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Artificial Intelligence Integration in Social Studies Education: A TPACK-based Analysis of Teachers' Awareness and a Proposed Link to Technology Acceptance

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Abstract

This study used the TPACK framework to analyze AI awareness among Social Studies teachers in AMAC secondary schools, Abuja, Nigeria, and proposes a link to the Technology Acceptance Model (TAM) for future research. A total of 325 teachers from public and private schools participated, covering nearly the entire estimated population of 350. Teachers completed a structured questionnaire (TAAITSSQ) measuring awareness across three TPACK domains: general technology knowledge (TK), content-specific technology knowledge (TCK), and pedagogical technology knowledge (TPK). The instrument was reliable ($\alpha = 0.85$). A repeated-measures ANOVA revealed significant differences across domains ($F[2, 648] = 312.45$, $p < .001$, $\eta^2 = 0.49$). Post-hoc tests showed a clear hierarchy: teachers scored highest on AI's pedagogical potential (TPK: $M = 3.90$), moderate on general technology awareness (TK: $M = 3.13$), and critically low on knowledge of AI tools tied to Social Studies content (TCK: $M = 2.36$). No significant difference emerged between public and private school teachers. These findings reveal a "hollow core" in teacher readiness. Teachers grasp generally why AI might help their teaching, but lack knowledge of which tools exist or how they connect to their subject. This TCK deficit is the main barrier between awareness and adoption. The study proposes a sequential TPACK-TAM model: low TCK likely suppresses perceived usefulness and raises anxiety about ease of use, blocking the move from knowledge to practice. Recommendations include TCK-focused workshops co-designed by AI specialists and Social Studies educators, and future research testing the full TPACK-TAM pathway through structural equation modelling.

Keywords: Artificial Intelligence (AI), Teacher Awareness, Social Studies Education, Nigeria, Secondary Education

Introduction

Artificial Intelligence (AI) has emerged as a transformative force in education, promising to redefine pedagogical practices through personalized learning, real-time feedback, and immersive instructional tools. Globally, teachers and policymakers are exploring AI's capacity to address diverse learner needs, streamline administrative tasks, and foster engagement (Baker et al., 2019)..

Yet, the adoption of these technologies remains uneven, particularly in regions grappling with infrastructural constraints, limited training opportunities, and disparities in digital literacy. In Nigeria, where educational innovation often contends with systemic challenges, understanding teachers' awareness of AI is a critical first step toward meaningful integration especially in subjects like Social Studies, which demand dynamic approaches to teaching complex sociopolitical and historical concepts.

Awareness, in this context, is not a monolithic construct. Grounded in the TPACK framework (Mishra & , 2006), it can be understood as a multi-dimensional phenomenon encompassing knowledge of technology in general (Technological Knowledge, TK), knowledge of technology's application to specific subject content (Technological Content Knowledge, TCK), and knowledge of technology's role in pedagogy (Technological Pedagogical Knowledge, TPK). Understanding the extent and nature of this multi-dimensional awareness permits a more precise identification of where the obstacles to AI integration lie. A teacher may have heard of AI (TK) and believe it can personalize learning (TPK) but remain unaware of how AI can be applied to teach historical causality or geographical spatial analysis (TCK). The existing literature lacks this level of specificity.

Social Studies education, with its focus on critical thinking, civic engagement, and interdisciplinary exploration, stands to gain significantly from AI-driven tools such as interactive simulations, data analytics platforms, and adaptive learning systems (Bower, 2019). These technologies can bring abstract concepts to life, enabling students to analyse historical events, model geographical processes, or engage with cultural narratives in innovative ways. However, the extent to which teachers recognize and leverage these opportunities depends on the specific dimensions of their AI awareness. While studies in technologically advanced contexts highlight growing enthusiasm for AI in education, there is limited empirical insight into the differentiated nature of AI awareness among teachers in resource-constrained environments.

