Liao, Y-C, Kasun, G. S., & Moyo, N. (2025). Computational literacy and artificial intelligence education: Unveiling perceptions and professional learning experiences of Fulbright teachers from less-resourced countries. *Contemporary Issues in Technology and Teacher Education, 25*(2), 245-267.

Computational Literacy and Artificial Intelligence Education: Unveiling Perceptions and Professional Learning Experiences of Fulbright Teachers From Less-Resourced Countries

Yin-Chan Liao, G. Sue Kasun, & Nozipho Moyo
Georgia State University

This study examined the impact of a U.S. federal teacher professional learning (PL) Fulbright program on computational literacy and artificial intelligence (AI) education for K-12 teachers (n = 21) from resource-constrained countries. Occurring shortly after the rise of generative AI in November 2023, the program may have further accentuated AI's potential in educational contexts. Its focus on equity and access fostered a positive shift in participants' attitudes, encouraging greater openness to change and a stronger intent to integrate computational literacy with AI tools. This study underscored the pivotal role of equity-centered PL in enhancing teacher capacity for equitable, inclusive education. While participants initially voiced concerns about infrastructure, leadership support, and teacher buy-in, they consistently valued computational literacy. The findings highlighted the necessity of systemic change, driven by a shared vision of integrating computing and AI across diverse educational settings. Additionally, well-designed PL can equip leaders with the knowledge and skills to address challenges, promote equitable access, and adapt solutions to specific contexts. This study provides preliminary evidence of how PL can empower educators to integrate computational and AI literacies, expanding global access to emerging digital literacy opportunities.

In today's rapidly evolving digital landscape, computational literacy and artificial intelligence (AI) literacy are becoming increasingly essential skills for students to thrive in the 21st-century workforce and navigate an increasingly technological world (Goel, 2017; Vincent-Lancrin & Van der Vlies, 2020). However, access to high-quality computing and AI education remains a significant challenge, particularly in less-resourced countries and marginalized communities. This lack of access perpetuates systemic disparities and widens the digital divide, hindering equitable opportunities for all students to develop the necessary technological knowledge and skills. It also occludes the opportunity to have richer voices in the research and design of computing and AI, a target area that serves the communities as well as the greater field. Otherwise, our education community is doomed to replicate the same disparities that present themselves in society as reflected directly in the programming of AI. Indeed, the United Nations and the OECD are creating, coordinating, and implementing frameworks that center on equity, sustainability, and access (Russo & Oder, 2023).

Addressing these equity issues in computing and AI education is crucial, as students from underrepresented groups, such as racial and ethnic minorities, low-income backgrounds, and rural areas, often face the most significant barriers to accessing these educational opportunities (Google & Gallup, 2016). The underrepresentation of these groups in computer science and related fields not only limits their future career prospects but also deprives the technology industry of diverse perspectives and innovative solutions (Camp et al., 2017).

Moreover, the integration of computational literacy and AI in education is not merely a matter of offering courses; it also encompasses how these subjects are taught, how students are recruited, and how classroom cultures support diverse learners and promote retention (DuBow & Gonzalez, 2020). Addressing equity in computing and AI education requires a holistic approach that addresses systemic barriers, challenges stereotypes, and empowers educators to integrate these technologies effectively into their teaching practices.

The study described here aimed to help bridge the equity gap by exploring the perspectives and needs of Fulbright K-12 teachers from less-resourced countries who participated in a 6-week program on computational literacy and AI education. By examining their perceptions, experiences, and contextual factors influencing their views on technology integration, we sought to contribute valuable insights.

This research can inform the development of effective strategies that promote equitable access to computing and AI education in diverse global settings. We framed the investigation through the lenses of equitable computer science and diffusion of innovation. While these educators faced significant challenges in accessing computing education, we explored their professional learning (PL) experiences in the U.S. and their reflections on teaching practices back home. This analysis aimed to identify key insights for achieving equitable access to computer science education on a global scale, particularly when such voices often are not centered in the research due to lack of access and the forces that have served to create the inequities we currently face. This study was guided by the following questions:

1. How do K-12 teachers from less-resourced countries perceive computational literacy and AI in education?

2. What are the experiences of less-resourced K-12 teachers in a professional learning program on computational literacy and AI education?

Literature Review

Equitable Computing and AI Education in Global Contexts

The integration of computational literacy and AI in education has garnered significant attention due to the increasing influence of computing and technology across various disciplines. Inequitable computing for students, highlighting the systemic disparities in access to and participation in computing education, is problematic, as computational literacy is fundamental in problem-solving, navigating digital information, and creating solutions in students' future careers, regardless of their field (DuBow & Gonzalez, 2020). However, access to computing education remains a significant challenge, particularly in less-resourced countries (Craig et al., 2014; Tshukudu et al., 2022).

In the U.S., where much research related to equity and computer science has occurred, many K–12 students today have limited opportunities to learn about computing concepts and practices and to understand how computer science influences their daily lives. There is a lack of access to meaningful computer science courses that include programming, with fewer than half of K–12 schools offering such courses (Google & Gallup, 2016). Students from underrepresented groups, such as Native American, Black, Latine, lower-income backgrounds, and rural areas, have the least access (Change the Equation, 2022). However, researchers have found that students who take a computer science course in high school are more likely to major in computer science in college, especially for underrepresented groups (Morgan & Klaric, 2007).

In addition to inequitable access, low participation rates for female, Black, Hispanic, and Native American students in computer science courses also raise a significant equity issue (Code.org et al., 2024). This underrepresentation persists in postsecondary education and industry, with low percentages of these groups earning computer science degrees and employed in computer and mathematical occupations. This means that the computing workforce, where complex world problems are tackled and solved, is led by preparatory privilege groups to computing (Margolis et al., 2010). Moreover, stereotypes about computer science being a field dominated by White or Asian males wearing glasses further perpetuate these disparities (Google & Gallup, 2016). Thus, how to address these equity gaps and issues remains an ongoing challenge in computing research and practice.

Broadening participation in computing and providing equitable computing education has been a global effort, as capacity and diversity issues exist in meeting the demands of the industry and workforce. The 2021 global education report on inclusion and education by UNESCO (Carney, 2022) revealed that many countries in Central and Eastern

Europe and Central Asia have improved in inclusion education to support marginalized student groups, but segregation and discrimination persist due to economic and linguistic disadvantages and gender stereotypes, similar to U.S. dynamics.

