

An MIT Exploration of Generative AI • From Novel Chemicals to Opera

Generative AI and Creative Learning: Concerns, Opportunities, and Choices

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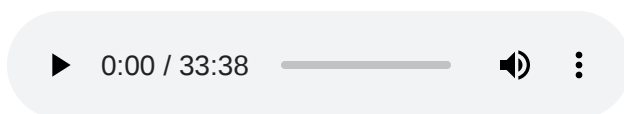
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ABSTRACT

As each new wave of technology ripples through society, we need to decide if and how to integrate the technology into our learning environments. That was true with personal computers, then with the internet, and now with generative AI technologies. For each new technology, there are many different ways that we can integrate the technology into how we teach and learn. These choices are critically important: different choices can have very different outcomes and implications.

How should we make these choices? I think we need to decide what type of learning and education we want for our children, our schools, and our society—and then design new technologies and applications that align with our educational values and visions.

What does that mean for the integration of new generative AI technologies such as ChatGPT into our learning environments?



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In my view, the top educational priority in today’s world is for young people to develop as creative, curious, caring, collaborative human beings. With the pace of change accelerating in all parts of the world, today’s children will face a stream of uncertain, unknown, and unpredictable challenges throughout their lives, and the proliferation of new AI technologies will further accelerate the changes and disruptions. As a result, it is more important than ever for children from diverse backgrounds to have opportunities to develop the most human of their abilities—the abilities to think creatively, engage empathetically, and work collaboratively—so that they can deal creatively, thoughtfully, and collectively with the challenges of a complex, fast-changing world.

Unfortunately, I find that many of the current uses of AI in education are not aligned with these values—and, in fact, they could further entrench existing educational approaches at a time when significant changes are needed. Too often, today’s AI technologies are used in ways that constrain learner agency, focus on “close-ended” problems, and undervalue human connection and community.

But I also see intriguing opportunities for new generative AI technologies. I believe that these new AI technologies (compared with earlier AI technologies) have greater potential for supporting young people in project-based, interest-driven creative learning experiences—and thus supporting their development as creative, curious, collaborative learners. We could be at a moment for significant educational change: the

disruptions caused by new generative AI technologies are leading more people to recognize the need for fundamental changes in our approaches to education and learning. But new AI technologies will contribute to these changes only if people make explicit, intentional choices in the ways they design and use these new tools.

In this article, I'll start by discussing my concerns about current uses of AI tools in education, then I'll explore how we might leverage new generative AI technologies to support creative learning experiences.

Concerns

Most critiques of AI systems highlight problems that the developers of the systems have not sufficiently focused on (e.g., biases or inaccuracies based on the sets of examples used to train the systems, and inadequate acknowledgment or compensation for artists and writers whose work is used in the training) and on problems that arise when the systems are used differently than the developers had hoped (e.g., students turning in papers produced by AI systems as if the work were their own). These are serious and important problems, and they need to be addressed. But in this article, I have a different focus. I will be discussing why I am concerned about many AI-in-education systems even when they work exactly how their developers intended and are used exactly how their developers had hoped.

Concern #1: Constraining Learner Agency

Back in the 1960s, as researchers were beginning to explore how computers might be used in education, there were two primary schools of thought. One focused on using computers to efficiently deliver instruction and information to the learner. The other focused on providing learners with opportunities to use technologies to create, experiment, and collaborate on personally meaningful projects. Seymour Papert referred to these two different approaches as instructionist and constructionist¹.

Over the years, most AI researchers and developers have focused on the first approach, developing “intelligent tutoring systems” or “AI coaches” that provide instruction to students on particular topics, continually adapting the trajectory of the instruction based on student responses to questions. These systems have been promoted as a personalized approach to teaching, aiming to provide each student with customized feedback and instruction based on their current level of understanding, as opposed to a one-size-fits-all approach in which the same instruction is delivered to all students.

With advances in AI technology, these tutoring systems have become more effective in delivering instruction that adapts to individual learners. For example, some AI tutors and AI coaches have demonstrated improved results when they deliver instruction through a virtual character that looks like the student's favorite teacher or favorite celebrity.