This study focuses on secondary school Social Studies teachers in the Abuja Municipal Area Council (AMAC), Nigeria, a region which represents the country's urban-rural educational divide. Despite national policies advocating technology-driven education, practical implementation remains fragmented, often leaving teachers without the knowledge or tools to navigate emerging technologies. Preliminary evidence suggests that while Nigerian teachers may acknowledge AI's theoretical potential, their content-specific and practical awareness remains underdeveloped. This gap risks perpetuating a cycle where technological advancements fail to translate into classroom practices, ultimately disadvantaging students in an increasingly digital world.

The primary purpose of this study is to use the TPACK framework as a diagnostic instrument to map the specific dimensions of AI awareness among Social Studies teachers in AMAC. This diagnosis serves a dual purpose: first, to empirically identify the precise knowledge gaps that must be addressed for effective professional development; and second, to provide the foundational evidence for a proposed sequential model that links TPACK-based awareness to the Technology Acceptance Model (TAM). We argue that diagnosing awareness through the TPACK lens is an essential prerequisite to predicting technology acceptance.

This study was guided by two research questions and one hypothesis:

Research Questions:

1. What is the level of awareness of Artificial Intelligence (AI) among Social Studies teachers in AMAC secondary schools across the three TPACK domains of TK, TCK, and TPK?
2. Is there a significant difference in AI awareness among Social Studies teachers across the three TPACK domains (TK, TCK, and TPK)?

Hypothesis:

H_{O1}: There is no significant difference in AI awareness between teachers in public and private secondary schools in AMAC.

1. Literature Review

The integration of Artificial Intelligence (AI) into education has emerged as a transformative force, reshaping pedagogical practices and learning outcomes globally. This section synthesizes existing research on AI in education, focusing on teacher awareness, contextual challenges in developing nations, and subject-specific applications, with an emphasis on Social Studies in Nigeria.

2.1 Global Trends and AI Adoption in Education

Globally, AI is recognized for its capacity to personalize learning, automate administrative tasks, and enhance student engagement (Zawacki-Richter et al., 2019; Chen et al., 2023). Intelligent Tutoring Systems (ITS), adaptive learning platforms, and AI-driven analytics tools are increasingly deployed in countries like the United States and China to address diverse learner needs which suggests a significant potential impact on education across various subjects (Xia et al., 2021; Woolf, 2020). For instance, Pelikan and Sliwka (2020) highlighted the UK's systematic adoption of AI for curriculum customization, while Alvarez and Dery (2020) demonstrated how AI-powered simulations in Social Studies foster critical thinking through interactive historical scenarios. However, UNESCO (2022) cautions that AI's benefits remain unevenly distributed, with developing nations lagging due to infrastructural deficits and insufficient teacher preparedness.

2.2 Challenges of AI Adoption in Sub-Saharan African Education

In Sub-Saharan Africa, AI adoption faces systemic barriers, including limited digital infrastructure, erratic internet access, and inadequate teacher training (Bajinath & Govender, 2023; Tshabalala et al., 2022). Adewumi et al. (2023) identified a critical gap in Nigeria: while educators acknowledge AI's theoretical potential, practical awareness of tools and implementation strategies remains low. Similarly, Kizito and van Dijk (2021) observed that Ghanaian teachers' enthusiasm for AI is tempered by a lack of institutional support and localized resources. These findings align with Scherer et al. (2023), who argue that technology acceptance in low-resource settings hinges on perceived ease of use and institutional trust—factors often overlooked in top-down policy frameworks. Notably, none of these studies has disaggregated teacher awareness into specific knowledge domains, leaving a significant gap in understanding precisely what kind of awareness is lacking.

