The Possibility of Artificial Intelligence Tutors

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The field of Artificial Intelligence (AI) is broad, and the advent of generative AI has sparked a new conversation about the role AI might play in education. A classmate asked a probing question that sparked the research for this paper: "How could generative AI be used as an assistive technology to provide individualized supports for students with exceptionalities (and students in general)?" (Vivian, 2023) Many are calling generative AI revolutionary, while others caution the hype around it, noting that it will take time for it to be widely adopted in ways that are useful for all (Humble & Mozelius, 2022). There is a long history of technology in education, including attempts at using previous iterations of AI (Kelkar, 2022), but the field of education is typically slow to change. While the potential applications for AI within education are diverse, this paper will focus on exploring potential uses and drawbacks of AI as an assistive technology providing intelligent tutoring for individual students.

Education, broadly speaking, is concerned with preparing people to navigate complex futures. Many point toward active engagement and collaboration with AI as essential for students who will live in a future where AI is expected to play a significant role, as well as to encourage ethical and responsible use of AI later in life. (Gašević et al., 2023; Rizvi et al., 2023). Interaction with an AI tutor is a form of engagement that

has potential to provide value for students as well as to remove some barriers that prevent students from accessing individualized education assistance (Kravitz, 2023).

Many of the latest AI technologies that have been attracting attention, like ChatGPT, are Generative Pre-Trained Transformers using a Large Language Model. This means that when a query is posed, the AI does not merely search the internet and find the answer. It generates a response based on the extensive language data with which it has been trained. It uses complex algorithms to pose the most likely response, generating new content that is transforming – meaning it is not repeated. The same query will generate different (transformed) responses (Davis, 2023). The result is that interaction with the AI can feel "natural," like interacting with a person. This ability to generate content in response to user query allows the AI to be interactive and adaptive to student need in a tutoring application.

Designers of AI tutors take different approaches to this feature of AI, with some applications like Amy (an AI math tutor) given a name and persona to make the AI more friendly for students (Moe, 2020). Others caution the danger of personifying AI. "As a predictive language model, ChatGPT replicates human language patterns, but not human understanding" (Steele, 2023). Students need to understand the generative, pre-trained and transformative nature of AI to be able to guard against errors and bias in the generated responses (Davis, 2023).

Khan Academy's Khanmigo AI tutor uses a "guardrail" approach. They partnered with OpenAI in the development of GPT-4, and used prompt engineering on top of the GPT-4 Application Programming Interface (API) to create boundaries that prevent it from giving answers or allowing inappropriate queries (Hills & Henkel, 2023). Khanmigo "gets a short prompt about how to be a Socratic tutor, asking students questions to get to the root of their misunderstanding, rather than just giving them the answer" (Schwartz, 2023). Their prompt engineering pre-trains the AI by giving it access to the Khan Academy platform, including information about what the students are learning, what unit their class is on, and what skills they have mastered. Additionally, to protect student safety and enhance learning support, all student interactions with Khanmigo are recorded and available to teachers and parents.

Vicki Davis similarly describes how as a classroom teacher she uses the Plus version of ChatGPT to create GPTs that follow specified prompts to serve specific purposes. She will create a GPT to help tutor students in a particular subject, for example, using prompt engineering that directs the AI to respond in the desired way or to access the prior-learning data needed for that subject (Davis, 2023).

Other companies are developing their own generative AI technologies that are also being used to develop tutoring applications for students. Google has released a tutoring application called Socratic, built on Google's AI, that can scan student questions and help provide step-by-step guidance to solve them. Sizzle is a new AI

application founded by the former VP of AI at Meta whose step-by-step guidance works best for subjects like math, physics, chemistry or calculus (Chacon & Sahota, 2023).

Many of the current AI applications seem to perform better at certain tasks than others. Sizzle and Socratic work well for step-by-step instruction, for example, whereas ChatGPT has had difficulty with math conversations where it needs to discuss problem-solving steps and strategies with students (Schwartz, 2023). Choosing the best application for the task may be part of effective intelligent tutor use in the present incarnation of AI technologies.