I do not doubt these research results, but I worry that some of these “improvements” are perpetuating and reinforcing an educational approach that is in need of a major overhaul. To a large degree, AI tutors and

coaches have been designed to be in control of the educational process: setting goals, delivering information, posing questions, assessing performance. That is also the way most classrooms have operated over the past couple centuries. But the realities of today's world require a different approach: providing students with opportunities to set their own goals, build on their own interests, express their own ideas, develop their own strategies, and feel a sense of control and ownership over their own learning. This type of learner agency is important in students' development, helping them develop the initiative, motivation, self-confidence, and creativity that will be needed to contribute meaningfully in their communities.

AI tutors and coaches are promoted as “personal” since they deliver personalized instruction. But in my view, a truly personal approach to learning would give the learner more choice and control over the learning process. I would like learners to have more control over how they are learning, what they are learning, when they are learning, where they are learning. When learners have more choice and control, they can build on their interests, so that learning becomes more motivating, more memorable, and more meaningful—and learners make stronger connections with the ideas that they are engaging with.

Some new AI tutors and coaches try to support greater learner agency. Instead of controlling the instructional flow, they are designed to provide tips, advice, and support when students ask for help. But even if AI tutors are designed with the best of intentions, I worry that some learners will experience them as intrusive. For example, Sal Khan of Khan Academy expects that future AI tutors will intervene when a student's attention wanders, telling the student: “Hey, I think you're a little distracted right now. Let's get focused on this.”² That type of intervention might be helpful for some students, but feel intrusive or disempowering for others. As one educator wrote to me: “I would absolutely crumble if I was a middle schooler and had to chat with an AI bot that was trying to pull the answer out of me.”

Concern #2: Focusing on “Close-Ended” Problems

Over the past decade, there has been a proliferation of websites designed to teach young people how to code. The vast majority of these sites are organized around a series of puzzles, asking students to create a program to move a virtual character past some obstacles to reach a goal. In the process of solving these puzzles, students learn basic coding skills and computer science concepts.

When our Lifelong Kindergarten group at the MIT Media Lab developed Scratch, we took a different approach. With Scratch, young people can create animations, games, and other interactive projects based on their interests—and share them with others in an online community. Through this project-based, interest-driven approach, students still learn important coding skills and computer science concepts, but they learn them in a more motivating and meaningful context, so they make deeper connections with the ideas. At the same time, the project-based, interest-driven approach helps young people develop their design, creativity, communications, and collaboration skills, which are more important than ever in today's world.

So why do so many coding sites focus on puzzles rather than projects? One reason is that it is easier to develop AI tutors and coaches to give advice to students as they work on puzzles. With puzzles, there is a clear goal. So as a student works on a puzzle, the AI tutor can analyze how far the student is from the goal, and give suggestions on how to reach the goal. With projects, the student's goal might not be clear, and might change over time, so it is more difficult to develop an AI tutor to give advice.

Over the years, most AI tutors and coaches have been designed to provide instruction on problems that are highly structured and well defined. With new AI technologies, there are possibilities for developing systems that could provide feedback and advice on more open-ended projects. But I have been disappointed by the way that most AI researchers and EdTech companies are putting these new technologies to use. For example, I recently saw a presentation in which a prominent AI researcher showed off a new ChatGPT-based system that was asking students a list of single-answer questions. The conversational interface was new, but the educational approach was old. And when Khan Academy recently introduced its AI tutor called Khanmigo, the first example it showed on its website was a multiplication problem involving a fraction (the tutor asked: “What do you think you need to do to multiply 2 by $5/12$?”). This type of problem has a single answer and well-defined strategies for getting to the answer—exactly the type of problem that AI tutors have traditionally focused on.

There is an important educational choice: Should schools focus more on open-ended projects or “close-ended” problems? My preference is to put more emphasis on projects where students have more opportunities to learn to think creatively, express their ideas, and collaborate with others—while still learning important concepts and basic skills, but in a more meaningful and motivating context.

