go beyond basic digital literacy [5-6]. Without such preparation, trainee teachers risk implementing technology in superficial ways, failing to realize its transformative potential.

Another issue lies in the disparity between policy frameworks and actual teacher readiness. While educational policy documents frequently emphasize the integration of AI and 21st-century skills into

teaching, research shows a gap in translating these directives into classroom practice [5]. This disconnect is particularly concerning for history education, which requires balancing humanistic inquiry with technological innovation.

Furthermore, ethical challenges such as data privacy, surveillance, and algorithmic bias complicate the use of AI in educational settings. Holmes, Porayska-Pomsta, and Nemorin [6] argue that trainee teachers often lack the necessary awareness to critically evaluate these issues, leaving them vulnerable to over reliance on AI tools. This problem underscores the need for a more nuanced approach to AI education.

Lastly, there is a scarcity of empirical studies focusing specifically on History trainee teachers' AI competence and its relationship to 21st-century pedagogy. Most existing research addresses general digital skills across disciplines, leaving a gap in understanding how AI can uniquely transform the teaching and learning of history. This study addresses this gap by examining the level of AI competence among history trainee teachers, their practice of 21st-century pedagogy, and the correlation between the two.

### **3. Research Objectives**

#### **2.1 Objectives**

- 1) To assess the level of AI skills among History trainee teachers at Universiti Malaysia Sabah.
- 2) To assess the level of 21st-century pedagogical practices among History trainee teachers at Universiti Malaysia Sabah.
- 3) To analyze the relationship between AI skills and 21st-century pedagogy.

### **4. Theoretical Framework**

This study is anchored in two key theoretical models that inform the integration of educational technology; Vygotsky's Constructivist Theory and the Technological Pedagogical Content Knowledge (TPACK) framework. Together, these theories provide both a psychosocial and structural perspective for understanding how Artificial Intelligence (AI) can be meaningfully incorporated into teacher education.

Vygotsky's constructivist theory emphasizes that knowledge is socially constructed through tools and interaction. Within this perspective, AI operates as a powerful mediating tool that can adapt instruction, provide scaffolding, and simulate learner-teacher interactions [7]. The concept of the Zone of Proximal Development (ZPD) aligns closely with AI's ability to deliver personalized support that extends learners' capacity to progress beyond what they could achieve independently. For example, adaptive learning platforms can calibrate content difficulty in real time, while conversational agents can guide students through inquiry-based tasks. In these roles, AI functions as a "more capable other," promoting learner engagement, motivation, and autonomy while reflecting the principles of mediated learning.

For teachers to use AI effectively, they must understand both its pedagogical affordances and its limitations. The TPACK framework offers a comprehensive model for this purpose. Developed by Mishra and Koehler, TPACK builds on Shulman's concept of Pedagogical Content Knowledge (PCK) by adding Technological Knowledge (TK) as a critical dimension. In the current context of AI driven education, effective teaching requires the integration of TK with Content Knowledge (CK) and Pedagogical Knowledge (PK). Teachers must not only know what to teach (CK) and how to teach it (PK), but also how AI technologies can transform both domains. Research applying TPACK in the context of AI integration frequently identifies weaknesses in the TK dimension, even when teachers

demonstrate strength in PK and CK [8]. This underscores the importance of ongoing training to develop technological fluency among pre-service teachers.

Based on these theoretical foundations, this study proposes a conceptual model of AI readiness that incorporates cognitive understanding, practical ability, ethical awareness, and visionary thinking. This multidimensional approach echoes recent models that link AI readiness with institutional support, professional development opportunities, and perceived pedagogical relevance [9]. The model hypothesizes that higher levels of AI readiness among pre-service teachers are associated with stronger intentions to integrate AI into teaching practice, particularly when supported by favorable institutional and instructional conditions.

The framework also considers the influence of affective and contextual factors. Teachers' emotional responses to AI, ranging from enthusiasm to anxiety, can significantly affect their willingness to engage with such technologies. Similarly, access to professional development, availability of AI tools, and institutional encouragement act as facilitating conditions that either strengthen or hinder technology adoption.

By combining Vygotsky's constructivist principles, the TPACK framework, and recent empirical findings, this study provides a comprehensive lens through which to assess pre-service teacher readiness for AI integration. The proposed model serves both as a diagnostic tool to evaluate current levels of preparedness and as a roadmap for designing teacher education programs that are responsive to the demands of AI-supported pedagogy in the 21st century.