In some Asia Pacific countries, gender stereotypes in computing and AI have been found to be a major concern, as they are likely to influence students' attitudes and self-efficacy in the field (Su & Ng, 2022). Studies have also found that students struggled to learn AI concepts in low and medium socioeconomic schools (Druga et al., 2019). Underrepresented communities in computing and AI fields can face disproportionate systematic barriers resulting from a lack of representation and resources, which can hinder their success and full participation in these fields (Roche et al., 2023).

While many countries have designated resources and efforts in bridging equity gaps by making technology devices and AI tools more accessible, inappropriate use or facilitation of technology might exacerbate discrimination with bias, stereotypes, and misinformation (Carney, 2022). Particularly with the rapid advent of generative AI in educational settings across all levels, the ways certain narratives and perspectives may be manipulated by misinformation and prioritized inequitably has become a significant concern.

Researchers have argued that socioeconomic factors, such as wealth and power, can significantly impact the ways algorithmically generated information is presented and received. This can lead to certain narratives being amplified as truth while others are marginalized, further deepening existing divides and inequalities in society (Heath & Mishra, 2023). Thus, being able to distinguish reality and truth versus misinformation and fake news has become a critical skill for teachers and learners. Teachers should be the focus of support for being digitally literate, as they are in a critical role of ensuring student learning that can benefit from technology uses and closing the equity gaps (Carney, 2022; Heath & Mishra, 2023).

Teachers from less-resourced countries often navigate these inequalities, facing limitations in technology, resources, and opportunities for PL in computational thinking and AI integration (Carney, 2022; Su & Ng, 2022). Comprehensive approaches that involve collaboration among governments, educational institutions, and civil society organizations are crucial for creating inclusive learning environments and providing targeted support to disadvantaged students. Additionally, sustainable support, stakeholder commitment, and community engagement are vital to ensuring equitable access to quality computing and AI education for all learners, especially in resource-constrained countries.

This study aligned with equitable CS principles by focusing on this marginalized group, aiming to understand their perceptions and experiences in the context of AI education. To better understand the complexities of integrating AI and computing education in less-resourced contexts, it is essential to examine teachers' knowledge and skills through an established theoretical framework.

The TPACK Framework: Contextualizing Computing Integration

The technological pedagogical content knowledge framework (also known as technology, pedagogy, and content knowledge, or TPACK; Mishra & Koehler, 2006) provides a valuable lens for understanding the factors influencing teachers' effective integration of technology, including computing and AI, in their instructional practices. This framework highlights the intersections between teachers' technological knowledge, pedagogical knowledge, and content knowledge as crucial determinants of their ability to leverage computing and technology in ways that support effective teaching and enhance student learning experiences.

Crucially, the TPACK framework emphasizes the pivotal role of context in shaping teachers' technology integration practices (Mishra, 2019; Rosenberg & Koehler, 2015). Kelly (2008) contended that the most critical aspect of TPACK is considering the "context of a specific, idiosyncratic teaching-learning situation, and its effectiveness is highly dependent on the extent to which teachers can pedagogically accommodate that context" (p. 51).

In 2019, the TPACK model was updated with an emphasis on contextual knowledge, "from a teachers' awareness of available technologies to the teachers' knowledge of the school, district, state, or national policies they operate within" that encompasses technological, pedagogical, and content knowledge (Mishra, 2019, p. 76). The recent literature on the TPACK model asserts that contextual factors, such as educational policies, cultural and social norms, school environments, and available resources, can significantly influence teachers' dispositions toward adopting and implementing computing and AI in their classrooms.

In less-resourced learning environments, contextual challenges, such as limited access to technology, inadequate infrastructure, and a lack of PL opportunities, can impede the development of teachers' TPACK (Rosenberg & Koehler, 2015). These challenges can contribute to resistance or skepticism toward integrating computing and AI, hindering equitable access to these educational opportunities for students. To achieve equitable computing education on a global scale, it is essential to understand and address the unique contexts and challenges faced by educators in less-resourced learning environments.

Our study explored the experiences and perspectives of a distinct group of K-12 teachers from underresourced countries who participated in a dedicated PL program for computational thinking and AI education in the U.S. This exploration aimed to inform approaches for addressing equity issues in computing education across broader contexts.

Methods

An exploratory qualitative approach (Patton, 2002) was employed to gain an understanding of these Fulbright teachers' perspectives on computing and AI and provide contextualization of the results. This paper was the result of educational researchers' interest in examining a central issue

related to equity — namely, the (lack of) access to technology for teachers from less-resourced countries.

Because the two faculty members were invited to participate as lead educators to a cohort of 21 K-12 teachers from 19 less-resourced countries on a prestigious Fulbright education award, they centered on providing clear and practical lessons on ways to integrate computational literacy and AI with the teachers.

Fulbright Teaching Excellence Program

The International Research and Exchanges Board (IREX) implements the logistics of the Fulbright Program Teaching in Excellence Program through a grant received from the United States Department of State. It was an opportunity for outstanding teachers to come to the United States for 6 weeks for PL and a cultural experience. The teachers participated in academic sessions and received instruction in the most recent teaching practices across different content areas. English language training and support were also key components of the curriculum.

Instructional technology and ways to incorporate the most recent technological practices in the classroom were significant to the educational experience for the teachers. The sessions were daily and typically lasted 3 hours. Additionally, civic and cultural experiences were vital components of the program, immersing teachers in US culture for a deeper understanding.

Specifically, two coauthors created two sets of instruction focusing on computational literacies and AI activities and taught the participants four 3-hour workshop sessions. These sessions were facilitated through modeling of instruction (e.g., how to use Nearpod to promote active learning in classrooms), small and whole group discussions, hands-on explorations of tools and resources, and teacher reflections. The sessions were also embedded with activities using Padlet (see Figure 1) and scenario-based challenges (see Figure 2) to enhance reflections and interactions. By engaging in comprehensive discussions, we ensured that teachers with varying backgrounds could relate the topics to their own instructional settings.

The technology and computing-focused sessions included an introduction to computing education, including the rationales, needs, and impacts of technologies and, specifically, ways computer science concepts and skills have been applied across disciplines and countries for advancement. The essential digital and computational literacies both educators need to support students as critical thinkers, problem solvers, and innovators in this digital world were also discussed. While the teachers learned about various examples of computing integration in current US teaching practices, they were also introduced to international and US competencies and standards, including *K-12 Computer Science Framework* (2016), the *International Society for Technology in Education's (ISTE) Standards for Students and Educators* (ISTE, 2016, 2017), and *ISTE Computational Thinking Competencies* (ISTE, 2018).

