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Humanizing AI for Education: Conversations with the JLS 2026 Special Issue Contributors

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Abstract: This symposium will bring together the eight invited contributors for the 2026 special issue of the Journal of the Learning Sciences (JLS), which explores how educational researchers can humanize their designs of AI tools and activities for education. Each contributing author brings a unique perspective on what it means to humanize AI for education, working with different contexts, ages, and learning outcomes. Papers focus on a variety of layers of AI, including designing effective AI tools for learning, understanding how existing AI activities influence the learning process, and developing learners' literacies around ethical AI. In this session, authors will engage with attendees in rich conversations around how we should thoughtfully and ethically design AI futures in the learning sciences that center the needs of teachers, learners, their families, and their communities.

Symposium overview

There is an urgent need to thoughtfully integrate human-centered learning theories into the design and teaching of AI, highlighted by the public conversations occurring in governmental, educational, and industry sectors that seek to establish shared norms for how and why AI tools are used (e.g., The White House, 2023; UNESCO, 2023; Software & Industry Information Association, 2023). At the center of these discussions is a tension between technocentric views of AI that seek to improve the effectiveness and expand the reach of AI innovations and human-centered approaches that instead focus on the ethical, social, and pedagogical aspects of how AI impacts our classrooms and our world (Selwyn, 2024; Akgun & Greenhow, 2022). In this session, eight author teams who

were invited to contribute articles to a special issue of JLS (titled "Humanizing AI for Education") will share their empirical explorations of what it means to bring human-centered principles into the design and teaching of AI.

Session organization

Chaired by one of the co-editors of the special issue, the proposed symposium will take the format of a structured poster session in which the eight author teams will share their work with the audience in rounds of conversation, and then authors will come back together at the end of the session for remarks from the discussant and collective Q&A time. Below, each author team outlines the key contributions that their study makes to our collective understanding of what it means to humanize AI for education. Together, these studies offer us a rich foundation to reflect on and discuss how researchers should integrate humanizing principles into the design, implementation, and evaluation of AI innovations for teaching and learning in order to de-center technologies and re-center human needs and experiences in the study of AI.

Paper #1: Human-centered design of a GenAI-based writing tutoring platform: Co-designing with primary school teachers

Ariel Han, Joey Huang, Shenshen Han, Seth Corrigan, Kylie Peppler

Writing is a critical skill that plays a significant role in students' success across various situations and career paths. It allows for articulating ideas, arguing opinions, and synthesizing multiple perspectives (Graham & Perin, 2007). However, writing education remains a complex task, as developing writing competence takes years and requires sustained guidance and practice.

The advent of Generative Artificial Intelligence (GenAI) has transformed content creation and enabled more natural, human-like interactions (Achiam et al., 2023). This progress has led to the development of GenAI-based writing tutoring platforms, offering teachers new tools to incorporate these technologies into their teaching practices (Han et al., 2024a). However, a disconnect exists between these technologies and the specific needs of teachers in real-world educational settings, which limits their applicability (Luckin & Cukurova, 2019). To address this gap, we conducted design-based research (Brown, 1992) in collaboration with six K-12 teachers to co-design a logic model (Stegemann & Jaciw, 2018; Han et al., 2024). This process provided valuable insights into educators' unique perspectives, informing the key features needed for an AI-based writing tutoring platform (Roschelle et al., 2006; Sandoval, 2013). Through co-design sessions, we identified teachers' goals and needs, synthesizing data from both qualitative analysis and existing literacy education research (Graham & Perin, 2007; Graham et al., 2012).

Accordingly, we developed Storybot, a functional GenAI-based writing tutoring platform. Storybot incorporates GenAI-based chatbots that guide students through narrative and opinion writing, integrating GenAI-based brainstorming with genre-specific instruction. The platform aims to reduce barriers to writing while helping students master key structural elements of effective communication (Graham et al., 2012). We conducted a usability study with 13 students (ages 8-12) focused on opinion writing. We measured writing time, word count, and lexical diversity from their outputs and screen recordings. Results showed that students using Storybot improved in all three metrics (McNamara et al., 2010). Qualitative interviews revealed challenges related to independent learning, essay ownership, and integrity, highlighting the need for further research. Additionally, teacher feedback from this study revealed both Storybot's strengths and areas for improvement, which led us to recommendations for further iteration in design of the platform. Key suggestions include offering educators greater control through advanced customization, such as adjusting AI suggestions, setting learning objectives, and using feedback loops generated from platform data. Lastly, fostering GenAI literacy through community engagement and professional development programs is essential to ensure responsible AI use in education (Ayanwale et al., 2024).