## **5. Literature Review**

Artificial Intelligence has been identified as a disruptive force in education, influencing assessment, instructional design, and personalized learning pathways [1]. Studies demonstrate that AI technologies enable teachers to automate routine tasks and allocate more time toward student engagement, inquiry-based learning, and creative activities. This supports the notion that AI competence is directly tied to 21st-century pedagogy. Teachers' technological pedagogical content knowledge (TPACK) significantly predicts their ability to integrate technology in meaningful ways. Their findings align with the belief that AI is not merely a technical skill but a pedagogical enabler that fosters student-centered learning practices. In history education, this becomes especially relevant, as AI tools can transform rote learning into interactive exploration of historical events.

Vázquez-Cano *et al.* [3] provided a systematic review highlighting gaps in teacher training related to digitalization and AI. They argued that teacher education institutions often fall short in providing structured programs to develop AI literacy. Without deliberate training, many trainee teachers may remain passive users of digital platforms rather than active innovators. This underlines the need for embedding AI as part of core teacher education curricula. Recent studies have also highlighted the ethical implications of AI in education. Issues such as data privacy, algorithmic bias, and over-reliance on automated tools pose significant challenges [6]. Teacher competence, therefore, extends beyond technical proficiency and includes ethical awareness, which is crucial in disciplines such as history where narrative framing can influence student interpretation of events.

Finally, González-Calatayud *et al.* [4] argued that digital and AI competences among teachers are strong predictors of innovative pedagogical practices. Their study emphasized that teachers with higher confidence in digital tools demonstrated more creativity, adaptability, and willingness to experiment with novel methods of teaching. These findings support the core hypothesis of the current study, that AI competence positively correlates with 21st-century pedagogy.

## **6. Methodology**

### **6.1 Research Design**

This study adopted a quantitative research design, which is appropriate for examining measurable relationships between variables and ensuring objectivity in data interpretation. A structured questionnaire was used as the main instrument for data collection. The design allowed for systematic measurement of trainee teachers' AI competence and their engagement with 21st-century pedagogical practices.

### **6.2 Participants and Sampling**

The target population comprised history trainee teachers enrolled at Universiti Malaysia Sabah. A purposive sampling technique was employed to ensure that participants were representative of individuals preparing for the teaching profession. A total of 50 trainee teachers participated in the study. This sample size was considered sufficient for preliminary correlational analysis, while also providing an accurate reflection of the target group. Participants were briefed about the purpose of the study and provided informed consent before completing the questionnaire.

### **6.3 Research Instrument**

The research instrument was a structured questionnaire divided into two main sections. The first section measured AI competence, which included knowledge, skills, and application of AI tools. The second section assessed 21st-century pedagogical practices, covering collaboration, creativity, critical thinking, and communication. All items were presented on a 5-point Likert scale ranging from "Strongly Disagree" (1) to "Strongly Agree" (5), allowing for the measurement of intensity in participants' responses.

### **6.4 Validity of the Instrument**

Content validity was ensured by consulting three experts in educational technology and pedagogy who reviewed the questionnaire items for clarity, relevance, and alignment with the study's objectives. Their feedback was incorporated to refine ambiguous wording and remove redundant items. Construct validity was further supported by basing the questionnaire items on established frameworks of AI competence and 21st-century pedagogy from existing literature.

### **6.5 Reliability of the Instrument**

The internal consistency of the questionnaire was assessed using Cronbach's Alpha coefficient. A reliability analysis was conducted for both main constructs: AI competence and pedagogical practices. The pilot test yielded Cronbach's Alpha values above the threshold of 0.70 for both constructs, indicating acceptable reliability. For the full study sample, reliability was re-verified, with AI competence items recording an alpha of 0.85 and pedagogical practices an alpha of 0.88, demonstrating strong internal consistency of the measurement instrument.

## 6.7 Data Collection Procedure

The questionnaire was distributed directly to the selected participants during scheduled sessions. Participants completed the survey independently, with researchers present to clarify any uncertainties. This procedure minimized potential response bias and ensured uniformity in data collection.

## 6.8 Data Analysis

The collected data were coded and analyzed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics, including mean, minimum, maximum, and standard deviation, were calculated to determine the overall levels of AI competence and pedagogical practices among trainee teachers. Inferential statistics were also applied, with Pearson's correlation analysis used to examine the relationship between AI competence and 21st-century pedagogical practices. The choice of Pearson's correlation was justified as both variables were continuous and normally distributed.