The potential for AI to serve as an assistant or tutor for students alongside their learning is intriguing and exciting. Some challenges remain, however, in the effective integration of AI as a tutor for individual students. One challenge lies in the profit orientation of many current AI applications in education. AI developers often "know little about learning sciences and lack pedagogical knowledge for the effective implementation of AI in teaching" (Celik et al., 2022; Chacon & Sahota, 2023). Companies like Khan Academy can help provide a test case for transformative use of an AI tutor within a pedagogically grounded educational environment.

Another challenge lies in the trustworthiness and reliability of AI technologies. Generative AI built on transformer-based architecture cannot discern the value of factual truthfulness over causal or temporal relational connections (Gašević et al., 2023)

and as a result has been found to occasionally fabricate information. Intelligent and creative use of prompt engineering can help mitigate this possibility, and further development and training of GPT technologies will continue to close the accuracy gap. Additionally, the reality of bias in the information used for the pre-training of generative AI technologies remains a significant ethical and practical weakness that impacts the trustworthiness of AI as a tutor for our children (Humble & Mozelius, 2022).

The potential for AI tutors to provide widespread access to education opportunities is great, but does not remove the need for trained educators to guide the learning and help students use these tools appropriately. Effective learning and teaching practices can help educators "harness the weaknesses of generative AI technologies as opportunities for promoting higher-order learning (e.g., analyze and scrutinize outputs produced by ChatGPT)" (Gašević et al., 2023).

I will conclude with a quote by Shreeharsh Kelkar from the University of California that keeps us grounded amid potentially transformative technology:

> Even as we are awash today with claims of "adaptive" and "personalized" algorithmic technologies—sometimes called AI in education—that will revolutionize learning…adoption and commercialization of technologies has less to do with fancy algorithms and more with centering the different clients and end-users of these systems (Kelkar, 2022).

As always in education, the goal is student success. AI tutors just may become another helpful tool toward that end.

Resource List:

Celik, I., Dindar, M., Muukkonen, H., & Järvelä, S. (2022). The Promises and Challenges of Artificial Intelligence for Teachers: a Systematic Review of Research. *TechTrends*, *66*(4), 616–630. https://doi.org/10.1007/s11528-022-00715-y

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Davis, V. (2023, December 5). Cool Cat Teacher's AI Insight: 10 Ways I'm Using AI Today (Ep. 809) [Audio podcast episode]. In *10 Minute Teacher Podcast with Cool Cat Teacher*. https://podcasts.apple.com/ca/podcast/10-minute-teacher-podcast-with-cool-cat-teacher/id1201263130?i=1000637572162

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Hills, L., & Henkel, O. (Hosts). (2023, November 19). The Inside Story Behind Khan Academy's AI Tutor Khanmigo (Ep. 3) [Audio podcast episode]. In *Ed-Technical*. https://podcasts.apple.com/ca/podcast/ed-technical/id1708162093?i=1000635354024

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Kravitz, N. (Host). (2023, June 6). MIT's Anant Agarwal on AI in Education (Ep. 197) [Audio podcast episode]. In *The AI Podcast*. NVIDIA. https://podcasts.apple.com/ca/podcast/the-ai-podcast/id1186480811?i=1000616043898

Moe, S. (Host) (2020, February 24). Raphael Nolden on the future of Tech and developing Amy, an AI powered maths tutor (Ep. 164) [Audio podcast episode]. In *Seeds*. https://podcasts.apple.com/ca/podcast/seeds/id1281908185?i=1000466544175

Rizvi, S., Waite, J., & Sentance, S. (2023). Artificial Intelligence teaching and learning in K-12 from 2019 to 2022: A systematic literature review. *Computers and Education: Artificial Intelligence, 4*, NA. https://doi.org/10.1016/j.caeai.2023.100145

Schwartz, S. (2023, June 14). What ChatGPT Could Mean for Tutoring; AI tools could help personalize tutoring plans, analyze coaching sessions, and potentially even take over as tutor. But is that a good idea? *Education Week, 42*(36), NA. https://link.gale.com/apps/doc/A753144479/AONE?u=queensulaw&sid=bookmark-AONE&xid=421d1b67

Steele, J. (2023). To GPT or not GPT? Empowering our students to learn with AI. *Computers and Education: Artificial Intelligence, 5*, NA. https://doi.org/10.1016/j.caeai.2023.100160

Vivian, J. (2023, August 30). *Generative AI* [Knowledge Forum post]. https://kf6-stage.ikit.org