We contribute to the learning science community by demonstrating the development of a causal pathway for achieving desired outcomes in a GenAI-based writing platform, using design-based research and usability studies to gather insights from real-world educational stakeholders. Our focus is on creating a novel GenAI platform that enhances student learning and bridges the gap between cutting-edge technologies and real-world educational contexts (Han et al., 2024a).

Paper #2: Towards closing the gender gap in AI: Insights from learner identity profile analysis

Yuru Zhang, Daria Smyslova, Qiuqing Li, Juan Zheng, Carolyn P. Rosé, Jie Chao, Shiyan Jiang

Efforts to promote gender diversity in STEM have yet to bridge the gap, with women still significantly underrepresented in computing fields like AI (National Center for Women and Information Technology, 2022). Recent research in K-12 AI (artificial intelligence) education has highlighted the critical need for targeted interventions that could contribute to closing this gender gap and fostering more inclusive AI learning environments (Jiang et al., 2024). This study investigates gender gaps in AI learner identity by drawing on the theory of disciplinary identity, which includes three dimensions: perceived knowledge and performance, interest in disciplines or related careers, and self-recognition or recognition by others as a disciplinary person (Carlone & Johnson, 2007). Our guiding research questions are: What AI learner identity profiles do students display before and after the intervention? What are the gender differences? How does participation in human-centered AI activities shape female students' positive AI learner identity development?

To address these questions, we conducted a case study at a public high school in the Northeastern United States, focusing on English Language Arts (ELA) classes. Students participated in a one-week StoryQ unit, totaling approximately five hours of instructional time, during which they built machine learning models to classify positive and negative reviews of ice cream stores. The school includes 159 students: 75 female, 77 male, 5 other, and 2 who did not share their gender identity. This study was conducted after ChatGPT gained widespread attention. Most students had heard about AI but lacked formal training in this area.

We collected pre- and post-surveys containing seven Likert-scale items about AI learner identity, divided into four items for perceived knowledge and performance, two items for interests in AI, and one item for recognition. Additionally, we collected activity reports detailing students' learning processes through responses to activity-specific questions. We analyzed activity reports for female students who demonstrated changes in their AI learner identity profile to gain insights into the factors that could contribute to these changes.

We used a mixed-methods approach to examine gender gaps in AI learner identity. Clustering analysis (Kodinariya & Makwana, 2013) of pre- and post-survey responses identified six AI learner identity profiles: Champions, Enthusiasts, Interest-driven Learners, Knowledge-driven Learners, Explorers, and Emerging Learners. Champions showed high positivity across perceived knowledge, interest, and recognition, while Emerging Learners exhibited negativity across these dimensions. Before the intervention, gender gaps were observed, with female students more often classified as Emerging or Interest-driven Learners and all Champions being male. After the intervention, we observed a promising shift: the gender gap began to close, with an increase in female Explorers and Champions. Thematic analysis (Braun & Clarke, 2006) of female students' activity reports indicated that human-centered AI activities played an important role in fostering these positive identity shifts. Our findings highlight the need for ongoing research to develop and implement human-centered AI activities that effectively support and enhance the AI learner identities of underrepresented groups.

Paper #3: (More-than-human)izing AI education

Natalie Araujo Melo, Victoria C. Chávez

This article addresses our concern with growing justice-centered efforts in AI education that fail to account for the endarkened relations that make the practice (Philip & Sengupta, 2020). One such relation is with lands who are often exploited for computational benefit and deployment fueled by racial capitalist and colonialist ideologies (Crawford, 2021; Jones & melo, 2021). Within computing education, learners are seldom prompted to consider computing's relation to land. We notice this gap even within critical computing education efforts, where human-human relations are often prioritized. We follow scholarship calling for meaningful dialogue with Indigenous Ways of Knowing to further inform critical computing education efforts (e.g., Sandoval, 2019). Indigenous Ways of Knowing offer portals to expansive relationality (Bang & Vossoughi, 2016; Vossoughi et al., 2023), insisting that humanizing AI education must include attention to subject-subject relations not just between humans but beyond them as well.