2.3 AI in Social Studies Education

Subject-specific applications of AI, particularly in Social Studies, offer unique opportunities to enrich content delivery. Nwosu et al. (2023) demonstrated how AI-driven Geographic Information Systems (GIS) enable Nigerian students to analyse spatial data, fostering deeper engagement with geography. Similarly, Akinola et al. (2021) emphasized AI's role in simulating sociopolitical

scenarios, allowing learners to explore historical causality interactively. Rakuasa (2023) examined the potential of AI tools like GIS in geography education for analysing spatial data and simulating environmental scenarios, suggesting opportunities for deeper analytical thinking and data-driven investigations. Despite these advancements, researchers noted a paucity of research on AI's integration into Social Studies compared to STEM subjects, underscoring the need for discipline-specific pedagogical strategies and an understanding of teachers' content-specific technological knowledge.

2.4 The Nigerian Context

Nigeria's National Digital Economy Policy (2020) envisions technology-driven education, yet implementation remains fragmented (Federal Ministry of Communications and Digital Economy, 2020). Studies by Olaleye et al. (2022) reveal that while urban educators in Lagos exhibit moderate AI awareness, rural counterparts in regions like AMAC face acute resource shortages. Ogunyemi et al. (2023) further identified infrastructural gaps and fear of job displacement as key deterrents to AI adoption among Nigerian teachers. Conversely, Adeyemi et al. (2023) advocate for localized AI tools—such as Yoruba-language chatbots—to bridge cultural and linguistic divides in pedagogy. Ayanwale et al. (2022) applied the Technology Acceptance Model to Nigerian teachers, finding that Perceived Usefulness and Perceived Ease of Use are heavily influenced by institutional support and socio-cultural trust in technology. Their study, however, assumed a baseline of awareness that this present research interrogates directly.

Prior research reveals two conflicting realities. On one hand, AI has clear potential to improve Social Studies education. On the other, its adoption in Nigeria is stalled by systemic barriers and gaps in teacher awareness. Most studies have centred on STEM subjects or urban schools, leaving Social Studies teachers in semi-urban areas like AMAC largely unexamined. Importantly, no study has used the TPACK framework to break AI awareness into its component knowledge domains in this context. This study fills that gap by measuring Social Studies teachers' awareness across TK, TCK, and TPK. The findings offer both a diagnostic base for targeted training and a foundation for linking awareness to technology acceptance.

2. Theoretical Framework

This study is anchored in the Technological Pedagogical Content Knowledge (TPACK) framework and proposes a conceptual link to the Technology Acceptance Model (TAM) for future empirical testing.

3.1 Technological Pedagogical Content Knowledge (TPACK) as a Diagnostic Framework

The TPACK framework (Mishra & Koehler, 2006; Koehler & Mishra, 2008) has been widely adopted to examine technology integration in education (Chukwuemeka, 2014; Chukwuemeka et al., 2019). It posits that effective teaching with technology requires an interaction of three core knowledge domains, whose intersections create additional knowledge types. For the purposes of this diagnostic study, we focus on three domains directly relevant to awareness:

- Technological Knowledge (TK): Foundational awareness of the existence and general functions of technologies. In this study, TK refers to a teacher's awareness that AI tools exist in the educational setting (e.g., having heard of AI in education, knowing about professional development opportunities).

- Technological Content Knowledge (TCK): Awareness of how technology can be applied to represent and transform specific subject content. In this study, TCK refers to a teacher's awareness of specific AI tools that can be used to teach Social Studies content (e.g., AI-driven history simulations, GIS tools for geography, AI grading tools for essays on civic issues).
- Technological Pedagogical Knowledge (TPK): Awareness of how technology can support general pedagogical strategies, independent of specific content. In this study, TPK refers to a teacher's awareness of how AI can personalize learning experiences or adapt to student needs broadly.

Recent adaptations of TPACK emphasize its utility as a diagnostic tool for identifying specific knowledge gaps (Chai et al., 2021; Agbo et al., 2023). Rosenberg and Koehler (2021) argue that awareness is the foundational layer of TK, TCK, and TPK, without which teachers cannot progress to higher-order integration. By measuring these domains independently, this study identifies precisely where Social Studies teachers' AI awareness is strong and where it is critically weak.