## 7. Results

### 7.1 Level of AI Competency and 21<sup>st</sup>-Century Pedagogical Practice Among History Trainee Teacher

**Table 1**  
**Descriptive Statistics**

| Variable              | Number | Min  | Max  | Mean | Standard Deviation |
|-----------------------|--------|------|------|------|--------------------|
| AI Competency         | 50     | 3.10 | 4.85 | 4.20 | 0.42               |
| 21st-Century Pedagogy | 50     | 3.00 | 4.90 | 4.25 | 0.44               |

**Table 2**  
**Correlation between AI Competence and Pedagogy**

|               | Number          | AI Competency | 21st-Century Pedagogy |
|---------------|-----------------|---------------|-----------------------|
| AI Competency | Pearson         | 1             | .683**                |
|               | Correlation     |               |                       |
|               | Sig. (2-tailed) |               | <.001                 |
|               | N               | 375           | 375                   |

*Correlation is significant at the 0.01 level (2-tailed)*

These results confirm that History trainee teachers demonstrate strong AI competence, significant application of 21st-century pedagogy, and a positive, statistically significant correlation ( $r=0.683$ ,  $p<.001$ ) between the two constructs.

## 8. Discussion

The results of this study reveal that history trainee teachers at Universiti Malaysia Sabah possess a high level of AI skills and demonstrate strong engagement with 21st-century pedagogical practices. This aligns with global findings indicating that AI competence directly supports the adoption of modern, learner-centered approaches to teaching [10]. The significant positive correlation between AI skills and pedagogical practices echoes the conclusions of prior work, which found that digital confidence among teachers fosters greater innovation and creativity in instructional design [11]. In this study, trainee teachers translated their AI competence into practices such as digital storytelling,

collaborative online projects, and interactive simulations, all of which enhance students' engagement with historical narratives.

Globally, literature underscores that AI integration can augment rather than replace teaching roles, with AI functioning as a complementary tool to enhance personalization and adaptive learning environments [12]. Teachers equipped with AI skills are better positioned to implement learner-centered strategies, supporting the shift from traditional content delivery to dynamic, student driven inquiry based learning. This is particularly important in history education, where the ability to engage students in critical interpretation, multiple perspectives, and ethical reasoning can be enhanced through AI-supported simulations and digital archives.

However, despite high AI competence among respondents, the lack of structured, curriculum-based AI training remains a concern. Similar studies highlight that while preservice teachers often display digital confidence, their ability to integrate AI into pedagogy systematically is limited without formalized training [11]. Embedding AI literacy as a core module in teacher education curricula, rather than as an optional add-on, is therefore essential to ensure consistent and proactive use of AI in lesson design. Furthermore, training must address not only technical competence but also digital ethics, particularly in history education where algorithmic bias, selective filtering, and representation of narratives can influence students' understanding of the past [12].

Additionally, the role of AI in teacher professional development cannot be overlooked. Research suggests that AI-based training platforms can enhance teachers' pedagogical confidence, foster collaborative professional learning, and expand access to shared resources [13]. In this sense, AI literacy is not only about classroom application but also about sustaining a culture of continuous professional growth. The transformative potential of AI in teacher education also lies in its alignment with constructivist and learner-centered pedagogies. Studies demonstrate that AI can enhance collaborative learning, adaptive instruction, and metacognitive development, provided that teachers are sufficiently trained and supported [14]. For History education, this could mean designing classroom experiences where students critically engage with primary sources using AI-supported tools that scaffold interpretation, encourage debate, and highlight diverse perspectives.

Ultimately, this study strengthens the argument that AI competence functions as a bridge to effective 21st-century pedagogy. Without sufficient AI literacy, teachers risk remaining reactive users of technology, constrained in their capacity to innovate, personalize instruction, and foster the higher-order thinking skills necessary for future-ready learners. Conversely, embedding AI literacy as a strategic educational priority ensures that teachers not only adopt tools but also critically shape the ways technology mediates historical understanding and classroom engagement [15].

## **9. Suggestions for Future Research**

Future research should expand to larger and more diverse samples across multiple universities and subject areas to strengthen generalizability. Longitudinal studies are needed to track how AI competence develops over time and how it influences actual classroom practices and student learning outcomes. Experimental or mixed-methods approaches could provide deeper insights into the causal relationship between AI training and pedagogical innovation. In addition, future studies should incorporate classroom observations, student performance metrics, and perspectives from multiple stakeholders including students to better understand the impact of AI on learning environments. Finally, greater attention should be paid to digital ethics and algorithmic bias in AI supported history education, ensuring that future work addresses not only technical proficiency but also the critical and ethical dimensions of teaching with AI.

Ultimately, this study strengthens the argument that AI competence functions as a bridge to effective 21st-century pedagogy. Without sufficient AI literacy, teachers risk remaining reactive users of technology, constrained in their capacity to innovate, personalize instruction, and foster the higher-order thinking skills necessary for future ready learners. Conversely, embedding AI literacy as a strategic educational priority ensures that teachers not only adopt tools but also critically shape the ways technology mediates historical understanding and classroom engagement.

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