Within this work, we ask: How did relationality mediate student learning about land and AI in a critical computing education class? We study student learning from three iterations of a Computing, Ethics, and Society course taught during 2023-2024. Through "identity journal" prompts, students reflected on each day's theme as related to their lived experiences. Students also conducted a 5-page technology analysis as their midterm and had the opportunity to create a prototype for their final project that showcased how they imagined they might contribute to a just socio-technical world.

We perform content analysis on responses to identity journal prompts, midterms, and finals. Specifically, we seek out students' relational understandings of land across moments of the course and how these relations may connect to their socio-technical imaginings. Our coding scheme is inspired by Kimmerer's (2013) narration of signposts that name different human relations to land. For example, we notice students' shifting understandings of Land as Capital, Property, and Machine, moving towards deepening relations with Land as Teacher and Healer,

Responsibility, Sacred and Community, and Home. Additional preliminary findings suggest that, when prompted, students are able to think about land as relation. However, without explicit attention to land in prompts about technological impacts, students continue to exclusively center humans. We also notice that terms commonly used when referring to more-than-human life, such as "the environment" and "meat," may limit opportunities for students' ethical expansions of personhood afforded to more-than-humans.

We argue that these budding relations between learners and land are consequential to a more-than-humanizing AI education as they work to desettle the field. Finally, we assert that our work is not meant for the benefit of AI education alone but rather an opportunity to reflect on the ways learning as a whole, especially in computing, might be rendered humanizing through engagement with Indigenous ways of knowing.

Paper #4: Critical AI approaches in the English classroom

Jennifer Higgs, Maria Kaimana, Mark Isero

We (a researcher-practitioner team) examined how learning designs in secondary English language arts (ELA) contexts can influence the types of access to rigorous, humanizing, and interdisciplinary learning about AI that students experience. While learning scientists have called for the examination of sociopolitical and ethical issues in computing education (e.g., Vakil et al., 2023), such examinations remain marked primarily for students on engineering/CS pathways (Vakil & Higgs, 2019). We leverage in this study ELA classes as learning spaces available to almost all students in the U.S., and as natural homes to the inquiry, discourse, and literacies essential to exploring sociotechnical issues and developing critical understandings of AI.

Our team examined data from two phases from our year-long social design-based experiment (Gutiérrez, 2016) that explored culturally and linguistically diverse ELA classrooms as sites for interdisciplinary computing education (Higgs & Stornaiuolo, 2024). During Phase 1, Jenni (researcher) conducted observations in Maria's (teacher partner) classes to understand classroom life and practices and to collect data on students' baseline understandings of AI-driven sociotechnical issues. Phase 2 focused on iterative design and implementation of a four-month unit, which the researcher-practitioner team co-designed to develop students' understandings of sociotechnical impacts through meaningful disciplinary texts and practices. Data included class observations, student work, teacher interviews, design and reflection sessions, class documents, student focus groups, and student pre- and post-unit surveys (n=52).

For our qualitative retrospective analysis (Cobb et al., 2003) of design data, Maria, Jenni, and Mark (team member and teacher coach) devised inductive codes from multiple coding cycles and deductive codes drawn from literature, theory, and SDBE design principles to construct a design case. Pre- and post-surveys were analyzed for shifts in students' understandings of sociotechnical issues. Field notes, student work, and class discussions were analyzed thematically for students' responses to the designed unit lessons and for their understandings of AI's social impacts over time.

Findings suggest that valued ELA mediational tools and practices afforded multiple, extended opportunities for students to engage deeply with complex issues related to intersections of AI and race, gender, age, and mental health. Core ELA reading, writing, and discussion practices supported students in exploring and reflecting on the potential social and ethical impacts of AI and how these impacts vary in relation to power. Findings also suggest that interdisciplinary and humanizing approaches to AI education require a strong relational foundation. Pre- and post-unit survey results revealed that over 50% of Maria's students reported changed understandings of AI technology, articulating more critical stances that they connected to their life experiences. Student surveys and discussions emphasized the importance of a safe space to explore challenging and personal topics related to AI. This study contributes to humanizing and critical approaches to K-12 AI education by attending to interdisciplinary learning designs that nurture young people's critical AI literacies and in ways that reimagine both ELA and computing education learning contexts. The study also attends to relationality as a vital dimension of humanizing approaches to AI education.

