Generative AI in STEM Teaching

Promises, Pitfalls, and Paths Forward

Jeremy F Price, PhD Indiana University Indianapolis **Shuchi Grover, PhD** Looking Glass Ventures

Promises of Generative AI

in STEM Teaching

Our Approach

Teacher learning and leadership

How can AI further teacher growth in STEM teaching and build my capacity for leadership among my peers?

Assessing student work and progress

How can AI support me in ascertaining where my students are in achieving learning goals, what they know, and what they are able to do?

Justice, equity and inclusion

How can I use AI to help me facilitate an inclusive STEM learning environment that promotes justice and equity, particularly for marginalized students in my classroom? Curricular decision-making and lesson planning

How can AI help me understand what needs to be taught in STEM and why?

Pedagogical practices and instruction

How can AI help me in varied pedagogical approaches, activities, and engaging experiences for teaching STEM content and practices?

Personalized Teaching

Personalized Teaching is...

honoring and promoting teacher agency the intentional adjustments that teachers, helping teachers recognize their footprint as cultural beings with experiences and backgrounds, providing a broad range of opportunities for change make to the learning environment students are not monolithic to address the unique needs of each student.

A Range of Possibilities for GenAI

Teacher learning and leadership

How can AI further teacher growth in STEM teaching and build my capacity for leadership among my peers?

Assessing student work and progress

How can AI support me in ascertaining where my students are in achieving learning goals, what they know, and what they are able to do?

Justice, equity and inclusion

Teachers may be more open to feedback from a GenAI chatbot than from a peer, coach, or administrator. Curricular decision-making and lesson planning

How can AI help me understand what needs to be taught in STEM and why?

Pedagogical practices and instruction

How can AI help me in varied pedagogical approaches, activities, and engaging experiences for teaching STEM content and practices?

Pitfalls of Generative AI

in STEM Teaching

The Mythical Paradox

The workings of Generative AI seem almost magical or mystical, but the large language models and applications that constitute the human-AI interface were designed and developed by humans with intentions and based on assumptions.

How do we avoid viewing Generative AI as a "Just-So Story" and recognize the sociohistorical and economic factors that contribute to its construction?

The Productivity Paradox

Generative AI can accomplish many tasks that are assigned to teachers much more quickly than a human can. This can lead to found time for teachers.

What will fill this found time for teachers?

The Big Data Paradox

The "magic" of Generative AI relies on vast datasets often used without consent, affecting both individuals and cultural legacies. This scale drives exploitative labor, particularly in the Global South, unsustainable environmental impacts, and limits AI's ability to handle "edge cases," so it defaults to "normal" identities.

How do we ensure the ethical training, development, and application of Generative AI when supporting STEM teachers?

Distribution Paradox

While Generative AI can certainly offer benefits to STEM teachers, some teachers in schools and communities who can benefit the most may have neither access nor opportunity to engage in AI-supported personalized teaching.

How do we ensure that the promises and benefits of Generative AI are more equally and equitably distributed?

Paths Forward for Generative AI

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Teacher's Helper

- Acknowledge the immeasurable importance of teachers in the classroom
- Support not supplant and Always center teachers must be the mantra for all GenAI-in-Ed efforts
- GenAI as part of a toolkit that allows teachers to make better decisions
 - Need to develop GenAI tools that are teacher-facing and are consciously designed to help teachers alleviate the challenges they face in enacting good STEM teaching
 - Take into account their context, needs, teaching philosophy, ...

Illuminating the Black Box

- For AI systems to be fully effective, the black box of GenAI-in-Ed must be fully open to examination throughout the development process
- GenAI models need to maintain situational awareness ⇒ situational knowledge of the teacher, students, and classroom context must be considered in GenAI's outputs
 - Human-AI interactions must be ongoing dialogues and co-constructive processes so that teachers and educators provide feedback to the GenAI to ensure that it is providing effective and relevant
 - Techniques such as fine-tuning, augmenting, and/or customizing LLMs to assist teachers in developing contextual STEM materials
 - provide teachers with tools and the know-how to perform the last mile of fine-tuning and contextualization of the LLMs they use in their teaching

Co-Design & Participatory Research

- Evidence-based deployment of GenAI requires research (many research trajectories outlined under each of the five sections)
- Only if teachers, families, and communities are part of the development process of both GenAI tools & datasets (on which GenAI models are trained) ⇒ GenAI can support our educational values of inclusion & fairness
- Community-engaged and critical participatory design research methodologies (Bang et al., 2016) as well as methodological frameworks for values-centered inclusive designs like Calo et al. (2021) must be leveraged for GenAI tool R&D
- The inclusion of educator and community voices can help move the conversation about GenAI tools R&D from a deficit-based approach to an asset- or strengths- based approach (Ocumpaugh et al., 2024)

Leveraging Past Research

- Extensive body of research in teaching & learning
- Crucial for GenAI LLMs to encode learning theory and findings from research on STEM teaching so that their outputs reflect the best evidence-based knowledge
- For example,
 - The importance of learning trajectories and progressions to establishing learning goals and standards, driving formative assessment and supporting STEM classroom pedagogy
 - Large body of research conducted on (pre-GenAI) ITSs devoted to understanding and encoding models of student cognition into AI models
 - Existing socioemotional learning frameworks (such as CASEL) into GenAI

Teacher GenAI Literacy

- Teacher understanding of GenAI is a prerequisite to GenAI-in-Ed
 - Teachers must not become reliant on GenAI while remaining blissfully ignorant about the technology.
- Invest in developing teachers' GenAI literacy practices
 - Understanding of AI and how AI works, issues of biases in LLMs, and developing prompt engineering skills, etc (many Teacher AI LIteracy frameworks have emerged)
 - Ability to evaluate GenAI outputs—help teachers recognize inaccuracies and generic, surface-level content and responses
 - Prepare preservice teachers and support in-service teachers to engage with GenAI intentionally and critically

 Ensure diverse training corpora to address the needs & experiences of diverse teachers and the students they teach

Thank You



Jeremy F Price jfprice@iu.edu

Shuchi Grover shuchigrover@acm.org