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# Exploring Faculty Members' Artificial Intelligence Literacy through the Lens of the TPACK Framework: A Qualitative Study

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**Title: WIP: Exploring University Instructors' AI Literacy through the Lens of the TPACK Framework: A Qualitative Study**

## Introduction

The development of AI in education has greatly impacted the ways we learn and teach, redefining instructional approaches and providing unique learning experiences. The integration of AI into education creates dynamic learning environments through the opening of new avenues which facilitate personalized learning, adaptive feedback and intelligent tutoring (Holmes et al., 2019). As such, it is essential for educators to understand how AI can effectively support educational goals and enhance pedagogical strategies. This was foreseen in the creation of the TPACK framework. TPACK stands for technological, pedagogical and content knowledge. It describes the intersection of knowledge from each of these domains required for effective teaching in the digital age (Mishra & Koehler, 2006).

The emergence of AI has led to transformation in traditional educational paradigms through the integration of tools with advanced functionalities. Even as early as elementary school, research highlights the importance of equipping young learners with AI competencies early on fostering critical thinking, digital literacy and responsible AI use (Yeter et al., 2024). Across all levels of education, these tools support teachers and instructors in their lessons. These range from the automation of routine taskings, to tailoring lessons that meet an individual's complex learning needs. Such advancements are especially meaningful in higher education to empower instructors to get across complex concepts to their students. AI automation also allows for more direct engagement, where instructors can spend less time on menial administrative taskings. As AI starts having greater integration, it is also important to understand 1) How well versed instructors are with AI in terms of literacy and 2) what methods they employ in utilizing AI in their lessons.

Despite the promising potential that AI continues to deliver, there is a knowledge gap regarding university educators' perception of AI within the TPACK framework. Specifically, regarding their AI literacy and how it shapes their pedagogical approaches to higher education. Existing studies on AI integration within the TPACK framework have largely employed quantitative methodologies, focusing on self-reported competencies. (Celik, 2022).

However, being more of a confidence indicator, these studies do not highlight the nuanced experiences, challenges and pedagogical shifts that occur in real-world classroom settings. Thus there is more to be explored on the qualitative frontier. This study addresses this gap by examining instructors' perspectives on AI literacy through the TPACK framework, providing richer insights into their experience and instructional strategies. This study will offer valuable insights into the role of AI literacy in shaping teaching practices within higher education, potentially informing future curriculum design and faculty development programs.

## Literature Review

The rapid advancement of AI in education has opened doors to a multitude of practical applications. One overarching implementation was to craft personalized lessons to student’s various learning needs (Zhang & Aslan, 2021). In higher education, AI tools such as adaptive learning platforms, intelligent tutoring systems and recommendation engines which provide feedback, make learning more efficient and engaging (Holmes et al., 2019). Cope et al. (2021)

highlight how AI can utilize machine learning to automate administrative taskings, grading and even attendance tracking, beyond instructional enhancement. This enables educators to focus on higher order instructional taskings. AI enhances student engagement through gamification of learning content and Virtual Learning Experiences through VR, which is valuable in fields that benefit from interactive content (Griol et al., 2014).

AI has been increasingly adopted in STEM fields, typically utilized for technical tasks such as data analysis and critical thinking. It has since been expansively used across various disciplines, even growing into domains such as social sciences and humanities where Lavidas et al. (2024) discuss applications such as language learning and visual perception. Even schools and institutions invest in AI. In Singapore, the Ministry of Education has introduced initiatives such as Authoring Co-Pilot and adaptive learning systems demonstrating AI's role in lesson planning and personalized education.

While offering significant benefits, AI's integration into education has raised several concerns. Key issues include data privacy and security. Others include the potential bias in AI algorithms, which often result from inadequate training data. A recent study highlights that the widespread adoption of AI tools in education has prompted concerns over assessment validity, with students who refrain from using AI tools feeling disadvantaged compared to their peers who utilize them. (Gambhir et al., 2024). Perhaps the most significant would be the impact on student-teacher relationships in a learning environment moving forward. The increased reliance on AI for education, risks learning interactions that become more transactional and diminish the relational aspects of teaching. However, some may argue that AI's ability to handle more menial tasks enables educators to allocate more time to meaningful, student centered engagements. (Selwyn, 2019)

The technological pedagogical and content knowledge (TPACK) framework was first introduced by (Mishra & Koehler, 2006). It provides an overview of a multifaceted approach to integrating technology into teaching, in the domains of technological, pedagogical and content knowledge. As stated by Mishra et al. (2023) successful integration requires the amalgamation of all three domains. Technological knowledge (TK) involves effectively using digital tools in teaching. Pedagogical knowledge (PK) covers designing lessons, assessing students and adapting teaching styles. Content knowledge (CK) is the understanding of the subject being taught and ability to teach the subject matter comprehensively.