Schools have generally preferred close-ended problems since they are easier to manage and assess. Schools end up valuing what they can most easily assess, rather than figuring out ways to assess the things that are most valuable. I worry that EdTech companies and schools will focus on AI tutors that fit in this same framework and further entrench this educational approach, crowding out much-needed changes in how and what students learn. Instead, as I discuss in the Opportunities section below, I hope that there are more efforts to use new AI technologies to support learners as they engage in project-based, interest-driven learning experiences.

Concern #3: Undervaluing Human Connection

In some situations, AI tutors and coaches can provide useful advice and information. And with advances in AI technology, these systems are becoming better at deciding what information to deliver when, and customizing the information based on what students have already learned and what misconceptions they might have.

But good teaching involves more than that. A good teacher builds relationships with students, understands students' motivations, empathizes with students' concerns, relates to students' lived experiences, and helps students connect with one another. Facilitating a student's learning is a subtle process, much more complex than simply delivering information and instruction at the right time. A good teacher understands how to

cultivate a caring community among students, so that students feel welcomed, understood, and supported. A good teacher understands how to create an environment in which students feel comfortable taking the risks that are an essential part of a creative learning process.

Some AI tutors and coaches now try to take social-emotional factors into account—for example, using sensors and cameras to get a sense of a student’s emotional state. But these AI systems still are not able to understand or empathize with a learner’s experience or cultivate a caring community the way a human teacher can.

So it bothers me when AI tutors and coaches are promoted as if they are equivalent to human teachers. For example, a promotional video for a new AI-based tutor from Microsoft says that it is “like there are 20 extra teachers in one classroom.” And Khan Academy promotes its Khanmigo system as “a world-class tutor for anyone, anywhere.” Some people might shrug off these descriptions as marketing hype. But I worry that they contribute to a devaluation of the human dimensions of teaching. Human teachers are fundamentally different from AI tutors, and I think it is important to recognize the special qualities of human teachers—while also recognizing what AI systems do particularly well.

Some AI researchers and EdTech companies try to avoid the direct comparison to human teachers by positioning their systems as AI companions, collaborators, or copilots rather than AI tutors. But they still try to emphasize the humanness of their systems. I find it especially troubling when AI systems describe their own behavior as if they were human. For example, I recently saw a presentation about a new AI system designed to interact with young children. In its interactions, the AI system talked in a humanlike way about its intentions and feelings. This felt problematic to me, since it could mislead young children to believe that AI systems have motivations and feelings similar to their own.

I do not want to idealize the capabilities of human teachers. Many teachers do not have experience or expertise in facilitating creative learning experiences—and many children do not have access to teachers who do. There is a role for AI-based systems to supplement human teachers (as discussed in the next section). But we should clearly recognize the limitations and constraints of these AI systems, and we should not be distracted from the important goal of helping more people become good teachers and facilitators.

More generally, we need to make sure that the current enthusiasm over AI systems does not lead to a reduction in interactions and collaborations with other people. The importance of the human connection and community became even more apparent during the pandemic, when different schools adopted different pedagogical approaches. Some schools implemented remote-learning routines focused on delivery of instruction based on the traditional curriculum; in those schools, many students felt increasingly isolated and disillusioned. Other schools focused more on social-emotional and community aspects of learning, emphasizing the importance of supporting and collaborating with one another; in those schools, students felt a stronger sense of connection, empathy, and engagement. As Harvard Graduate School of Education professor Jal Mehta wrote: “Classrooms

that are thriving during the pandemic are the ones where teachers have built strong relationships and warm communities, whereas those that focus on compliance are really struggling.”³

The pandemic highlighted the importance of empathy, connection, and community in teaching and learning. As the pandemic recedes, and as AI systems proliferate, we should keep our focus on these very special human qualities.