Figure 1
Example of Defining AI Activity on Padlet

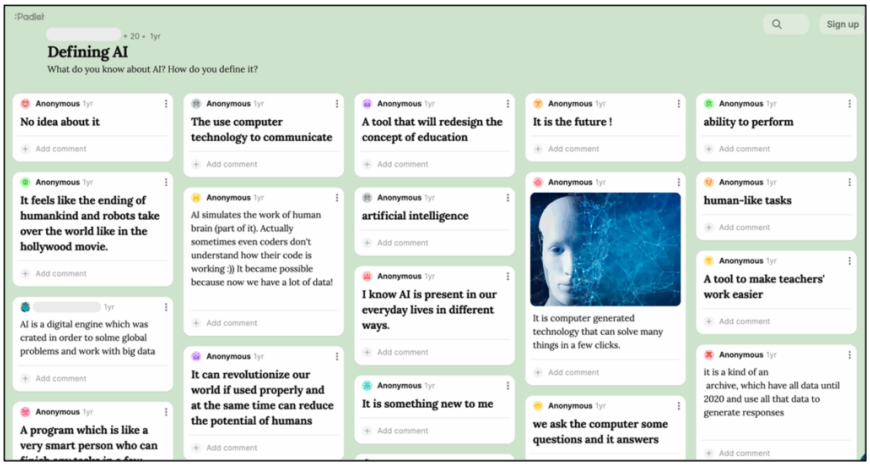
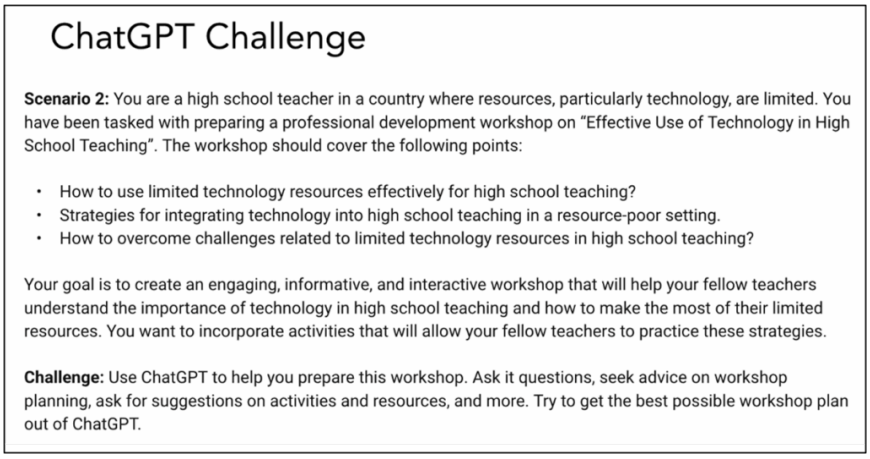


Figure 2
Example of a Scenario-Based ChatGPT Challenge Activity



In the AI-oriented sessions, the general information about what AI is and how it is programmed to work, as well as multiple current examples of AI in use, were shared. For instance, the audience considered how AI might be used in schools for tracking student behavior and their neural activity after viewing a *Wall Street Journal* report on how young children in China are already being tracked through such wearable technology. The teachers also did hands-on engagement with AI tools such as ChatGPT, in particular — the first time at least half were using it — on how they could find, create, and implement teaching materials. Similarly, they worked with image generators to consider them as a tool for instruction in their various classes and shared them in small groups before designing several collective lesson plans related to implementing AI in their teaching.

For the AI instruction, we featured freely available tools and discussed the pitfalls and inherent inequities of subscription-based services. We also discussed how the free tools were offering the user data to the platforms.

Participants

The 21 participants in the Fulbright program represented the following 19 countries: Armenia, Argentina, Bangladesh, Cote d'Ivoire, Ghana, Haiti, Honduras, Kazakhstan, Latvia, Malawi, Malaysia, Mali, Russia, Sri Lanka, Tanzania, Thailand, Uzbekistan, Vietnam, and Zambia. To apply for the program, the teachers were required to attend interviews conducted at the U.S. Consulate in their home countries after submitting multiple essays.

The cohort consisted of social studies and English language arts teachers who taught primarily at public schools, mostly coed and at the secondary level. Their students came from varying socioeconomic, ethnic, and religious backgrounds, though most of their students had fewer economic resources and less access to technology than is customary in Global North countries. In fact, the norm was for participating teachers to feel they had "too many" students, including 40 or more per classroom, on average. Several teachers were forced for economic reasons to teach at more than one school. All teachers reported having to travel to different classrooms to teach instead of having students arrive at one classroom, which they stayed in to teach all day.

In addition to their teaching roles, some participants' roles included head of the department, assistant principal, PL coordinator, teacher trainer, counselor, and club sponsor. Two participants from Africa were leaders in their respective country's English Language Teachers' Association. Through their participation in this organization, they presented at conferences and provided instruction in PL. One of the participants stated that she was interested in teaching methodologies and incorporating technology at the conferences.

Further formal education greatly interested many of the participants, who expressed interest in pursuing graduate degrees. One participant obtained her Ph.D. in History several years ago and used her knowledge to develop curricula at the high school and university levels. Two others were enrolled in doctoral programs previously.

Role of Researchers

As researchers and program designers, we tuned into our backgrounds and professional areas of expertise to guide this work. The first author is a Taiwanese scholar in computing education who focuses on expanding teacher capacity to support K-12 educators and learners' digital and computational literacies through teacher preparation and PL in her research. The second author has been doing research on transnational cultural practices, language, and education for over 15 years. She is a White, bilingual woman who has lived in Mexico for over 6 years total during her career. The third author is a Zimbabwean doctoral student who speaks several languages and has been involved with several multinational, equity-focused research projects in education.

We leaned into these sensitivities to build programming that the educators might be able to take back home, leaning toward less expensive and free tools, for instance, while also offering sensitivity to the limitations we anticipated these educators might have (not unlike educators' limitations in the Global North).

Data Collection and Analysis

We used multiple data sources to help answer the research questions (see Table 1). Pre- and postsurveys, focusing on participating teachers' understanding, self-efficacy, experiences, and needs in computing and AI education, were distributed before and after the Fulbright program. Seventeen of them completed the presurvey, 11 completed the postsurvey, and nine completed both pre- and postsurveys.