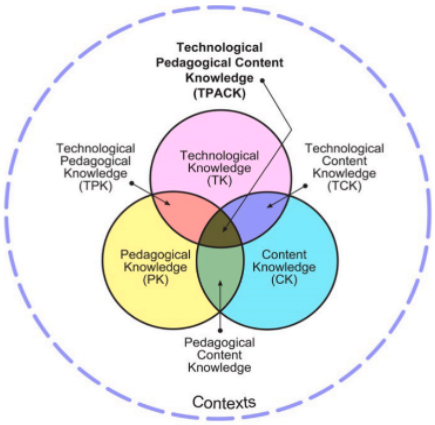

Fig. 1: Tpack framework (tpack.org).

Mishra et al. (2023) note that in the context of AI integration into higher education, there are four key areas which will be most impacted: TK, TPK, TCK and TPACK as a whole. Technological Pedagogical Knowledge (TPK) focuses on how AI can enhance instructional methods, such as using AI-driven analytics to track student progress or implementing chatbots for personalized tutoring. Technological Content Knowledge (TCK) addresses how AI can facilitate subject-specific instruction, such as using AI-driven simulations in engineering or automated translation tools in language learning. Recent studies emphasize the importance of faculty development in AI literacy, particularly in establishing clear institutional guidelines on ethical AI use and assessment (Gambhir et al., 2024).

While TPACK provides a structured approach to technology integration, AI literacy is particularly relevant within the TK and TPK domains. Instructors' ability to effectively adopt AI depends not only on their technical proficiency, but also their pedagogical adaptability; about how AI tools influence teaching strategies and student engagement. (Ng et al., 2021).

**Method**

This study utilized a qualitative approach to investigate university Instructors' AI literacy and its implication for learning and teaching. For the data, interviews were conducted with 32 university instructors from diverse academic disciplines (both 16 STEM and 16 non-STEM fields). This was to gain deeper insights into instructors' experiences and perspectives of AI literacy. Purposive sampling was employed to select participants, higher education instructors, with an interest in exploring the potential of AI in higher education. Interview questions were aligned with the TPACK framework, probing instructors' knowledge, challenges and perceptions regarding AI integration in their teaching practices.

They were structured into the individual domains of Technological, Pedagogical and Content Knowledge as well as TPACK as a whole. The interviews were audio recorded and thereafter transcribed. A de-identification process was carried out on the participants to maintain anonymity, based on the framework outlined by Yeter et al. (2019) in their empirical study. Following the steps in Appendix C, we removed personally identifiable information and employed coding techniques to ensure participant confidentiality and compliance with ethical standards. Each interview lasted approximately 40 minutes, guided by questions structured around the TPACK framework's components. The interview questions are reflected in **Appendix A,** with pseudonymized participant information in **Appendix B**. Data was analyzed thematically, identifying key themes and patterns in the de-identified transcripts of instructors' responses.

**Results and Discussion**

STEM instructors primarily conceptualized AI literacy as the practical understanding of AI tools, developed through their exposure to technical disciplines and teaching responsibilities. Some said it also involves understanding their ethical and pedagogical implications. Non-STEM instructors described AI literacy as the ability to discern AI's limitations, especially in writing and research. Jessica noted: "I think students should understand where AI stops and where their thinking begins." To instructors that had knowledge of machine learning and coding due to their teaching and professional training, these were seen as contextual rather than a requirement of defining AI literacy. While some instructors expressed confidence in using AI tools for personal

taskings, they were more cautious about the academic applications. A key concern was the reliability and ethical implications of AI in an educational setting. As quoted by John, “For recreation? Pretty confident. For work, not so confident, because we don’t have much opportunity to utilize it.” STEM instructors predominantly applied AI in discipline-specific contexts, leveraging tools for a myriad of operations, but mostly for personal use. These included personal tasks such as debugging code, running simulations, or streamlining technical processes. In relation to pedagogy, instructors have utilized tools such as LaTex databases for their students. For Non-STEM instructors, AI encompassed broader applications such as fostering critical discussions and even generating conversational prompts to scaffold language practice.

