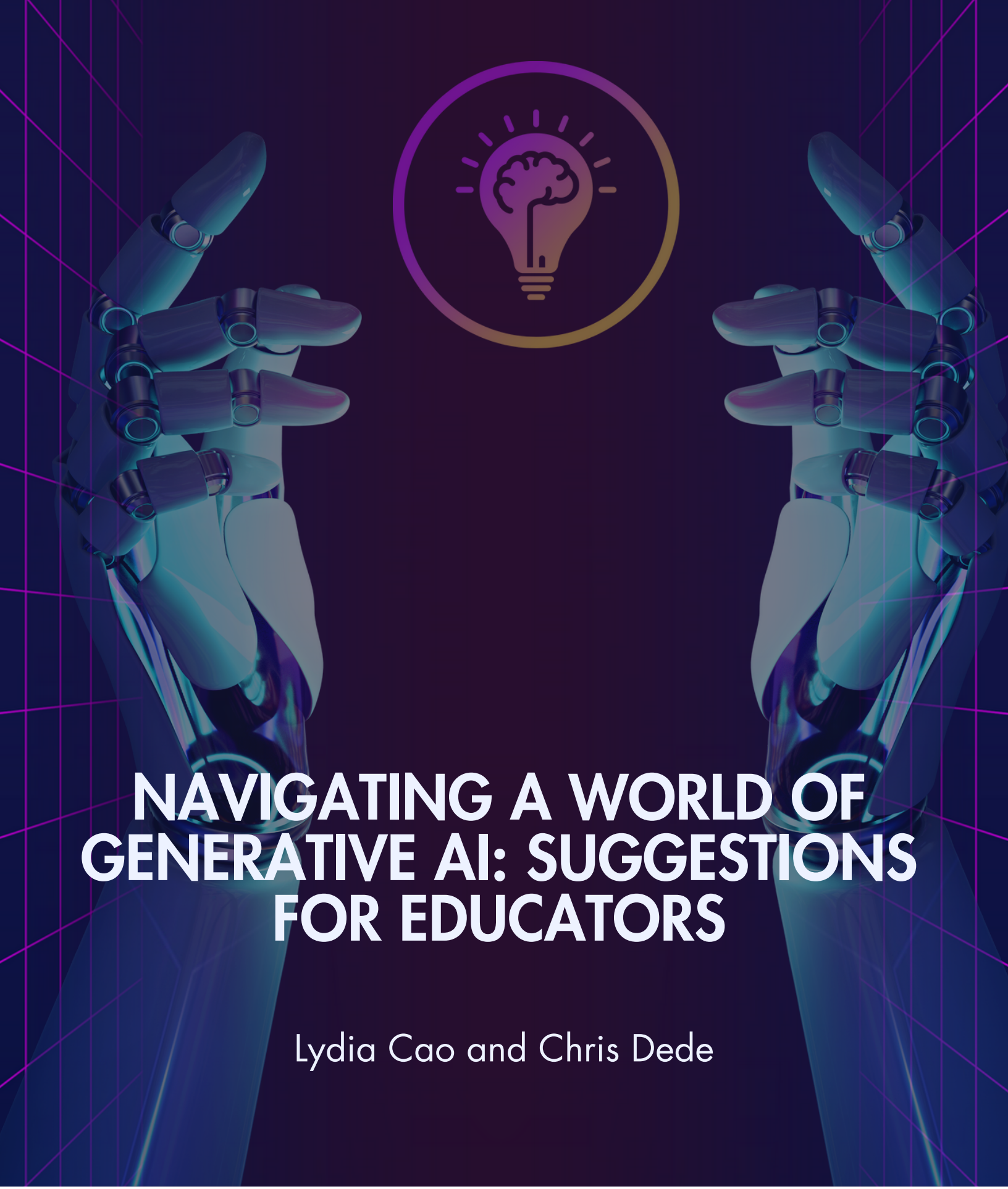

# NAVIGATING A WORLD OF GENERATIVE AI: SUGGESTIONS FOR EDUCATORS

Lydia Cao and Chris Dede

HARVARD GRADUATE SCHOOL OF EDUCATION

NEXT LEVEL LAB

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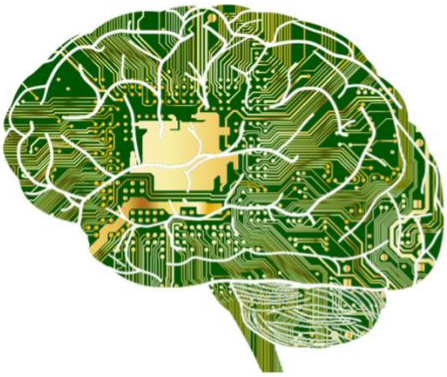
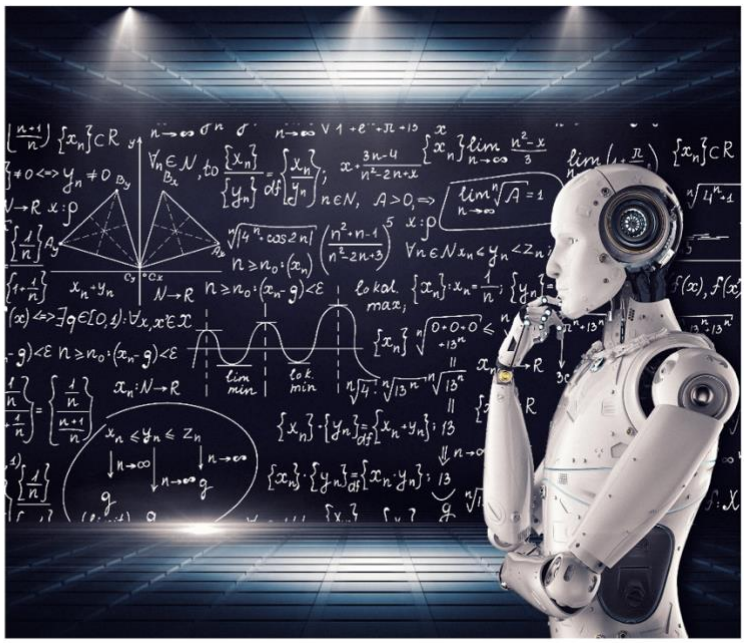
Lydia Cao and Chris Dede
The Next Level Lab, Harvard Graduate School of Education

## Understanding the Nature of Generative AI

What images come to your mind when you think of artificial intelligence (AI)? Popular illustrations include human-like robots, or a brain intertwined with chips and wires. However, these images and metaphors do not accurately reflect what AI is. The field of AI encompasses a wide range of techniques and methods that perform functions we may not typically associate with it, such as facial recognition, personalized news feeds on social media, customized suggestions and advertisements, route planning (e.g., Google Maps), and search engines (e.g., Google Search, which uses AI to improve accuracy and relevance of search results). Generative AI is an umbrella term for any AI system that can generate content--such as images, texts, audio, and codes--based on the data on which the GPT-based Large Language Model (LLM) is trained (Bender et al., 2021; Chiang, 2023). Much of the Worldwide Web on the Internet is the core dataset of current LLMs, which are then fed additional selective data to tune their responses for particular purposes.