We collected artifacts, including their in-class work on Jamboard, Nearpod, and Padlet (free at the time of program development) activities, as well as group lesson plans in Google Docs, during the four 3-hour sessions of PL, where the teachers shared their school cultures and expressed their understanding and perspectives of computing and AI education topics. We also took field notes during the sessions.

After the sessions on computing and AI education, the Fulbright teachers were invited to participate in a focus group emphasizing their PL experiences and reflection on computing and AI integration into their future teaching practices. Nine of the 21 participants volunteered to attend the focus group session during their free time, reflecting their care and concern about this area of education.

While pre- and postsurveys provided insight into shifts in Fulbright teachers' attitudes toward computational literacy and AI education and the mixed gain in knowledge, the focus groups yielded more detailed, nuanced perspectives, along with contextual information and rationales. Plus, only nine out of 21 teachers completed both pre- and postsurveys for comparable data. Therefore, qualitative data from focus groups were emphasized in the analysis and findings, supplemented by survey data where applicable. Thematic analysis (Braun et al., 2016) was employed to identify themes across the data. We also used content analysis (Patton, 2002) to help identify examples and evidence in artifacts.

Results

The perspectives of participating K-12 teachers from less-resourced countries on computing and AI education (Research Question 1) were reflected in three themes that emerged from our data: (a) the participating teachers valued and recognized the importance of computational literacy, (b) various contextual factors influenced and shaped these Fulbright teachers' dispositions toward computing and AI, and (c) major challenges included lack of infrastructure, leadership support, and teacher buy-in.

Table 1
Overview of Data Sources and Their Contributions to Findings

Data Source	Purpose	Contribution to Findings
Presurvey (n = 17)	Examine teachers' existing perceptions of computing and AI education prior to the Fulbright program activities	Captured initial technoskepticism and perceived barriers
Postsurvey (n = 11)	Identify changes in attitudes, values, and knowledge at the end of the Fulbright program	Showed increased openness to AI, but knowledge gain was mixed
Focus group (n = 9)	Deepen understanding of teachers' perspectives on computational literacy and AI education and experiences in the Fulbright program	Provided rich qualitative insights on contextual challenges, infrastructure concerns, and attitudes toward AI
Artifacts (e.g., lesson plans, Jamboard, Padlet)	Triangulate data information and capture applied learning and pedagogical decisions	Illustrated how teachers planned to integrate computational literacy and AI into their teaching

While our Fulbright teachers' PL experiences deepened their understanding of computational literacy and AI, these workshops did not equip them with the requisite knowledge to the degree that they felt they could serve as change agents advocating computation and AI literacies within their school contexts. Specifically, they expressed a need for more in-depth training and support to promote the integration of computing and AI into their school curricula, thereby preparing their students with the essential skills and concepts necessary for success in the digital age. After four sessions on computing and AI education, these Fulbright teachers showed an increased openness to change and intentions to integrate computational literacy and AI into their teaching and leadership practices. The results showed that these teachers' dispositions and perceptions toward computing and AI education developed differently, on a case-by-case basis, due to various contextual factors such as cultures, school systems, and infrastructure.

Perceptions of Computational Literacy and AI in Education

High Values of Computational Literacy and AI

The Fulbright teachers from less-resourced countries held receptive attitudes toward technology in their daily lives and recognized the importance of preparing K-12 students with computational literacy in K-12 education. When computational thinking was introduced, these teachers instantly connected the concept with their teaching practices. The teacher from Sri Lanka said in the focus group,

> I really like the part when we talk about breaking down a concept in those smaller steps, which I think is a part of the computational

> thinking and how we can adapt it into teaching a language on the other subjects…. That really gives a strong impression on me.

Other teachers also said that the infusion of technology, including AI, in teaching and learning, is inevitable. A Bangladeshi teacher stressed that "we [teachers] cannot avoid using AI or technologies and we cannot ban our learners from using them because now they are digital natives" (focus group). However, these teachers held different perspectives on the knowledge and skills their students should have in order to be digitally and computationally literate. According to teachers' presurvey responses, the essential knowledge and skills students should have ranged from basic technology skills (e.g., how to use Microsoft Office) to critically evaluating online information and safety and utilizing technology to solve social problems.

The teachers were excited about the accessibility and applicability of computing and AI to support student learning in their countries. For instance, a Malaysian teacher shared his idea of integrating computing into a vocabulary lesson to allow more accessible learning opportunities: "[I want to] introduce the idea of coding and making it accessible to many students and not just for competitions or for science class students." When discussing teaching text-to-image AI tools, two teachers, one from Malawi and the other from Argentina, suggested using ChatGPT to create images with specific prompts, which they said could foster creativity and problem-solving skills in language learning.

In the same focus group, a Russian history teacher also proposed a critical question: "How can we actually prepare our students to develop career readiness?" He then shared his value of computing and AI: "We have a special skill to write without mistakes. What's the skill for them [students] to prepare or to write the correct prompts to ChatGPT? How can we assess this? I think this is very interesting for the future."

Another teacher from Bangladesh noted how rich ChatGPT can be as a resource to make her instruction and curricular materials more robust:

> So I can integrate AI to create resources like for reading, for listening. For example, if I'm having one topic and I don't have material for assessment, I can just find the text and ask ChatGPT for example to make some multiple choice questions or fill in the Gap questions. The same for listening.

This is a robust example of how ChatGPT can be an excellent provider of resources in a space where physical materials are lacking and also an example of how generative AI can be used as a tool for equity and access.

A subset of participants had a dramatic shift in their understanding of AI. Some had arrived at the program deeply reluctant even to engage the tools. The teacher from Ghana explained, "Prior to coming here, I thought using artificial intelligence was a crime." After learning with us, he was excited to use various tools instead of avoiding them and discouraging his students' use of AI tools. Similarly, a language teacher from Honduras explained that he was deeply unfamiliar with AI but realized, thanks to our instruction, that it is a necessary tool now for both teachers and students:

There is that 21st skills that not only student must have, but the teacher, as well, because in order to use that inside our classroom, we need to be aware how to use it and taking account the ethical parts, too, because our students are digital natives so they can probably learn more about artificial intelligence instead of teachers.

He returned to Honduras and reported taking school-level leadership roles to introduce AI to the instructors at his large urban high school.

Contextual Factors Shaped Teacher Dispositions

Despite the fact that the participating Fulbright teachers perceived the importance of computational literacy for all learners and the potential of computing and AI transforming education, some teachers expressed skepticism and reservations about the topics on technology, especially AI tools, due to the conservative, structured educational systems or school culture.