3.2 Technology Acceptance Model (TAM)

The Technology Acceptance Model (Davis, 1989) predicts technology adoption through two key constructs: Perceived Usefulness (PU), the belief that a tool enhances job performance, and Perceived Ease of Use (PEOU), the belief that a tool requires minimal effort. Critically, awareness precedes these perceptions (Ogunyemi et al., 2023). A teacher cannot judge a tool's usefulness or ease of use without first knowing it exists and understanding its application to their specific teaching context.

3.3 Conceptualizing Integration of TPACK and TAM: Sequential Process Model

By integrating TPACK and TAM, this study adopts a comprehensive theoretical lens to examine AI awareness. TPACK provides a structure for understanding the types of knowledge (starting with awareness) relevant to integrating technology like AI into social studies teaching, encompassing awareness of the technology itself (TK), its relevance to content (TCK), and its potential pedagogical applications (TPK). TAM complements this by highlighting how this initial awareness informs crucial perceptions of usefulness and ease of use (PU and PEOU), which are the immediate precursors to considering or accepting the technology for future use.

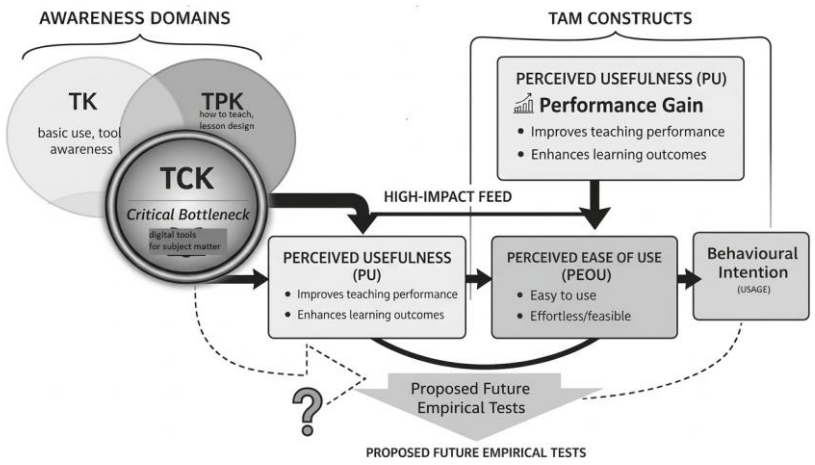

Figure 1. Theoretical Model Linking of TPACK and TAM through AI Awareness

This study proposes a sequential process model in which the three TPACK awareness domains differentially predict TAM's acceptance constructs. We argue that awareness is not a uniform predictor of acceptance but a differentiated one:

- TPK (Pedagogical Awareness) may create a general disposition of enthusiasm or openness towards AI's educational role but is insufficient for adoption.
- TK (General Technological Awareness) provides a necessary but not sufficient condition; a teacher must know tools exist before they can evaluate them.
- TCK (Content-Specific Awareness) is the critical mediator. A teacher with high TPK and moderate TK but critically low TCK will be unable to perceive a specific tool's usefulness (PU) because they cannot map the technology onto their Social Studies content. Furthermore, this uncertainty about practical application will inflate anxiety about ease of use (PEOU), creating a negative loop that blocks the transition from awareness to acceptance.

This integrated perspective provides a robust theoretical basis for the present diagnostic study and a clear, testable hypothesis for future research. The present study empirically establishes the differential levels of TK, TCK, and TPK awareness which is the first and necessary step in testing the full model.

4. METHODOLOGY

This study employed a descriptive survey research design, appropriate for systematically assessing the current state of a phenomenon across multiple dimensions (Creswell & Creswell, 2017). The design was specifically chosen to generate a TPACK-based diagnosis of AI awareness.

The population comprised all Social Studies teachers in secondary schools within the Abuja Municipal Area Council (AMAC), estimated at approximately 325 teachers out of a broader teacher population of 1,500. A total of 325 teachers were successfully reached and participated in the study, representing a 93% coverage of the target population. This near-census approach provides a highly representative and reliable picture of the population's awareness profile. The achieved sample included teachers from both public (n = 187, 57.5%) and private (n = 138, 42.5%) schools, ensuring balanced representation. Participants had a mean teaching experience of 8.4 years (SD = 5.2), with 58.2% holding a Bachelor's degree and 41.8% holding a Master's degree or higher.