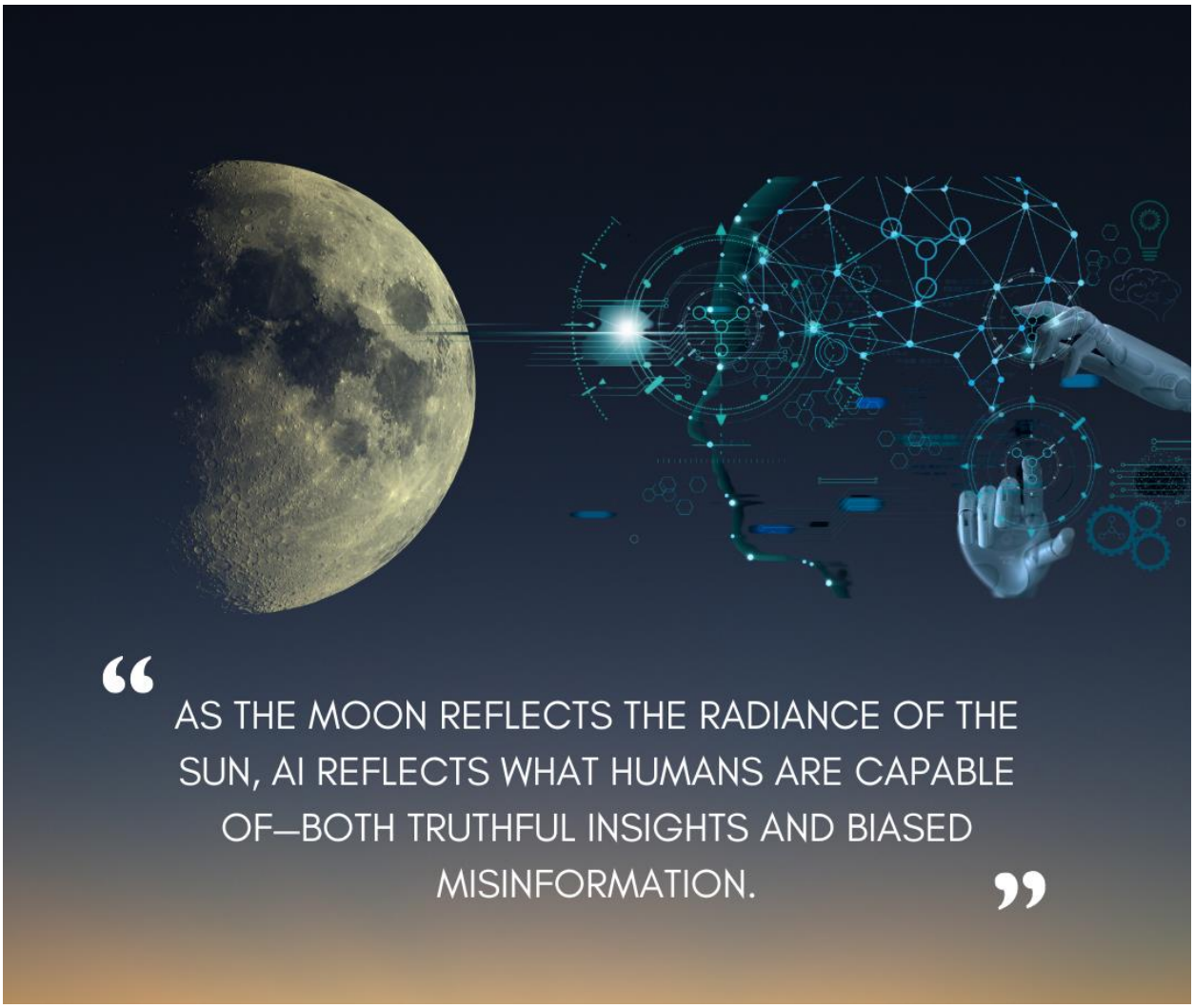


Although some AI architectures, such as digital neural networks and deep learning systems, are built to mimic the structure and function of human neural networks, these are far from being equivalent to a human brain. An LLM can be described as a brain without sensory inputs or agency – a brain without a mind, consciousness, and self-awareness. In constructing replies to textual questions, generative AI predicts words one by one without comprehension or awareness of its

own output. Like a parrot repeating what it has heard without comprehending what these words mean, LLMs are a performance of exposition without understanding or metacognition.

As an analogy, we can think of AI as moonlight and human accomplishments as sunlight. As the moon reflects the radiance of the sun, AI reflects what humans are capable of—both truthful insights and biased misinformation. AI is trained using existing data from the world wide web, which leads to the potential problem of "garbage in, garbage out," as well as pervasive issues of AI "hallucinations" where it generates responses that sound plausible but are factually incorrect, such as fabrication of citations of research articles that do not exist.