Fulbright teachers from contexts with more traditional educational systems or restrictive school cultures reported feeling hesitant about using technology, particularly AI tools. These limitations were often described as stemming from limited flexibility in curriculum and restrictions on what can be used and taught, according to, for instance, scripted curricula articulated with national instruction standards. For instance, one teacher from Malawi shared frustrations about a prescribed curriculum that left little room for incorporating innovative teaching methods like AI-powered lesson planning, which the participants explored during course time.

> On the national exam, they will ask for the attributes of dam building. If the students do not give the exact five the system expects, the student will get the question wrong and eventually fail the test if we do not teach exactly what the system wants.

This sentiment highlights the potential conflict between teachers' desire to embrace new technologies and the constraints imposed by rigid educational structures.

A few Fulbright teachers expressed concerns about ethics and AI in their teaching contexts. These concerns appeared to be rooted in broader contextual factors, such as political environments, cultural norms, and school policies surrounding technology use. During the workshop sessions, teachers discussed potential biases embedded in AI algorithms, reflecting anxieties about the alignment of AI tools with their cultural values. A teacher leader from Malaysia said, "We have talked so much about the potentials of AI and how it's going to revolutionize future education. But I also believe that there's always fear behind it, and there's always a clash between this technology and morality."

These concerns highlight the importance of considering the ethical implications of AI integration within specific cultural and political contexts. However, some Fulbright teachers with strong dispositions, like the teacher from Mali, emphasized the importance of human oversight alongside AI tools, "We cannot get to a point and allow AI to make all our decisions for us," she said. This perspective suggests that teachers can play

a crucial role in mitigating ethical risks and ensuring responsible AI use in education.

The results underscore the complex interplay between contextual factors, teacher agency, and dispositions toward computational literacy and AI integration. While limitations imposed by traditional educational systems and ethical considerations create challenges, Fulbright teachers with strong dispositions explained they can navigate these obstacles through creative adaptation and a focus on responsible AI use. Their ability to find workarounds within a rigid curriculum and prioritize ethical considerations demonstrates their commitment to promoting computational literacy and AI education despite limitations. Indeed, sometimes constraints actually provide incentives for educators to work more creatively to disrupt systems and old ways of thinking (Kasun et al., 2019).

Major Challenges: Lack of Infrastructure, Leadership Support, and Teacher Buy-In

Despite the enthusiasm of these Fulbright teachers for integrating computational literacy and AI education in their classrooms, significant challenges were reported related to resource constraints, leadership support, and teacher buy-in.

Resource Constraints and Infrastructure Limitations. A major perceived challenge was the lack of essential technological infrastructure, agreed to by nearly all participating Fulbright teachers. They expressed concerns about unreliable internet connectivity, insufficient hardware such as computers and tablets, and outdated software. "My principal refuses to allow us to have Internet in the school; he thinks we should teach children without it completely," one participant from Bangladesh explained. This reluctance on the part of some administrators points to the specific limitations they anticipated facing upon returning home. Without reliable technology access, effectively integrating computing and AI tools becomes a significant concern.

Leadership Support and Professional Learning Needs. The absence of broad leadership support and PL opportunities was another major concern. The participating Fulbright teachers felt a strong need for school administrators to champion computational literacy preparation and AI education for all students. This included not only providing financial resources but also establishing a clear vision and offering ongoing support for teachers implementing these new practices. Furthermore, the lack of PL opportunities was perceived as a barrier, restricting teachers' ability to develop the skills and knowledge necessary to confidently integrate technology into their lessons. These factors raise concerns about the long-term sustainability of computing and AI integration efforts without a strong foundation of leadership support and ongoing PL.

Teacher Buy-in and School Culture Considerations. Teacher buy-in is crucial for successful implementation, and some Fulbright teachers expressed concerns about colleagues' skepticism and resistance to change. This was particularly true in contexts with traditional educational systems

or rigid school cultures. These concerns mirrored those expressed by a Honduran teacher (focus group), who emphasized the importance of building shared visions and obtaining buy-in from other teachers before implementing new approaches. He explained,

> If students start talking to other teachers, "Hey, I like what my English teacher taught. He's teaching about artificial intelligence," and if the rest of my colleagues or other teachers from different areas say, "Why are you teaching that? That's going to make them lazy," I will let them first discuss it with the principal of my school. So, if he approves to kids, I can carry out a workshop because once my other teacher from my school knows that AI can make your life easier, I bet that everybody would like to start using it. So, I think it's beneficial to first discuss it with other teachers, not go directly with students, because sometimes the teachers criticize the style of other teachers.

Overcoming potential resistance and fostering a collaborative school culture were seen as essential steps for successful integration for this teacher. Looking ahead, addressing these concerns proactively can help mitigate teacher resistance and create a more supportive environment for computing and AI education to flourish.

In addition to the immediate challenges, the Fulbright teachers also expressed concerns about what might arise in the future. Ethical considerations surrounding AI use in education were a particular concern, especially regarding potential biases embedded in algorithms and the alignment of AI tools with their cultural values. These concerns highlight the need to carefully consider the ethical implications of AI integration within specific cultural and political contexts. Furthermore, some Fulbright teachers worried about curriculum alignment, particularly within contexts with limited flexibility or a prescribed curriculum. They expressed concerns about finding ways to integrate computing and AI concepts effectively without disrupting existing curriculum structures. Addressing these concerns will require creative solutions and strategies for adapting curriculum materials to embrace the unique opportunities within specific instructional contexts.

Professional Learning on Computational Literacy and AI Education

Mixed Knowledge Gain

Pre- and postsurvey data indicated a mixed level of knowledge gain regarding AI concepts amongst participants. While some Fulbright teachers reported a deeper understanding of computational literacy and AI, others experienced less significant knowledge growth. At the same time, the surveys were not completed by all participants. This variability could be attributed to several factors, including differences in prior knowledge, learning preferences, and the specific content of the program. When asked about the meaning of computing and AI education, a few teachers considered the development of computational literacy and AI education the same as using technology in their teaching practices, based on open-ended responses from the surveys. Only a few teachers could

clearly define and explain both concepts of computational literacy and AI in survey responses. We suspect this result also reflects a general audience of global teachers' abilities to do so, and we did not explicitly teach the difference or reinforce a contrast in these understandings. For instance, in the postsurvey, the teacher from Uzbekistan defined AI simply as the "assistant of humans," while another teacher from Malawi defined it as "the development of computer-generated systems capable of performing tasks that typically require human intellectual capabilities."