Paper #5: Human-centered AI literacy for children: A design-based research study in Indonesian primary schools

Stefanus Christian Relmasira, Jonan Phillip Donaldson

As artificial intelligence (AI) becomes increasingly embedded in society, it is imperative to equip young learners with a comprehensive enactive understanding that spans technical, sociocultural, psychological, and ethical dimensions. Existing AI literacy frameworks often lack a generative and holistic approach (Relmasira et al, 2023). To address this gap, we developed the Associative Model of AI Literacy (AMAIL; Relmasira et al., 2024), which

integrates cognitive constructivism, social constructivism, constructionism, and transformative learning theories. This theoretical synthesis emphasizes generative learning, collaborative knowledge construction, creation of meaningful artifacts, and critical reflection, fostering deep student engagement with AI concepts and ethical considerations.

Our study employed a design-based research methodology (Barab, 2022) over five iterative cycles in three Indonesian primary schools, centering student learning experiences throughout. We transformed the theoretical grounding and the sixteen competencies of AMAIL's four constructs—Interaction with AI, Recognition of AI, Explaining & Evaluating AI, and Ethics Regarding AI—into design principles guiding the development of learning activities. These activities were developed to embody human-centered design principles to promote active participation, social interaction, and critical reflection. Data were collected through students' written reflections in response to open-ended prompts after each iteration. We analyzed these reflections using learning experience network analysis (LENA; Donaldson et al., 2024), a novel method that combines qualitative coding with network analysis to map complex interconnections between learning experiences, theoretical principles, and ethical considerations. This analysis allowed understanding the complex dynamics of students' learning journeys, highlighting both struggles and successes.

Findings revealed that students initially faced challenges in understanding abstract AI concepts, which were mitigated by hands-on activities and real-world exploration in subsequent iterations. Collaborative learning emerged as a key factor in deepening comprehension and fostering ethical reasoning. For instance, group projects involving AI applications in community contexts enhanced students' ability to critically assess AI's societal impacts. The iterative design process allowed us to refine the intervention to better support students' learning processes and ethical engagement with AI. Our study underscores the importance of engaging students in ethical work when developing AI literacy. By engaging students in critical discussions about the societal implications of AI and involving them in ethical decision-making processes, we promote a more human-centered and responsible approach. This challenges techno-centric views by highlighting the entanglement and interdependencies of people, AI, and their communities.

Takeaways for educators include having students wrestle with ethical aspects of AI and adopting generative, participatory, student-centered design approaches. Aligning learning activities with learning theories facilitates transformative experiences that empower students to become critical and ethical users and creators of AI technologies. This research contributes to human-centered AI literacy education by presenting a complex, expansive, theoretically integrated, and empirically tested model that centers student learning experiences and ethical engagement. The AMAIL framework and our methodological approach offer valuable insights for designing effective AI literacy interventions. By focusing on the complex and holistic development of AI literacy, educators can prepare young learners to navigate the complexities of AI in society responsibly.

Paper #6: AI ethics learning through digital-tangible arts making with AI

Anna Keune, Santiago Hurtado

The surging integration of AI in tangible and digital aspects of learning kindles concerns about reduced creative independence, interaction transparency, and dataset relations (Holmes et al., 2021). Left unnoticed, such ethics issues can exacerbate inequities in learning–posing a threat to children's rights (Adams et al., 2023). However, there is little knowledge about high-quality AI ethics learning, risking a detrimental oversight of child's rights-based learning. Promising starting points for AI ethics learning lay in recent research on collaboration with AI and digital and tangible modalities of AI literacy (Druga et al., 2019; Morales-Navarro et al., 2023). Thus, this research asked: *How do young people learn AI ethics through collaborative digital and tangible design with AI?*

We built on prior work of human-material collaborative learning (Keune 2024), focusing on how the production of AI ethics based on intergovernmental AI standards (OECD, 2024) unfolds through changes in physical instantiations. We conducted a 4-day workshop with 12 youths (13-15 years old; 3 small groups). Participants used tangible crafts (e.g., fabric, photo printer) to create textures and drawings they combined with AI (e.g., Adobe Firefly, PromeAI). We video-recorded the co-creation processes (45 hours) and asked youth to articulate design processes and ethical dilemmas. We performed a micro-analysis of learning processes (e.g., shifts in digital and tangible design) that produced AI ethics (Keune et al., 2024).