With this description in mind, let's reflect on the role of generative AI in learning and how this pushes us to reconceptualize our visions of effective education.



## Assessing Learning: Process vs. Product

Our model of education has long been product-focused: Can you write an effective and cogent essay? Can you score high on the SAT or other high-stakes psychometric tests? Do you know how to say, "I'd like a cup of coffee," in French? Unsurprisingly, major concerns about generative AI are related to plagiarism because of LLMs' capacity to generate "products of learning" as if the student had created these. Some school districts and universities have even banned the use of ChatGPT. But why shouldn't students use ChatGPT to write their essays if writing is solely about producing a text? Why would we need to learn a second language if there is translation software? If the goal of education is to solely produce these products, why would students not take a shortcut?


An education that is heavily focused on products reduces learning to a transaction, exchanging a product for a grade, rather than providing a transformative human experience. Learning is much more than generating a product; in fact, the essence of learning is in the process – the journey rather than the destination. Learning to write is not primarily about producing a well-structured piece of text but about developing the capacity to organize one's ideas, connect these to others' ideas, analyze claims, synthesize insights, and fulfill our fundamental need to communicate with and learn from others (Chiang, 2023). Similarly, learning a new language is much more than being able to speak in that tongue; bilingualism is about learning another style of thinking, taking on a different cultural identity, and embodying an alternative way of being and living in the world (Mills & Moulton, 2017).

For decades, educators and researchers have been pushing for process-oriented learning rather than heavily product-oriented instruction, including moving away from standardized assessments centered on memorization of content and execution of formulaic processes (National Academies of Sciences, Engineering, and Medicine, 2018). On the policy front, some ministries are recognizing the limitations of standardized testing; for example, the Ministry of Education in British Columbia, Canada has removed all standardized tests until students reach Grade 10 (Blades, 2019). Some progress has been made in developing performance assessments that are more authentic, situated, and embedded into the learning process. For example, Physics Playground is a computer game designed to support students to learn Newtonian physics using an approach called stealth assessment, seamlessly weaving assessment into the process of learning (Shute et al., 2021).

The advent of ChatGPT is further disrupting the product-focused model of education because teachers can no longer accurately evaluate student learning based on submitted artifacts. Some

districts and schools have tried to mitigate the risk of plagiarism by limiting student work to within the physical classroom under supervision. However, this is a superficial solution to the fundamental problem that formulaic products don't necessarily reflect deep understanding or represent the complexity of problem-solving in the real world. Instead, we need to equip students for a world full of uncertainties and challenges and prepare them to do the complex work of problem-solving, embracing a messy process rather than becoming good at following "cognitive recipes." The issue of plagiarism leads us to our second point of reflection, the purpose of learning.

## Why Do We Learn: Extrinsic vs. Intrinsic Motivation

The issue of plagiarism is not new, though it has certainly been intensified by generative AI. Before thinking about how we can stop plagiarism, let's take a step back and consider why people plagiarize. Boris Steipe said, "Nobody plagiarizes in their diary." That's true, since plagiarism would defeat the purpose of writing a diary, which is a *process* of self-expression. People write diaries not because they *have to*, but because they *want to*. Such intrinsic motivation is often missing in current schooling. Humans are naturally curious beings who are intrinsically motivated to learn and explore (Gopnik et al., 2001). Children ask around 10,000 questions each year in the process of spending one hour each day in the company of a familiar caregiver (Harris, 2015). However, education and schooling can stifle children's curiosity and intrinsic motivation. For example, multiple studies have shown that students' interest in science declines as they progress through school (Anderhag et al., 2016; Potvin & Hasni, 2014). Traditional education often uses levers for extrinsic motivation, such as giving students awards and norm-referenced grades. If the education system is mainly based on extrinsic motivation, plagiarism is going to be rampant. It is understandable that we are concerned about plagiarism, but what we ought to be more concerned about is how to rekindle students' love for learning and intrinsic motivation. Now, let's consider, to what extent can AI support learning through its instruction?