Tailoring future programming to address individual needs and prior knowledge might enhance overall knowledge acquisition. Also, working with smaller groups and providing examples of computational literacy as well as AI from teachers' home country contexts could be an effective strategy for instruction.

Enthusiasm for Innovation and Integration

Despite the variation in knowledge gain, all of the teachers were excited about exploring new ideas, tools, and instructional strategies for their classrooms. This enthusiasm was evident in the example of a language teacher from Malaysia, who envisioned using coding to enhance language learning, making it "accessible to many students and not just for competitions or science class students." This quotation exemplifies the program's success in fostering a growth mindset and a desire to innovate among participants. Teachers' eagerness to share best practices and integrate new approaches into their teaching suggests the program fostered a positive learning environment.

We also identified the positive impact of the program on Fulbright teachers' intention to integrate computing and AI into their teaching practices. Many participants, like an Argentine teacher, expressed a newfound enthusiasm for using technology to enhance student learning and engagement:

> I'm really happy that with those sessions, I got to know that in many ways I can use it [AI] very positively in a way that can incorporate both the technology and the creativity of the students. So, I really love that.

Moreover, she recognized the potential of AI and other computational tools to support teaching effectiveness and efficiency, emphasizing the importance of educators being aware of AI and using AI positively. She added, "Artificial intelligence is something that is going to be the future. So, if we consider it as something negative and if we do not know how to use it positively, it is going to be a disaster." This shift in the teachers' attitudes suggests the program successfully promoted a growth mindset and willingness to embrace new technologies.

Discussion

This study explored the perspectives of 21 K-12 teachers from less-resourced countries regarding the integration of computing and AI into their educational practices, as well as their PL experiences in a Fulbright

teaching excellence program in the United States. Through an exploration of these perspectives, the study revealed the complex interplay between teachers' enthusiasm for these technologies' transformative potential and the contextual factors influencing their perspectives and dispositions toward computing and AI education.

Contextual Factors Play a Critical Role

The study underscored the critical influence of teachers' instructional contexts, particularly access and infrastructure, in shaping teachers' understanding and dispositions of computing and AI education. Teachers in more resource-constrained settings tended to be more technoskeptical (Krutka et al., 2022) due to limited exposure to up-to-date information and resources and the challenges of implementing computing within underdeveloped infrastructure environments.

Our initial survey results indicated a general sense of this technoskepticism. During a workshop discussion, the teacher from Ghana expressed concerns about the internet and device access and was unsure of the benefits of computing and AI applications within his specific context. This concern contrasted with the more optimistic outlook of the teacher from Russia, who due to exposure to AI applications and news, envisioned computing and AI as valuable skills and tools to expand applications in education, the workforce, and even national defense.

The results showed that various contextual factors, including school environment, infrastructure, community norms and expectations, and political culture, can influence teachers' perceptions and knowledge of computing. These findings highlighted the importance of equity in access to resources and fundamental infrastructure when supporting computing and AI education initiatives across instructional contexts in equitable ways (as also in Fletcher & Warner, 2021; Resta et al., 2018). National policy and local school mission discussions need to address this critical aspect to ensure all students are prepared with computational literacies that are aligned with students' cultures and communities and have a chance to benefit from and apply these skills in their daily lives in this information, technology-rich digital age (Kafai & Proctor, 2022).

In light of these findings, policy advocacy becomes imperative to influence national policies regarding technology infrastructure and resource allocation, with equity constantly being advocated and monitored (Margolis et al., 2015). As highlighted by researchers, resource development initiatives should focus on creating open-source educational materials, low-cost technology solutions, and culturally relevant curriculum materials tailored to diverse cultural contexts (Resta et al., 2018). Additionally, collaborative efforts between governments, educational institutions, and international organizations are essential to drive policy changes that promote equitable access to computing and AI education. Large companies that profit from engaging global users should also consider ways to create and provide additional robust digital access tools.

Building Capacity and Going Beyond Access

While access to infrastructure is essential, creating a meaningful PL environment is equally important in building teacher capacity, when the goal is equitable computing and AI education (McGill et al., 2023). Especially in resource-constrained instructional environments, barriers such as cultural resistance to adopting technology, noncontextual educational content, and language obstacles can hinder the adoption of technology and innovation (Kamat & Nasnodkar, 2019). Normalizing the PL context by using low-cost or open-source resources and incorporating unplugged CT activities can make these workshops more relevant and engaging for teachers in resource-constrained settings (Bell & Vahrenhold, 2018); indeed, in our instruction, each of these approaches was engaged and appreciated by the teachers.

Providing hands-on learning opportunities for teachers to explore technology and AI tools firsthand fostered a sense of agency and increased teachers' comfort level by integrating them into their classrooms. This aligns with the findings of Oleson et al.'s work (2022) that emphasized acknowledging subjectivity in research and using relatable contexts to enhance participant engagement. While the Fulbright teachers from less-resourced countries obtained some new knowledge, instructional ideas, and examples of computing and AI integration from the program, we ensured that teachers from diverse backgrounds could connect the discussions to their own instructional contexts.

It is important for teachers to have critical contextual knowledge to appropriately remix and integrate these knowledge and skills into their classrooms to best benefit their students (Mishra et al., 2023). By teachers' integration of context-specific computing and AI content into their classrooms, students are not only able to access learning opportunities but also engaging learning experiences even within resource-constrained environments.

Building Capacity Through Equity-Focused, Culturally Relevant Pedagogies

The participating Fulbright teachers voiced concerns and obstacles, yet their enthusiasm for computing and AI education demonstrated their dedication to student success. However, concerns about limited resources, leadership support, and teacher buy-in create a complex situation. Addressing these challenges requires a multifaceted approach that prioritizes capacity building and culturally relevant pedagogies. As suggested by Ladson-Billings (1995), culturally relevant pedagogies emphasize integrating local knowledge and experiences into lessons to make them more meaningful and engaging for diverse learners. This approach can help overcome challenges related to teacher buy-in by fostering a sense of ownership and relevance in the curriculum (Madkins et al., 2020).

However, simply embedding culturally relevant content is not enough. This study underscored the need for robust professional development programs specifically focused on CT, AI, and culturally relevant pedagogies. These programs should equip teachers with the skills and

knowledge to integrate technology effectively while addressing equity concerns. Furthermore, PL sessions should acknowledge the ethical considerations surrounding AI use in education, such as potential biases in algorithms and issues with academic dishonesty as the concerns shared by some teachers in the surveys.