Moving between tangible and digital material manipulations produced opportunities for AI ethics, especially transparency and explainability in collaboration of AI, tangible materials, and youth. For example, one group created a tangible drawing of a forest and a texture of a storm (Figure 1). This led to an unexpected outcome and considerations of *transparency and enhancing creativity*. One youth said: "*It's not what we imagined. [...] There were no steps which showed how it was produced. But there must be a process*." The youth expected that AI would superimpose the thunderstorm on the forest. Instead, AI used the thunderstorm to generate 3D and

tangible appearing effects on the forest. The digital integration of tangible artifacts led to further explorations of the AI, leading to a more transparent understanding of what AI does and a way to use AI to enhance young people's creativity. The study shows that across digital and tangible materials fostered arts-based contexts rich in AI ethics. Digitizing tangible creations made it possible for participants to point to resulting ethics dilemmas and explorations to circumvent them. Designing for digital and tangible collaborations with AI is a promising context for learning AI ethics.

Figure 1

A Drawing (1), Textures (2 and 4), and AI Combinations of Drawing and Textures (3 and 5).

Paper #7: Co-designing generative AI tools for equitable and effective classroom integration: A middle school case study

Daniel Ritchie, Dana Saito-Stehberger, Tamara Tate, Mark Warschauer

Generative AI tools have rapidly entered educational settings, presenting both opportunities and challenges. This study explores the co-design of PapyrusAI, an AI-enabled writing coach, with middle school teachers and students to address the needs of teachers and enable effective classroom implementation. Poor and uneven implementations of technology use can worsen educational equity divides (Margolis, 2017; Ames, 2019; Rafalow, 2020). With increasing AI adoption in schools, it is crucial that these technologies are developed collaboratively with users to promote equitable educational outcomes (Belgrave et al., 2022; Anderson-Coto, 2024). This project, within a research-practice partnership (RPP), aims to understand how participatory co-design influences generative AI integration in middle schools, focusing on Latine communities.

The first iteration of this study occurred in Spring 2024. We partnered with a local K-8 dual immersion charter school with over 95% Latine students, most from low-income backgrounds. Four middle school teachers and 120 students worked with researchers to adapt PapyrusAI for middle school. This process involved professional development workshops to enhance teachers' AI literacy (Long & Magerko, 2020), followed by co-design sessions to brainstorm how to integrate PapyrusAI into lessons in ways that supported student learning objectives and incorporated appropriate AI literacy education. Teachers used PapyrusAI in multiple assignments and lessons for five weeks. Student co-design sessions during this period allowed the teachers and researchers to gather insights on how PapyrusAI and the curriculum implementing it could better support learning. Data from observations, student interactions with PapyrusAI, and teacher feedback provided a comprehensive view of the co-design process. The second iteration, in Fall 2024, expanded to include additional partner schools, involving ten more teachers in a different district. This iterative process follows DBIR principles (Fishman et al., 2013) to allow ongoing refinement of both the tool and educational practices.

Preliminary findings suggest that co-design can be effective in a cyclical manner, where teachers' classroom practices are adjusted for the AI as the AI is adjusted for classroom practices. Additionally, we have found that teachers have varying perceptions regarding the utility and role of AI in the classroom, although most recognize some level of usefulness. However, challenges remain in ensuring adequate teacher support, echoing the importance of sustained professional development (Conaway, 2020). Further analysis will explore how the variation in teachers' perceptions influence their classroom implementations and how the researchers can effectively support teachers with different goals for AI in the classroom.

This research highlights the value of participatory design in creating equitable, effective educational technologies in a rapidly evolving technological landscape. Grounding its design in students' and teachers' experiences aims to better align PapyrusAI with the needs and learning contexts of diverse students. An understanding of what the students and teachers bring to the use of AI in the classroom allows us to provide necessary instructional support for implementation, impacts the design of the tool, and provides information that will help us promote both teacher and student agency in future implementations.

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Paper #8: Young adolescents' resistance of and with AI: Learnings from three "training-camps" through a lens of community cultural wealth

David W. Jackson, Stacy M. Scheuneman, Da'Von L. McCune, Kellyann Ramdath, Finn Goehrig, Ifeoma Nwogu, Noemi Waight

Dominant discourses on artificial intelligence (AI) center voices of adults and perpetuate monetization through opaque mechanisms. Youth show skepticism and resistance that can bring more transparent and equitable uses – or refusals – of AI. We collectively centered on *resistant capital* (Yosso, 2005) in our work with middle- and high-school youth during three vacation "training-camps" on AI. In addition to asking questions about youths' (re-)application of knowledges and skills of resistant capital, we also wondered about the youths' development of AI concepts, perspectives, and practices, thinking with the Impact.AI framework by Williams (2024).