## What Types of Knowledge Can AI Teach?

There has been considerable discussion and speculation on whether AI is going to replace teachers. To address this question, we take another step back and ask: What types of content, skills, socio-emotional abilities, and dispositions can AI teach? We think that AI can provide only limited forms of instruction; several weaknesses of AI restrict its usefulness.

First, everyone who is a teacher has once been a learner themselves. Teachers have contextualized knowledge acquired through their own learning experiences, which enables them to understand the needs of their learners and why they may encounter difficulties in specific situations. On the other hand, AI has never "learned" the same way a human does, so the answer it provides may not always be contextually relevant to the problem the learner is facing. This is especially true if a learner has not yet developed enough prior knowledge to have the language to articulate the problem, because AI depends on the prompt or the question that was asked. For example, when learning programming, many people go back and forth between generative AI and

Stack Overflow (a question-and-answer forum for programmers) to answer their questions. What is helpful in Stack Overflow is that one often finds another person who experienced the same issue and can suggest a useful strategy.

Secondly, a critical aspect of a teacher's job is to model their thinking process with students, like a master demonstrating for an apprentice (see research on cognitive apprenticeship (Collins & Kapur, 2014)). Research has shown that engaging in metacognition, reflecting on one's own thinking process, is one of the most effective ways in enhancing learning (Hattie, 2008). However, AI lacks comprehension of its own response (Yu & Guo, 2023). Generative AI can provide seemingly reasoning about its responses when being asked, but it is not always accurate or sensible because it is based on the prediction of the text rather than reflection. Using ChatGPT's own words:

> As an AI language model, I lack the ability to be self-aware or possess any intrinsic "explainability." However, I can provide explanations for a wide range of topics and answer questions to the best of my abilities. When you ask me a question, I generate responses based on patterns and associations learned from vast amounts of data during my training. While I can offer insights and explanations for various concepts, my responses are still determined by the data I was trained on and might not always be accurate or up-to-date. AI models like me are designed to be black-box systems, meaning the inner workings and decisions made during processing might not be easily interpretable by humans.

Further, another significant limitation of AI is that it will attempt to provide instruction on skills that cannot be explicitly taught. Important skills and dispositions such as higher-order thinking, leadership, creativity, resilience, and open-mindedness cannot be taught explicitly. When we try to teach them, we often reduce them to a recipe and procedure that do not reflect the complexity of the real-world (Dede, 2022). A Chinese idiom says "Words transmit, actions teach (言传身教)," acknowledging the importance of both explicit teaching through words and implicit teaching through modeling and action.

"Implicit teaching" is often embedded in the learning process and human relations. Going back to our earlier example of learning a foreign language, what could be a better way of developing cultural literacy and cultivating a mindset of openness than learning a language and embodying a different way of living? The transformative power of implicit teaching is apparent when we ask people about the teaching that transforms their lives – people rarely speak about particular content that a teacher taught, instead describing implicit gains from human psychosocial interactions and connections that AI cannot provide.

Despite these limitations, AI has some advantages for specialized types of instruction. For example, LLMs have "infinite patience," are accessible 24/7, and can be scaled to reach many more learners than a single teacher can. Learners also often feel more comfortable asking questions of an AI agent due to its non-judgemental nature (Seo et al., 2021). Instead of replacement of teachers, we think that the future of teaching will be a human teacher/AI partnership. Future research should look more at the ways AI can augment teacher capacity,

embracing intelligence augmentation (IA), rather than focusing primarily on what AI can do by itself (Dede et al., 2021).

Research on AI-enhanced teaching and learning is currently being pioneered by five AI Institutes funded by the National Science Foundation (NSF). EngageAI is creating AI-driven narrative-centered learning environments to advance STEM learning and teaching. Student-AI Teaming (iSAT) is aiming to foster deep conceptual learning via rich socio-collaborative learning experiences. The vision of the AI-ALOE Institute is to enhance the quality of adult online education, such as tools that enhance the upskilling and reskilling of workers (including teachers). The goal of Exceptional Education at the University of Buffalo is to develop AI solutions for children with speech and language processing challenges. Finally, Inclusive and Intelligent Technologies for Education (INVITE) based at the University of Illinois Urbana-Champaign (UIUC) focus on accelerating youths' achievement in science, technology, engineering, and math (STEM).