Additionally, teacher PL can incorporate critical inquiry and lens as a pedagogical tool in computing education for teachers. Kafai and Proctor (2022) noted that "a critical framing of computational thinking contextualizes cognitive and situated practices within broader cultural formations such as race, gender, class, and language" (p. 148). By fostering this critical lens, teachers may emphasize the examination of the social and cultural contexts in which technology operates, including potential biases within algorithms and the broader societal impact of AI and computing systems. Thus, teachers can also empower students to become responsible digital citizens who leverage computing for social good and advocate for ethical and equitable practices in technology development and integration.

Equipping teachers with pedagogical tools in PL provides them with resources that address the specific needs and lived experiences of their diverse student populations. For instance, a teacher in a low-income community might utilize computing concepts to analyze local environmental data sets, fostering connections between abstract computational thinking and real-world issues relevant to their students' lives. Similarly, incorporating local narratives and cultural contexts into computing-integrated lessons can make the subject matter more meaningful and engaging for students from diverse backgrounds (Morales-Chicas et al., 2019). By providing teachers with the knowledge, pedagogies, and tools to navigate these ethical dilemmas, teacher educators can ensure that AI is used responsibly and ethically in the classroom.

Beyond in-service teacher PL, these findings also have broader implications for teacher education programs. Integrating computational literacy and AI into the teacher education curriculum can better prepare future educators to navigate the evolving technological landscape. This integration is crucial, as it equips teachers with the skills necessary to foster students' computational thinking and AI literacy, which are increasingly important in today's digital world (Ayanwale et al., 2022). The efforts in teacher education can support not only expanding teacher capacity in K-12 computing and AI education but also further broadening student participation in K-12 classrooms.

Additionally, higher education faculty members and other teacher educators responsible for teacher preparation need PL opportunities to engage with AI tools critically (Alexandrowicz, 2024). Embedding AI ethics, algorithmic bias, and culturally responsive computing practices into teacher education coursework can create a more sustainable, long-term approach to AI integration in global education systems (Roche et al., 2023).

Collaboration and Rethinking Education for Global Equity

The findings highlight the importance of collaboration among universities, research institutions, and educational leaders from less-resourced countries. We underscore the need to center the identities of the target audiences and sensitivities to their contexts when attempting to provide meaningful and actionable PL. This should never be condescending but appropriate when considering both the eagerness educators can bring and the limitations they might face.

Through thoughtful collaboration, knowledge and resources can be shared, fostering a more equitable global CT and AI education landscape. We also envision a world where flows move from the Global South toward more resourced countries through open-source creation and other forms of innovation. These flows can create new questions and foreground the uses of these technologies not yet envisioned. Furthermore, the limitations of subscription-based educational resources expose the need to rethink traditional education models and explore alternative approaches that are more accessible and democratic.

Limitations

The participants in this study were highly ambitious educators from across the world, who harnessed the resources to apply and succeed at achieving a Fulbright award. As such, we recognized their voices are not representative of all the teachers in the countries they come from. We also recognized that because the cohort was exclusively secondary-level educators, there were no elementary educator perspectives, and the two may vary greatly.

Conclusion

This teaching exchange allowed us the opportunity to share tools and gauge global contexts in terms of access, openness, and possibilities in the 19 unique countries represented. While we cannot generalize our findings, we take them as a signpost for what might be happening in other less-resourced countries. By acknowledging the influence of context, prioritizing equity, and fostering capacity building through culturally relevant pedagogies and collaboration, we can empower teachers with the tools and strategies necessary to harness the transformative potential of computing and AI in their classrooms. This, in turn, will enable all students, regardless of background or resource constraints, to develop the critical skills and digital fluency essential for success in a technologically driven world.

Acknowledgment

We extend sincere gratitude to Leah Harris, a graduate student at Georgia State University, for her invaluable contributions to the data analysis in this research project.

References

Alexandrowicz, V. (2024). Artificial intelligence integration in teacher education: Navigating benefits, challenges, and transformative pedagogy. *Journal of Education and Learning, 13*(6), 346-364. https://doi.org/10.5539/jel.v13n6p346

Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D., & Oyelere, S. S. (2022). Teachers' readiness and intention to teach artificial intelligence in schools. *Computers and Education: Artificial Intelligence, 3*, 100099. https://doi.org/10.1016/j.caeai.2022.100099

Bell, T., & Vahrenhold, J. (2018). CS unplugged—how is it used, and does it work? In H.-J. Böckenhauer, D. Komm, & W. Unger (Eds.), *Adventures between lower bounds and higher altitudes: essays dedicated to Juraj Hromkovič on the occasion of his 60th birthday* (pp. 497–521). Springer. https://doi.org/10.1007/978-3-319-98355-4_29

Braun, V., Clarke, V., & Weate, P. (2016). Using thematic analysis in sport and exercise research. In B. Smith & A. C. Sparkes (Eds.), *Routledge handbook of qualitative research in sport and exercise* (pp. 213–227). Routledge.

Carney, S. (2022). Reimagining our futures together: A new social contract for education. *Comparative Education, 58*(4), 568-569. http://doi.org/10.1080/03050068.2022.2102326

Camp, T., Adrion, W. R., Bizot, B., Davidson, S., Hall, M., Hambrusch, S., Walker, E., & Zweben, S. (2017). Generation CS: The growth of computer science. *ACM Inroads*, *8*(2), 44–50. https://doi.org/10.1145/3084362

Change the Equation (2022). Vital signs: Reports on the condition of STEM learning in the U.S. https://www.ecs.org/wp-content/uploads/TEL-Report_0.pdf

Code.org, CSTA, & ECEP Alliance. (2024). 2024 State of computer science education: Accelerating action through advocacy. https://code.org/assets/advocacy/stateofcs/2024_state_of_cs.pdf

Craig, A., Lang, C., Giannakos, M.N., Kleiner, C., & Gal-Ezer, J. (2014). Looking outside: What can be learnt from computing education around the world? *Proceedings of the 45th ACM Technical Symposium on Computer Science Education*, 371-372. https://doi.org/10.1145/2538862.2538871

DeLyser, L. A., & Wortel-London, S. (2022). Identifying the systems in systems change: Building equitable and sustainable CS education at scale. *Digitalkunde, 3*. https://d-nb.info/1297946863/34#page=1.00

Druga, S., Vu, S. T., Likhith, E., & Qiu, T. (2019). Inclusive AI literacy for kids around the world. *Proceedings of FabLearn,* 104-111. https://doi.org/10.1145/3311890.3311904

DuBow, W., & Gonzalez, J. J. (2020). *NCWIT scorecard: The status of women in technology*. National Center for Women & Information Technology.