The primary instrument used was a structured questionnaire titled "Teachers' Awareness of Artificial Intelligence (AI) in Teaching Social Studies Questionnaire (TAAITSSQ)", which comprises of two section namely; Section A: Captured demographic information such as age, gender, years of experience, school type and qualifications and Section B: Focused on teachers' awareness of AI in Social Studies teaching consisting of eight items measuring AI awareness, each rated on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). To operationalize the TPACK framework, each item was explicitly mapped to its corresponding TPACK knowledge domain during the instrument design phase.

The instrument underwent face and content validation by a panel of three experts: one in Educational Technology, one in Social Studies Education, and one in Measurement and Evaluation. Experts assessed each item for relevance to the construct, clarity of wording, and alignment with the assigned TPACK domain. Items were revised based on feedback prior to pilot testing. A pilot study was conducted with 30 Social Studies teachers from a neighbouring educational zone not included

in the main study. Cronbach's alpha coefficients were calculated for each sub-scale: TK = 0.78, TCK = 0.84, TPK = 0.81, and for the overall instrument = 0.85, confirming acceptable to good internal consistency.

Data collection was conducted over two weeks with prior ethical clearance and consent from relevant educational authorities. Trained research assistants supported the questionnaire administration to ensure comprehension and consistency. Participation was voluntary, anonymous, and confidential. All participants provided informed consent.

Data analysis proceeded in three stages, aligned with the research questions and hypothesis:

- **Stage 1 (RQ1):** Descriptive statistics (means and standard deviations) were computed for each item and for the composite scores of the three TPACK domains. For item-level interpretation, mean scores of 3.41–5.00 indicated high awareness, 2.61–3.40 moderate awareness, and below 2.60 low awareness.
- **Stage 2 (RQ2):** A one-way repeated-measures ANOVA was conducted to compare the composite mean scores of the three TPACK domains (TK, TCK, TPK). Mauchly's test assessed sphericity, and Greenhouse-Geisser corrections were applied if violated. Partial eta squared (η^2) was reported as a measure of effect size. Post-hoc pairwise comparisons with Bonferroni correction identified specific domain differences.
- **Stage 3 (H_{O1}):** An independent samples t-test compared the overall AI awareness composite mean scores between public and private school teachers. Assumptions of normality and homogeneity of variance were assessed.

All analyses were conducted using SPSS version 27, with alpha set at .05.

5. Results

Research Question 1: Level of AI Awareness across TPACK Domains

Table 1 presents the item-level descriptive statistics along with their mapped TPACK domains.

Table 1: Item-Level Mean Scores, Standard Deviations, and TPACK Domain Mapping

SN	Statement	Domain	Mean	SD	Decision
1	I have heard of AI tools being used in education.	TK	3.91	1	High
6	I am aware of potential challenges or limitations of using AI in the classroom.	TK	2.37	1.2	Low
8	I am aware of professional development opportunities related to AI for teachers.	TK	2.34	1.2	Low
2	I am familiar with AI tools that can assist in teaching Social Studies.	TCK	2.38	1.2	Low
4	I am aware of specific AI tools that can grade assignments automatically.	TCK	2.34	1.2	Low
5	I know where to find information about AI in education relevant to social studies.	TCK	2.86	1.2	Moderate
3	I am aware of AI's potential to enhance teaching in Social Studies.	TPK	4.08	0.9	High
7	I am aware of how AI can personalize learning experiences for students in social studies.	TPK	3.71	1.2	High

Table 1 shows that teachers scored highest on items reflecting a broad, conceptual sense of AI's potential (Items 3 and 7, both TPK) and on basic name-recognition of AI (Item 1, TK). In contrast, every item requiring specific, practical knowledge familiarity with Social Studies AI tools (Item 2), awareness of AI grading tools (Item 4), knowledge of professional development resources (Item 8), and understanding of AI's classroom limitations (Item 6) fell in the low-awareness range. The only item registering moderate awareness asked whether teachers knew where to find AI-related information (Item 5), suggesting some confidence in locating resources that is not matched by actual knowledge of tools. This gap between general optimism and concrete tool knowledge is the central finding that the composite TPACK domain analysis in Table 2 examines further.