The influence on teaching approaches was divisive. Many instructors of the engineering field, especially mechanical and electrical, stated that AI does not influence the way they teach a subject. This related specifically to instructors of more classical engineering concepts such as thermodynamics and mechanics who had cited that their methods of delivery are based on experience and the general situation of student's receptiveness in learning. As Alfred noted, “Teaching thermodynamics is about understanding core principles; AI doesn’t change that.” Others in the Sciences fields have stated that with technological progression, AI image analysing software and tools have been integrated for practical laboratory sessions, providing students with a better visualisation of their analysis. As Edward remarked, “For practical lab sessions, AI helps students visualize their analysis better,” illustrating AI’s role in enhancing experimental learning experiences. Non-STEM instructors were more open to AI’s role in content delivery, for prompting discussions and immersing students better in the content, but noted that AI cannot replicate the empathy humans share.

AI literacy influenced instructor’s technological knowledge (TK) by enabling them to experiment with AI tools such as ChatGPT, Copilot, for tasks such as lesson planning and content generation. However, skepticism remained about the effectiveness of these tools in technical fields, with Michael stating, “I tried using AI to generate slides, but it wasn’t fruitful”. Pedagogical knowledge (PK) was adapted to mitigate AI misuse by students, with instructors incorporating probing techniques to elicit genuine responses and deeper engagement. Some had intentionally utilized AI to generate incorrect answers to test students’ attentiveness in understanding fundamental concepts. Several instructors adapted assessment strategies, incorporating oral exams or in-class problem-solving to evaluate genuine understanding beyond AI-generated work. Content Knowledge (CK) benefitted from AI’s ability to provide up to date material, though concerns about accuracy and context remained prevalent. Henry emphasized, “We need to verify AI-generated content because it can sound convincing but still be incorrect.” These perspectives indicate that while AI is gradually being integrated, its role varies significantly across disciplines and instructional strategies.

Faculty identified several challenges, including the unreliability of AI-generated outputs, which often required extensive verification. Academic integrity concerns, particularly related to students over-reliance on AI tools were frequently raised, emphasizing the need for clearer guidelines and policies. This also led to the concern that AI had the potential to flatten critical thinking. Many cited this as an inhibition depriving students of the necessary understanding of fundamental concepts, a university wide concern ranging from technical concepts to even writing techniques. While the institution advocates for AI integration, Instructors called for more

consistency in tailoring structured training programs that are discipline-specific, citing that "general AI seminars often fail to address the technical nuances we face." Faculty emphasized the importance of understanding AI's capabilities and limitations to make informed decisions about its use in teaching.

Instructors also noted the opportunities present like AI's ability to automate routine tasks, such as content organisation and grading of online tests, freeing them to focus on high-order teaching activities. This reinforces the research conducted by Cope et al. (2021). AI tools were also recognized for their potential to personalise learning experiences, enabling tailored feedback. Some instructors emphasized efforts to create AI chatbots, similar to the smaller 'helpdesk chatbot' popouts seen on websites. Language instructors in particular, highlighted a potential idea for more immersive lessons that use AI to simulate cultural conversations for students.

**Implications and Future Research**

The findings thus far have highlighted that while pilot programmes are being conducted by the institution for AI integration, there remains a need for targeted professional development initiatives. Findings have indicated that many experienced instructors have limited exposure for AI tools, relying on traditional teaching methods. Evelyn noted "I still absorb new AI developments like a layperson" highlighting a gap in structured AI training programs.

These efforts should focus on equipping more seasoned instructors with the skills and confidence to effectively adopt AI in their teaching practices. Tailored training programs that address both technical and pedagogical applications of AI would bridge existing gaps. The unique perspective from instructors teaching ICC (Interdisciplinary core) modules have underscored the value of interdisciplinary approaches to AI integration. Collaborations between disciplines could foster innovative teaching strategies and help address common challenges like ethical concerns and technological accessibility. However the distinction between the teaching of general content and technical content suggests that AI integration strategies should be discipline - specific, ensuring alignment with pedagogical objectives.