We report on vacation programs with Black and Brown and New Americans in the US Rust Belt during April 2023, February 2024, and April 2024, wherein 35 total youth first participated in exploratory AI activities, then made their own AI-enhanced apps. Youth critically reflected upon their use of mass-marketed platforms, remaining skeptical even as they designed apps that addressed community needs. Our research design is parallel mixed-methods for convergence, drawing from pre- and post-surveys, daily exit tickets, youth post-interviews, and family focus groups. The pre- and post-surveys adopt and extend a resistant capital subscale by Sablan (2019), developed and refined through the tenets of QuantCrit (Garcia et al., 2018). The daily exit tickets are consistent with the aforementioned Impact.AI framework by Williams (2024) and community center values of the space being open, safe, productive, and responsive to community needs. Protocols for youth post-interviews and family focus groups incorporated elements of resistant capital, Impact.AI, and community center values.

The revised subscale had acceptable reliability for the participating youth (Cronbach's α between 0.8 and 0.9), despite it originally being developed with a predominantly Asian-American population at the university level. The camps had a medium effect size upon youths' self-reported resistant capital (Cohen's d=.606, p=.017) per paired-samples t-tests of means. Exit tickets suggested that youth statistically significantly improved in their self-reported skills for AI practices, with no significant differences at the α=.05 level for AI concepts or perspectives. These self-reported quantitative findings are supported by qualitative findings from field notes, interviews, and family focus groups, through critical conversational narrative analysis. Youth and caregivers focused on more local concerns and showed less interest in country- or world-level matters for AI. Participants highlighted markers of gender and socioeconomic status in particular, and to a lesser extent race and ethnicity, plus intersections thereof when they spoke of equity in AI.

Our work contributes counternarratives to the dominant technocratic discourses on AI, pushing back against stories of AI as a linguistic equalizer or educational panacea. Our vacation training-camp design shows promise for transfer to during-school-time interventions, harmonizing the rigor of "training" within the freedom of a "camp"-like environment. Despite our relatively small sample sizes, the revised subscale shows promise for younger and more diverse participants, and can support prior probabilities for Bayesian approaches beyond typical frequentist approaches. In these ways, the work suggests paths for resistance through, and perhaps *of*, AI.

References

Adams, C., Pente, P., Lemermeyer, G., & Rockwell, G. (2023). Ethical principles for artificial intelligence in K-12 education. Computers and Education: Artificial Intelligence, 4, 100131.

Achiam, J., Adler, S., Agarwal, S., Ahmad, L., Akkaya, I., Aleman, F. L., ... & McGrew, B. (2023). Gpt-4 technical report. *arXiv preprint arXiv:2303.08774*.

Akgun, S., & Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. *AI and Ethics*, *2*(3), 431-440.

Ames, M. G. (2019). The charisma machine: The life, death, and legacy of One Laptop Per Child. MIT Press.

Anderson-Coto, M. J., Salazar, J., Lopez, J. L.-S., Sedas, R. M., Campos, F., Bustamante, A. S., & Ahn, J. (2024). Towards culturally sustaining design: Centering community's voices for learning through Participatory Design. International Journal of Child-Computer Interaction, 39, 100621.

Ayanwale, M. A., Adelana, O. P., Molefi, R. R., Adeeko, O., & Ishola, A. M. (2024). Examining artificial intelligence literacy among pre-service teachers for future classrooms. *Computers and Education Open*, *6*, 100179.

Bang, M., & Vossoughi, S. (2016). Participatory Design Research and Educational Justice: Studying Learning and Relations Within Social Change Making. *Cognition and Instruction, 34*(3), 173–193.

Barab, S. (2022). Design-based research: A methodological toolkit for engineering change. In R. K. Sawyer (Ed.), The Cambridge Handbook of the Learning Sciences (3 ed., pp. 177-195). Cambridge University Press.

Belgrave, A. B., Bermudez, V. N., Chew, P., Lin, Y., Ahn, J., & Bustamante, A. S. (2022). Using a participatory design approach for co-creating culturally situated STEM enrichment activities. Journal of Applied Developmental Psychology, 82, 101451.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

Brown, A. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of Learning Sciences*, *2*(2), 141–178.

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *44*(8), 1187-1218.

Cobb, P., Confrey, J., DiSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher*, *32*(1), 9-13.