Table 2 presents the composite mean scores, standard deviations, and internal consistency for each TPACK domain.

Table 2: Composite TPACK Domain Scores

TPACK Domain	No. of Items	Mean	SD
TK (Technological Knowledge)	3	2.87	0.8
TCK (Technological Content Knowledge)	3	2.53	1
TPK (Technological Pedagogical Knowledge)	2	3.9	0.9

Table 2 confirms the pattern observed at the item level, now captured as domain-level composites. Teachers reported high awareness of AI's pedagogical potential (TPK: M = 3.90, SD = 0.88), indicating a general belief that AI can enhance teaching and personalise learning. General technological awareness (TK: M = 2.87, SD = 0.81) fell in the moderate range, though this average was inflated by the single high-scoring item on having heard of AI in education, masking low scores on knowledge of challenges and professional development. Most critically, content-specific awareness (TCK: M = 2.53, SD = 0.98) was the lowest of the three domains, firmly in the low-awareness range. This means that while teachers hold an abstract conviction that AI is useful for pedagogy, they lack knowledge of specific AI tools tied to Social Studies content.

Research Question 2: Differences in Awareness across TPACK Domains

Table 3: Repeated-Measures ANOVA Results and Post-Hoc Comparisons of AI Awareness across TPACK Domains

TPACK Domain	M	SD	F	df	p	η^2	Post-Hoc
TK	2.9	0.8					TK > TCK*
TCK	2.5	1	312.5	1.89, 612.47	< .001	0.5	TCK < TK, *TCK < TPK*
TPK	3.9	0.9					TPK > TK, *TPK > TCK*

Note. N = 325. df corrected with Greenhouse-Geisser estimate (ε = .95). Post-hoc comparisons used Bonferroni correction. TK = Technological Knowledge; TCK = Technological Content Knowledge; TPK = Technological Pedagogical Knowledge.
*p < .001.

A one-way repeated-measures ANOVA confirmed that the differences in AI awareness across the three TPACK domains were statistically significant, with a large effect size (F[1.89, 612.47] =

312.45, $p < .001$, $\eta^2 = .49$). This means that nearly half the variance in awareness scores is explained by which knowledge domain is being measured. Bonferroni-corrected post-hoc comparisons showed that all three domains differed significantly from one another ($p < .001$). Teachers' awareness of AI's pedagogical potential (TPK) was significantly higher than both their general technological knowledge (TK) and their content-specific knowledge (TCK). TK was, in turn, significantly higher than TCK, which recorded the lowest mean of all three domains.

Hypothesis 1: School Type Differences

Table 5: Independent Samples t-Test Comparing AI Awareness between Public and Private School Teachers

School Type	n	M	SD	SEM	95% CI
Public	187	3	0.74	0.054	[2.84, 3.06]
Private	138	3	0.81	0.069	[2.90, 3.18]
	t	df	p	Cohen's d	95% CI of Difference
Public vs. Private	-1	323	0.3	0.12	[-0.26, 0.08]

Note. N = 325. Levene's test confirmed equality of variances ($F = 2.14$, $p = .144$). Overall composite mean scores were used. CI = Confidence Interval. SEM = Standard Error of the Mean.

An independent samples t-test was conducted to compare overall AI awareness composite scores between public school teachers ($n = 187$, $M = 2.95$, $SD = 0.74$) and private school teachers ($n = 138$, $M = 3.04$, $SD = 0.81$). Levene's test confirmed equality of variances ($F = 2.14$, $p = .144$). There was no statistically significant difference between the two groups, $t(323) = -1.04$, $p = .301$, $d = 0.12$. The null hypothesis was retained.