While this study provides valuable insights into faculty perception of AI literacy and its integration within the TPACK framework, further research is needed to build upon these qualitative insights. Quantitative data on instructor's AI literacy would be beneficial. As AI remains relatively new in educational contexts, future research could evolve into longitudinal studies to track changes over time, particularly as institutions develop clearer policies and targeted professional development initiatives.

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**Appendix A**

**Interview Semi-Structured Interview Questions**

Start up Questions

- What field(s) are you currently teaching in?
- How long have you been teaching?
- How would you describe your experience with technology in teaching?
- Are there any tools you employ for in class lessons?
- Anything specific to AI course?
- What is your current knowledge about TPACK?

Part 1: Technological Knowledge (TK)

This refers to the understanding of the utilisation and integration of digital tools, software and technology effectively into teaching.

- General AI Knowledge:
    1. How would you define AI literacy in the context of your field?
    2. What kinds of AI tools or technologies are you familiar with in your academic practice?
    3. How confident are you in using AI technologies? Can you provide examples of AI tools you've integrated into your courses?

- Challenges with AI Tools:
    4. What challenges have you encountered when working with AI tools in your teaching?
    5. How do you stay updated with advancements in AI technologies related to your field?

Part 2: Pedagogical Knowledge (PK)

This is the understanding of teaching methods and practices. It covers aspects of pedagogy such as designing lessons, assessing students as well as adapting various teaching styles to the learner's needs.

Provide a little bit of details:

- AI and Pedagogical Approaches:
    6. How has your understanding of AI influenced your teaching strategies?
    7. Can you describe any pedagogical shifts or adjustments you've made when incorporating AI tools in your teaching?

8. How do you think AI impacts student engagement or learning outcomes?

- Pedagogical Support:
  9. Do you feel that your institution provides adequate support for integrating AI into teaching? What kind of professional development would help enhance your AI literacy and pedagogical practices?

Part 3: Content Knowledge (CK)

This refers to the understanding of the subject being taught and being able to explain and teach the subject matter comprehensively. It also extends to knowing the content applies in real world scenarios.

Provide a little bit of details:

- AI in Your Subject Matter:
  10. How do you see AI technologies influencing the way you teach content in your discipline?
  11. Can you provide specific examples of how you've integrated AI into the core content of your courses?

- AI as a Content Topic:
  12. In your opinion, how important is it for students in your discipline to develop AI literacy? How do you incorporate AI-related topics into your curriculum?

Part 4: Intersections in TPACK (Technological, Pedagogical, and Content Knowledge)

TPACK as a whole deals with engaging students in the content to be taught through utilising adaptable teaching methods while adopting technological tools to aid the users in their learning.

- AI's Role in the TPACK Framework:

  13. In what ways do you feel AI has enhanced or hindered your ability to balance technology, pedagogy, and content in your teaching?
  14. How do you see AI changing the landscape of higher education in the next 5–10 years in relation to your teaching practices?

- Future Developments:
  15. What future opportunities do you envision for integrating AI into teaching, especially in balancing technology with pedagogy and content?

Thank you so much for taking the time to participate in this study. Before we conclude the interview,

- Is there anything you would like to add or suggest? Any comments?

**Appendix B**

**Participant Demographics**

| **Name** | **Teaching Fields** |
|---|---|
| John | Mechanical Engineering |
| Ben | Mechanical Engineering |
| Alfred | Mechanical Engineering |
| Bill | Neuroscience |
| George | Chemical Engineering |
| Edward | Biomedical Engineering |
| Beverly | Electrical Engineering |
| Michael | Mathematics |
| Justin | Engineering Physics |
| Julia | Materials Engineering |
| Hannah | Chemical Engineering |
| Henry | Physics |
| Gerard | Mechanical Engineering |
| Alexander | Aerospace Engineering |
| Clark | Engineering Mathematics |
| Selena | Mechanical Engineering |
| Kelly | Language |
| Dana | Language |
| Vanessa | Pedagogy |
| Jessica | Communication |
| Valerie | Communication |
| Sally | Language |

| | |
|---|---|
| Evelyn | Social Sciences |
| Shaun | Communication |
| Marcus | Finance |
| Joyce | Language |
| Daniel | Pedagogy |
| Nicole | Communication |
| David | Management |
| Bruce | Physical Education |
| Tony | Social Sciences |
| Charmaine | Social Sciences |