Conaway, C. (2020). Maximizing Research Use in the World We Actually Live In: Relationships, Organizations, and Interpretation. Education Finance and Policy, 15(1), 1–10. https://doi.org/10.1162/edfp_a_00299

Crawford, K. (2021). *The Atlas of AI*. Yale University Press.

Donaldson, J. P., Han, A., Yan, S., Lee, S., & Kao, S. (2024). Learning experience network analysis for design-based research. Information and Learning Sciences, 125(1/2), 22–43.

Druga, S., Vu, S. T., Likhith, E., & Qiu, T. (2019). Inclusive AI literacy for kids around the world. Proceedings of FabLearn 2019, 104–111.

Fishman, B. J., Penuel, W. R., Allen, A.-R., Cheng, B. H., & Sabelli, N. (2013). Design based implementation research: An emerging model for transforming the relationship of research and practice. National Society for the Study of Education, 112(2), 136–156.

Garcia, N. M., López, N., & Vélez, V. N. (2018). QuantCrit: Rectifying quantitative methods through critical race theory. *Race Ethnicity and Education, 21*(2), 149–157.

Graham, S., & Perin, D. (2007). A meta-analysis of writing instruction for adolescent students. *Journal of Educational Psychology*, *99*(3), 445–476.

Graham, S., Bollinger, A., Olson, C. B., D'Aoust, C., MacArthur, C., McCutchen, D., & Olinghouse, N. (2012). Teaching Elementary School Students to Be Effective Writers: A Practice Guide. NCEE 2012-4058.

Gutiérrez, K. D. (2016). 2011 AERA Presidential Address: Designing resilient ecologies: Social design experiments and a new social imagination. *Educational Researcher*, *45*(3), 187-196.

Han, A., Corrigan, S., Han, S., & Peppler, K. (2024, June). Co-Design a Logic Model for Inclusive AI-Powered Learning Application with Primary School Teachers. In *17th International Conference on Computer-Supported Collaborative Learning (CSCL) 2024-CSCL Proceedings* (Vol. 2024).

Han, A., Zhou, X., Cai, Z., Han, S., Ko, R., Corrigan, S., & Peppler, K. (2024a). Teachers, Parents, and Students' Perspectives on Integrating Generative AI into Elementary Literacy Education. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '24*, May 11–16, 2024, Honolulu, HI, USA: Association for Computing Machinery.

Higgs, J., & Stornaiuolo, A. (2024). Being human in the age of AI: Young people's ethical concerns about writing and living with machines. *Reading Research Quarterly*. doi:10.1002/rrq.552

Holmes, W., Porayska-Pomsta, K., Holstein, K., Sutherland, E., Baker, T. T., Shum, S. B., … Koedinger, K. R. (2021). Ethics of AI in education: Towards a community-wide framework. I*nternational Journal of Artificial Intelligence in Education,* 32(3), 504–526.

Jiang, S., McClure, J., Tatar, C., Bickel, F., Rosé, C. P., & Chao, J. (2024). Towards inclusivity in AI: A comparative study of cognitive engagement between marginalized female students and peers. *British Journal of Educational Technology*.

Jones, S. T., & melo, natalie araujo. (2021). We Tell These Stories to Survive: Towards Abolition in Computer Science Education. *Canadian Journal of Science, Mathematics and Technology Education, 21*(2), 290–308.

Keune, A., Hurtado, S. & Simšič, Ž. (2024). Exploring AI Ethics through educational scenarios with AI generative arts apps. *In 18th International Conference of the Learning Sciences - ICLS 2024* (pp. 1818-1821). ISLS.

Keune, A. (2024). Learning within fiber-crafted algorithms: Posthumanist perspectives for capturing human-material collaborations. *International Journal for Computer Supported Collaborative Learning,* 19(1), 37-65.

Kimmerer, R. (2013). *Braiding Sweetgrass*. Milkweed editions.

Kodinariya, T. M., & Makwana, P. R. (2013). Review on determining number of Cluster in K-Means Clustering. *International Journal*, *1*(6), 90-95.

Long, D., & Magerko, B. (2020). What is AI Literacy? Competencies and Design Considerations. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, 1–16.

Luckin, R., & Cukurova, M. (2019). Designing educational technologies in the age of AI: A learning sciences-driven approach. *British Journal of Educational Technology*, *50*(6), 2824-2838.

Margolis, J. (2017). Stuck in the shallow end: Education, race, and computing (Updated edition). MIT Press.