## What Can Educators Do to Support Learners in the Face of Generative AI?

We have four recommendations for how educators can use generative AI**:**

### Demystify AI: Teach learners the nature of generative AI


Using analogies, such as moonlight, a parrot, or a brain without a mind can help explain AI-related concepts effectively and make the topic more accessible (see explanation in the introduction of this article). Further, providing experiential learning opportunities, such as coding with AI tools and experimenting with platforms like ChatGPT, can help learners to deepen their understanding of the workings of AI. A number of resources have been developed to demystify AI and equip learners of all ages with the necessary knowledge and skills. RAISE (Responsible AI for Social Empowerment and Education), an initiative of MIT and CRAFT (Classroom-Ready Resources About AI For Teaching) at Stanford University have curated a range of resources for AI literacy. We are highlighting some of them in this article. For older audiences, the University of Helsinki and MinnaLearn have developed Elements of AI, a series of free online courses about the fundamentals of AI and how to build AI systems. For middle schoolers, the DAILy Curriculum developed by MIT provides hands-on, computer-based activities to teach AI concepts, ethical considerations, and implications of AI for the future. Younger learners can learn with Zhorai, a conversational agent designed specifically to teach machine-learning concepts to a younger audience.

It is important to note that the process of doing activities is, in itself, not sufficient – it is critical to have a space to unpack the thinking and experiences during the activities to consolidate understanding. To this end, educators can design opportunities for discussion in both small and whole-class settings on the affordances, ethics, biases, and limitations of AI. Since many of the critical problems we face in the world are "wicked problems" that are ill-defined and complex (Buchanan, 1992), educators should try to stretch out the tension and embrace the fear of uncertainty during discussion without jumping into quick solutions. Educators' role is not to funnel students' voices towards a pre-determined solution, but to create favorable conditions for collective interaction and shape the dialogic space as the discussion unfolds to support students to improve their ideas together (Cao, 2022).

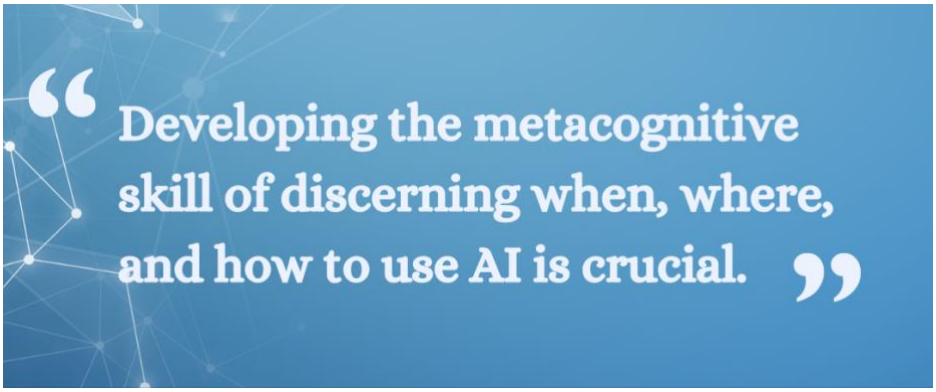
### Focus on the process of learning rather than just the product

Learners are usually rewarded for submitting final products rather than engaging in careful observations and deep thinking. Educators can emphasize the process of learning by encouraging students to slow down and do active processing and to attend to the complexity and relationships that are often overlooked (Tishman, 2017). To do this, educators can try several thinking routines, such as "Slow Complexity Capture" and "Parts, People, Interactions" (Project Zero's Thinking Routine Toolbox). Educators can also draw students' attention to the process of learning by designing assignments that create space for learners to make their thinking and learning visible and to showcase their work-in-progress. Additionally, educators can provide multiple interim check-in points for reflection and informal feedback. Feedback should be specific and informative, aimed at helping learners to close the gap between one's current performance and one's goals rather than evaluative and generic comments such as "well done," "good job," or "try again." Furthermore, feedback involves both cognitive and affective dimensions; thus, it is important for educators to attend to the feelings and emotions of learners when giving feedback. Strategies such as the "Ladder of Feedback" could be helpful in constructing productive feedback. Also, educators should support learners to build their capacity to monitor and regulate their own learning, positioning them as active seekers and processors of feedback rather than as passive recipients (Cuzzolino & Grotzer, 2022; Xu & Grotzer, 2022). Educators can create opportunities for peer feedback such as doing a Gallery Walk and model productive feedback using strategies such as a Fish Bowl.