Fletcher, C. L., & Warner, J. R. (2021). CAPE: A framework for assessing equity throughout the computer science education ecosystem. *Communications of the ACM*, *64*(2), 23–25.

Goel, A. (2017). AI education for the world. *AI magazine*, *38*(2), 3–4. https://doi.org/10.1609/aimag.v38i2.2740

Google & Gallup (2016). *Diversity gaps in computer science: exploring the underrepresentation of girls, Blacks and Hispanics*. Google Inc. & Gallup Inc.

Heath, M., & Mishra, P. (2023). Generative AI, possibilities, promises, perils, practices, and policy (GenAI-P5). https://ntls.info/wp-content/uploads/2024/02/NTLS-GenAI-P5.pdf

International Society for Technology in Education. (2016). *ISTE standards for students*. https://www.iste.org/standards/iste-standards-for-students

International Society for Technology in Education. (2017). *ISTE standards for educators*. https://www.iste.org/standards/for-educators

International Society for Technology in Education. (2018). *ISTE computational thinking competencies*. https://www.iste.org/standards/iste-standards-for-computational-thinking

K–12 Computer Science Framework. (2016). http://www.k12cs.org

Kafai, Y. B., & Proctor, C. (2022). A revaluation of computational thinking in K–12 education: Moving toward computational literacies. *Educational Researcher*, *51*(2), 146–151.

Kasun, G. S., Clark, S. J., Kaneria, J., & Staker, E. (2019). What if you don't have boots let alone bootstraps? An ELL teacher's use of narrative to achieve and generate agency in the face of contextual constraints. In H. Kayi-Aydar, X. Gao, E. R. Miller, M. Varghese, & G. Vitanova. (Eds.), *Theorizing and analyzing language teacher agency* (pp. 44-62). Multilingual Matters.

Kamat, Y., & Nasnodkar, S. (2019). A survey on the barriers and facilitators to edtech adoption in rural schools in developing countries. *International Journal of Intelligent Automation and Computing*, *2*(1), 32–51.

Kelly, M. A. (2014). Bridging digital and cultural divides: TPCK for equity of access to technology. In AACTE Committee on Innovation and Technology (Ed.), *Handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 31–58). American Association of Colleges of Teacher Education and Routledge.

Krutka, D. G., Heath, M. K., & Smits, R. M. (2022). Toward a civics of technology. *Journal of Technology and Teacher Education*, *30*(2), 229–237.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal*, *32*(3), 465–491. https://doi.org/10.3102/00028312032003465

Madkins, T. C., Howard, N. R., & Freed, N. (2020). Engaging equity pedagogies in computer science learning environments. *Journal of Computer Science Integration*, *3*(2).

Margolis, J., Estrella, R., Goode, J., Holme, J. J., & Nao, K. (2010). Stuck in the shallow end: Education, race, and computing. https:// mitpress.mit.edu/9780262260961/stuck-in-the-shallow-end/

Margolis, J., Goode, J., & Chapman, G. (2015). An equity lens for scaling: A critical juncture for exploring computer science. *ACM Inroads*, *6*(3), 58–66.

McGill, M. M., Thompson, A., Gransbury, I., Heckman, S., Rosato, J., & Delyser, L. A. (2023, March). Building upon the cape framework for broader understanding of capacity in K-12 CS education. In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V.1* (pp. 577-582). Association for Computing Machinery.

Mishra, P. (2019). Considering contextual knowledge: The TPACK diagram gets an upgrade. *Journal of Digital Learning in Teacher Education*, *35*(2), 76–78.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Mishra, P., Warr, M., & Islam, R. (2023). TPACK in the age of ChatGPT and generative AI. *Journal of Digital Learning in Teacher Education*, *39*(4), 235–251.

Morales-Chicas, J., Castillo, M., Bernal, I., Ramos, P., & Guzman, B. L. (2019). Computing with relevance and purpose: A review of culturally relevant education in computing. *International Journal of Multicultural Education*, *21*(1), 125–155.

Morgan, R., & Klaric, J. (2007). *AP® students in college: An analysis of five-year academic careers*. College Board.

Oleson, A., Xie, B., Salac, J., Everson, J., Kivuva, F. M., & Ko, A. J. (2022). A decade of demographics in computing education research: A critical review of trends in collection, reporting, and use. *Proceedings of the 2022 ACM Conference on International Computing Education Research, 1*, 323–343.

Patton, M. Q. (2002). *Qualitative research and evaluation methods: Integrating theory and practice*. Sage.

Resta, P., Laferrière, T., McLaughlin, R., & Kouraogo, A. (2018). Issues and challenges related to digital equity: An overview. In J. Voogt, G. Knezek, R. Christensen, & K.-W. Lai (Eds.), *Second handbook of information technology in primary and secondary education* (pp. 987–1004). Springer.

Roche, C., Wall, P. J., & Lewis, D. (2023). Ethics and diversity in artificial intelligence policies, strategies and initiatives. *AI and Ethics*, *3*(4), 1095-1115.

Rosenberg, J. M., & Koehler, M. J. (2015). Context and technological pedagogical content knowledge (TPACK): A systematic review. *Journal of Research on Technology in Education*, *47*(3), 186-210.

Russo, L. & Oder, J. (2023). *How countries are implementing the OECD principles for trustworthy AI*. OECD. https://oecd.ai/en/wonk/national-policies-2https://oecd.ai/en/wonk/national-policies-2

Su, J., Zhong, Y., & Ng, D. T. K. (2022). A meta-review of literature on educational approaches for teaching AI at the K-12 levels in the Asia-Pacific region. *Computers and Education: Artificial Intelligence*, *3*, 100065.

Tshukudu, E., Sentance, S., Adelakun-Adeyemo, O., Nyaringita, B., Quille, K., & Zhong, Z. (2022). Investigating K-12 computing education in four African countries (Botswana, Kenya, Nigeria, and Uganda). *ACM Transactions on Computing Education, 23*, 1-29.

Vincent-Lancrin, S., & Van der Vlies, R. (2020). Trustworthy artificial intelligence (AI) in education: Promises and challenges. https://doi.org/10.1787/a6c90fa9-en