Discussion of Findings

This study set out to analyze AI awareness among Social Studies teachers in AMAC secondary schools using the TPACK framework.

The findings show a statistically significant and practically large disparity in awareness across the three TPACK domains ($\eta^2 = 0.49$). Teachers reported high awareness of AI's pedagogical potential (TPK: $M = 3.90$), with strong agreement that AI can enhance teaching (Item 3, $M = 4.08$) and personalize learning (Item 7, $M = 3.71$). This pattern reflects a conceptual optimism consistent with global trends in educational technology discourse (Baker et al., 2019; Woolf, 2020). Teachers in this study appeared to have absorbed the aspirational narrative surrounding AI without possessing the knowledge infrastructure to put it into practice.

However, this high TPK rested on a weaker foundation. General Technological Knowledge (TK: $M = 2.87$) was moderate at best, driven almost entirely by a single item having broadly "heard of AI tools being used in education" (Item 1, $M = 3.91$) while awareness of challenges (Item 6, $M = 2.37$) and professional development opportunities (Item 8, $M = 2.34$) was low. This finding suggests that teachers' general AI knowledge was superficial, mediated by informal channels such as media headlines or peer conversations, rather than structured professional engagement (Adewumi et al., 2023).

Technological Content Knowledge (TCK: $M = 2.53$) was the lowest of all three domains and significantly lower than both TK and TPK. The authors term this pattern the "hollow core" of AI

awareness. Teachers reported not knowing which AI tools existed for Social Studies teaching (Item 2, M = 2.38), were unaware of specific functional tools like automated grading systems (Item 4, M = 2.34), and had only a vague sense of where to find relevant information (Item 5, M = 2.86). This pattern indicates that while teachers had absorbed the general argument that AI could be useful for pedagogy, they lacked the content-specific knowledge that would allow them to translate this belief into a classroom application. This finding corroborates and extends the work of Tshabalala et al. (2022) in South Africa and Kizito and van Dijk (2021) in Ghana by identifying the precise kind of knowledge missing: not generic technology awareness but content-technology integration awareness.

The disparity between high TPK and low TCK can be explained by the probable sources of teachers' knowledge. General pedagogical benefits of AI such as personalisation, engagement, efficiency appear frequently in broad educational discourse, policy documents, and popular media. Teachers could readily absorb the idea that "AI personalises learning" without needing to see a specific tool in action. In contrast, TCK—knowing that an AI-driven GIS platform could map historical migration patterns for a Social Studies lesson on the transatlantic slave trade, for instance, required exposure to specific, content-aligned demonstrations, training, or resources. The low TCK scores in this study suggested that such specific, content-focused professional development was absent from the AMAC context, a systemic gap noted across Sub-Saharan Africa (Bajinath & Govender, 2023).

The finding of no significant difference between public and private school teachers ($p = .301$) is noteworthy. This result challenges the assumption of a private-school advantage in technology awareness in Nigeria. This null result suggests that the awareness deficit was a systemic, sector-wide issue in this context, likely driven by shared limitations in pre-service and in-service training curricula, rather than factors unique to either public or private institutional settings (Olaleye et al., 2022). The problem was not simply one of resources; both well-resourced and under-resourced schools failed to develop content-specific AI knowledge among their Social Studies teachers.

Implications for the Proposed TPACK-TAM Sequential Model

The results of this study point to a practical problem that can be tested in future research. Our proposed model suggests that low content-specific knowledge (TCK) is the main roadblock between being aware of AI and actually using it. This simply means;

Firstly, that a teacher who believes "AI is good for teaching" (high TPK) and has heard of AI tools in general (moderate TK) still cannot take the next step if they do not know a single AI tool that fits their subject (low TCK). There is simply no bridge between a general good feeling about AI and a decision to use it in a Social Studies lesson.