Educators can also encourage learners to leverage generative AI to enhance their process of learning, emphasizing the value of the journey rather than just the final product. Instead of perceiving generative AI as the one who "knows the answer," a more productive way is to view it as a "dialogue partner." Wegerif's dialogic theory (2010) posits that creativity arises within the "dialogic space," the infinite space of potentiality that emerges from the interanimation of different voices. Therefore, diversity of voices expands the dialogic space, resulting in a higher potentiality for the creation of new perspectives and ideas. By considering AI's responses as voices among many, learners can use AI to expand the dialogic space, "rise above" existing ideas, and generate novel insights (Scardamalia & Bereiter, 2016). Another way to leverage generative AI to enhance the learning process is to seek feedback rather than a final product. Recognizing the limitations of generative AI mentioned earlier (e.g., lacking comprehension), the usefulness of the

feedback provided by AI may vary. This provides an opportunity for learners to hone their critical thinking and judgment skills by evaluating AI-generated content through reflection and discussion. In this way, AI is not doing the thinking for the learners, but supporting them to think better.

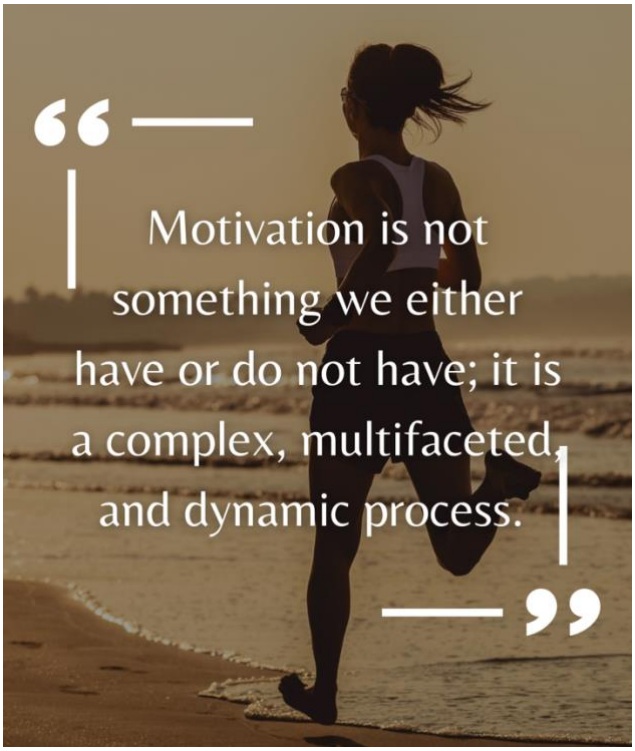
When incorporating AI into the learning process, we want to highlight the tension between "facing the blank canvas" and "building on AI-generated ideas." Sometimes, it is important to sit with an empty canvas, face the unknown, and draw inspiration from personal experiences. At other times, AI can assist in stimulating creative thinking. Developing the metacognitive skill of discerning when, where, and how to use AI is crucial. That's why we believe it is important to provide the space for learners to experiment with AI rather than banning it. Through experimentation, open discussion, and learning about the workings of AI, learners can become mindful users and creators of AI.