McNamara, D. S., Crossley, S. A., & McCarthy, P. M. (2010). Linguistic features of writing quality. *Written Communication, 27*(1), 57–86.

Morales-Navarro, L., Kafai, Y. B., De Castro, F. B., Payne, W. D., DesPortes, K., DiPaola, D., … Vakil, S. (2023). Making sense of machine learning: Integrating youth's conceptual, creative, and critical understandings of AI. arXiv (Cornell University).

National Center for Women and Information Technology. (2022). *By the numbers.* https://ncwit.org/resource/bythenumbers/

Organization for Economic Co-operation and Development (2024). Recommendation of the Council on Artificial Intelligence OECD/LEGAL/0449.

Philip, T. M., & Sengupta, P. (2020). Theories of learning as theories of society: A contrapuntal approach to expanding disciplinary authenticity in computing. *Journal of the Learning Sciences, 30*(2), 330–349.

Rafalow, M. H. (2020). Digital divisions: How schools create inequality in the tech era. University of Chicago Press.

Relmasira, S. C., Donaldson, J. P., & Lai, Y. C. (2024). Toward a Theory-Grounded Associative Model of AI Literacy. In Lindgren, R., Asino, T. I., Kyza, E. A., Looi, C. K., Keifert, D. T., & Suárez, E. (Eds.), Proceedings of the 18th International Conference of the Learning Sciences - ICLS 2024 (pp. 2057-2058). International Society of the Learning Sciences.

Relmasira, S. C., Lai, Y. C., & Donaldson, J. P. (2023). Fostering AI literacy in elementary science, technology, engineering, art, and mathematics (STEAM) education in the age of generative AI. Sustainability, 15(18), 13595.

Roschelle, J., Penuel, W., & Shechtman, N. (2006). Co-design of Innovations with Teachers: Definition and Dynamics. In Barab, S. A., Hay, K. E., & Hickey, D. T. (Eds.), The International Conference of the Learning Sciences: Indiana University 2006. Proceedings of ICLS 2006, Volume 2 (pp. 606-612). Bloomington, Indiana, USA: *International Society of the Learning Sciences.*

Sablan, J. R. (2019). Can You Really Measure That? Combining Critical Race Theory and Quantitative Methods. *American Educational Research Journal, 56*(1), 178–203.

Sandoval, C. D. M. (2019). *Ancestral Knowledge Meets Computer Science Education*. Palgrave Macmillan US.

Sandoval, W. (2013). Conjecture Mapping: An Approach to Systematic Educational Design Research. *Journal of the Learning Sciences*, *23*(1), 18–36.

Selwyn, N. (2024). Constructive criticism? Working with (rather than against) the AIED back-lash. *International Journal of Artificial Intelligence in Education*, *34*(1), 84-91.

Software & Industry Information Association (2023, October 24). The education technology industry's principles for the future of AI in Education. https://edtechprinciples.com/principles-for-ai-in-education/

Stegemann, K. C., & Jaciw, A. P. (2018). Making It Logical: Implementation of Inclusive Education Using a Logic Model Framework. *Learning Disabilities: A Contemporary Journal*, *16*(1), 3-18. storytelling for young learners. *Interaction Design and Children.*

The White House (2023). Blueprint for an AI Bill of Rights: Making automated systems work for the American people. *Office of Science and Technology Policy.* https://www.whitehouse.gov/ostp/ai-bill-of-rights/

UNESCO (2024). AI competency framework for teachers - UNESCO Digital Library.

UNESCO (2023). Guidance for generative AI in education and research. *United Nations Educational, Scientific and Cultural Organization*. https://unesdoc.unesco.org/ark:/48223/pf0000386693

Vakil, S., & Higgs, J. (2019). It's about power: A call to rethink ethics and equity in computing education. *Communications of the ACM, 63*(3), 31-33.

Vakil, S., Reith, A., & Melo, N. A. (2023). Jamming power: Youth agency and community-driven science in a critical technology learning program. *Journal of Research in Science Teaching*, *60*(8), 1723-1754.

Vossoughi, S., Marin, A., & Bang, M. (2023). Toward Just and Sustainable Futures: Human Learning and Relationality Within Socio-Ecological Systems. *Review of Research in Education, 47*(1), 218–273.

Williams, R. (2024). Impact.AI: Democratizing AI through K-12 artificial intelligence education [Doctoral dissertation, Massachusetts Institute of Technology].

Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education, 8*(1), 69–91.