Secondly, that whether a teacher finds a tool useful depends on seeing how it connects to their actual classroom work. A teacher who cannot name or picture an AI tool for teaching history or geography cannot reasonably judge it as useful for their job. Usefulness is always about something specific.

Thirdly, that not knowing what tools exist or how they work breeds uncertainty. That uncertainty likely makes AI feel harder to use than it actually is. When something feels difficult and unclear, teachers are less likely to try it.

In summary, this study identifies low TCK as the likely bottleneck. Teachers are stuck not because they reject AI, but because they have never been shown what AI looks like in a Social Studies classroom. Future research should test this directly by measuring usefulness and ease of use alongside the three types of awareness and mapping the relationships between them. What this study provides is strong evidence for where the blockage probably sits.

Conclusion

This study employed the TPACK framework to diagnose the multi-dimensional nature of AI awareness among Social Studies teachers in AMAC secondary schools. The findings showed that awareness of AI was not a unitary construct. Rather, it was a hierarchically structured phenomenon characterized by high pedagogical optimism (TPK), superficial general knowledge (TK), and a low foundation of content-specific knowledge (TCK). The authors term this pattern the "hollow core." The absence of a public-private school divide further indicated a systemic, sector-wide challenge rooted in the lack of content-focused AI professional development.

The study's contribution was both empirical and theoretical. Empirically, it provided the first TPACK-based diagnostic map of AI awareness among Social Studies teachers in this context, pinpointing TCK as the area of greatest deficit. Theoretically, it proposed a sequential TPACK-TAM process model that hypothesized this TCK deficit as a mediator that suppressed Perceived Usefulness and reduced Perceived Ease of Use, thereby blocking the transition from knowledge to acceptance. This model offered a testable roadmap for future research and provided a framework for designing interventions.

Without targeted intervention focused specifically on building Technological Content Knowledge, teaching Social Studies educators which AI tools existed for their subject and demonstrating their direct application to the curriculum—AI integration in Nigerian Social Studies classrooms risked remaining a theoretical aspiration indefinitely.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. **Design and Implement TCK-Focused Professional Development:** Teacher training should move beyond generic "AI literacy" workshops. The Ministry of Education and professional development bodies should commission and fund a series of hands-on workshops co-designed and co-facilitated by AI technology specialists and experienced Social Studies master teachers. These workshops should focus exclusively on demonstrating, exploring, and practising with specific AI tools mapped to the Social Studies curriculum (e.g., AI-driven historical simulations for teaching colonialism, GIS platforms for population geography, AI debate analysis tools for civic education). The explicit objective was to raise the low TCK identified in this study.
2. **Develop Localised, Curriculum-Aligned AI Resource Repositories:** Educational authorities should establish an accessible online repository of vetted, free, or low-bandwidth-appropriate AI tools for Social Studies, complete with lesson plans, video demonstrations, and curriculum alignment charts developed in the Nigerian context. This recommendation directly addressed the finding that teachers did not know where to find relevant information (Item 5).

3. **Integrate AI TCK into Pre-Service Teacher Education:** Faculties of Education in Nigerian universities should revise their Educational Technology and Social Studies methods courses to incorporate TCK development around emerging technologies. Pre-service teachers should graduate not just with a theoretical understanding of AI's potential (TPK) but with a portfolio of content-specific technology integration competencies.
4. **Empirically Test the Proposed TPACK-TAM Sequential Model:** A follow-up study is required. Future research should administer a combined instrument measuring TPACK-based awareness, Perceived Usefulness, and Perceived Ease of Use to a similar population. Using structural equation modelling (SEM) or path analysis, researchers should test the hypothesized pathway: that TPACK awareness domains differentially predict PU and PEOU, with TCK serving as a primary mediator. Such a study would provide empirical validation for the proposed model and offer a generalizable framework for understanding AI adoption in resource-constrained educational settings globally.

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Data availability
The datasets generated and analyzed during the current study are available upon reasonable request from the corresponding author as included in the paper. (Correspondence: emekac.joshua@gmail.com)

Declarations

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