## Honor learner agency and orchestrate multiple sources of motivation

Why do we learn what we learn? Learners often engage in learning without necessarily understanding the purpose or establishing personal relevance. Motivation is personal — people are motivated and engaged by different things. Educators should get to know their learners by understanding what motivates them and creating spaces for learners to reflect on their purpose of learning. For example, at the beginning of the school year, instead of asking for a generic introduction, teachers can engage students in discussion, using a prompt like "What is something that you do on a regular basis that you do because you enjoy it so much, that you keep coming back to it?"(See this seminar about motivation featuring Professor Chris Dede). Educators can honor student agency by providing choice and autonomy in learning and can empower learners to pursue topics with entry points that they are genuinely interested in (Grotzer, 2021; Grotzer et al., 2019).

While tapping into learners' intrinsic motivation increases the chance for them to experience "flow," a particular state of heightened consciousness when one is completely engaged in an activity for its own sake (Nakamura & Csikszentmihalyi, 2014), intrinsic motivation is not a panacea. Being intrinsically motivated does not prevent failures or frustration. In fact, for any learning to take place, learners have to be at the edge of their competency (Bereiter & Scardamalia, 1993). Furthermore, people are not always intrinsically motivated. There is not a one-size-fits-all recipe to engineer motivation — what works for me might not work for you, and what works in one situation might not work for another. For instance, some people enjoy cleaning and are intrinsically motivated to tidy their houses. However, others might require extrinsic incentives to motivate themselves. What is important is to understand what works for whom and in what context to engineer an ecosystem of motivations for optimal performance.




Motivation is not something we either have or do not have; it is a complex, multifaceted, and dynamic process. Teachers should thus also consider each learner's self-regulation, executive function, beliefs (including self-efficacy, growth mindset, and stereotype threat), and dispositions such as tenacity and resilience. In addition, educators should support learners to be engineers of their ecosystem of motivation — encouraging them to be metacognitive about their own motivation, document and reflect on their learning process, monitor their own state of emotion, and pro-actively seek, create, or modify conditions that best support them (see Next Level Lab's work on Fast Fish Learning).

## Cultivate skills that AI cannot perform

The current curriculum and high-stakes tests often prioritize fostering skills at which AI excels, such as *reckoning skills* involving calculative prediction and formulaic decision-making. However, AI cannot easily replicate human *judgment*, which is a deliberative thought process that is flexible and contextual based on experiential knowledge, ethics, values, relationships, and culture (Dede et al., 2021). Educators can foster learners' skills in judgment by presenting genuine and authentic real-world problems that are ambiguous, complex, and multidisciplinary without one single solution. For example, educators could present a challenge for learners to design community-based solutions for mitigation and adaptation in the face of climate change. In such an exercise, learners can experiment with partnering with AI during problem-solving and design. For instance, learners may leverage AI's reckoning skills, asking AI to summarize the precipitation

and average temperature trend in their community over the past 50 years and cross-check with meteorological data from various sources. At the same time, learners can exercise their judgment skills by incorporating their lived experience and understanding of the local culture to design effective solutions that have buy-in from the local community. As access to generative AI for the public is relatively recent, there is a lack of regulations and understanding of what it means to partner with AI. Educators and learners can contribute to the ongoing debate and discussion by documenting their experience with AI and providing examples of human-AI partnerships.


## Conclusion

Understanding the nature of generative AI is crucial for educators to navigate the evolving landscape of education. The generative AI can generate content based on existing data, appearing "intelligent." However, it is important to recognize that AI differs fundamentally from human intelligence, lacking essential qualities such as comprehension, self-awareness, emotions, embodiment, ethics, values, and culture. While AI offers advantages such as accessibility, scalability, personalization, and non-judgemental interactions, its ability to teach is limited by an intrinsic lack of contextual and experiential knowledge, comprehension, and ways to teach implicit skills and dispositions. Though there are concerns about plagiarism and the replacement of human jobs, a more productive way forward is for educators to focus on demystifying AI, emphasizing the learning process over the final product, honoring learner agency, orchestrating multiple sources of motivation, cultivating skills that AI cannot easily replicate, and fostering intelligence augmentation (IA) by building human-AI partnerships. Through these approaches, educators can harness the benefits of AI while nurturing the unique abilities of humans to tackle big challenges in the 21st century.

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