Opportunities

Over the past year, there have been a growing number of educational initiatives to teach K-12 students about generative AI. While some of these initiatives, in my view, focus too much on teaching technical details on how current AI systems work (much like teaching students about floppy disks and motherboards in the early days of personal computing), the initiatives play a valuable educational role in helping student gain an understanding of the ethical and societal implications of generative AI technologies and an awareness of how these technologies can provide biased results and misleading information.

But I think the most important educational opportunities will come not from *teaching students about AI* but rather in *helping students learn with AI*—that is, supporting students in using AI tools to imagine, create, share, and learn. And, as a bonus, learning *with AI* can be the best way for students to learn *about AI* too.

Unfortunately, when most EdTech companies and AI researchers focus on *learning with AI*, they tend to package it in an instructionist paradigm, developing intelligent tutoring systems (e.g., teaching arithmetic skills or vocabulary words) that are subject to all of the problems described above. But it does not have to be that way. I believe that generative AI technologies (compared with earlier AI technologies) provide greater opportunities for breaking out of the instructionist paradigm and supporting a more constructionist approach to learning. That is, there is potential to design and use generative AI technologies to support young people in project-based, design-oriented, interest-driven creative learning experiences—and thus help them develop the creativity, curiosity, and collaboration skills that are needed to thrive in today’s fast-changing world. But that will happen only if we make intentional choices in how to design and use these new technologies.

Supporting the Creative Learning Process

So how can people design and use generative AI technologies to support a more constructionist approach to learning? In our work in the Lifelong Kindergarten research group, we have identified four guiding principles for supporting this type of learning. We call them the Four P’s of Creative Learning: projects, passion, peers, and play.⁴ That is, young people are most likely to develop as creative, curious, collaborative learners when they have opportunities to work on projects, based on their passions, in collaboration with peers, in a playful spirit.

So, as researchers, companies, and educators integrate generative AI technologies into learning environments, and as students use these new technologies, they should all consider how AI can be used to support the Four P's of projects, passion, peers, and play:

- **Projects.** We should provide students with opportunities to use generative AI tools throughout the process of working on a project, while making sure that they retain creative control. If they are feeling stuck at the start of a project, they could enter a few preliminary ideas and ask the system for variants or refinements of the ideas. When something does not work as expected in the project, they could explain the problem to an AI system and ask for help in debugging it.
- **Passion.** When people work on projects that they really care about, they are willing to work longer and harder, persist in the face of challenges, and make deeper connections to the ideas they encounter. So we should explore ways for students to use generative AI tools to create projects that they find personally meaningful. For example, Karishma Chadha at the MIT Media Lab is developing generative AI tools and activities that enable young people to create dynamic representations of themselves—and create and share personal stories based on those representations—as a way to explore and express their cultural identity.
- **Peers.** Most AI tutoring tools have been designed for one-to-one interaction. But we know that most creative learning experiences involve people learning with and from one another. So generative AI tools should be designed to engage young people working together on projects, helping them connect and collaborate with others who have similar interests or complementary skills.
- **Play.** A playful attitude is not just about laughing and having fun. It is based on a willingness to experiment, try new things, take risks, and push the boundaries. So rather than developing AI tutors that guide students toward a solution, we should provide young people with opportunities to use AI technologies to explore new directions, tinker with new possibilities, and iteratively refine their ideas.

This 4P approach to designing and using generative AI technologies is very different from traditional AI tutoring systems. In the 4P approach, students have greater control of the process, choosing how and when to use AI tools to support their own design and problem-solving practices, and using the tools as a catalyst (not a replacement) for their own creative process and their collaboration with others. It is somewhat similar to the way that people, while working on a project, do an online search or watch a YouTube video to get new ideas or information. Generative AI systems can serve as an additional resource during the creative-learning process.

We should not expect (or want) AI systems to play the same role as human tutors or coaches or companions. Rather, we should consider AI systems as a new category of educational resource, with their own affordances and limitations. When learners are looking for help or inspiration, they sometimes talk with a friend or refer to a book or do an online search or watch a video. Each plays a different role. We can add AI systems to this mix of resources.

How Could Generative AI Transform Coding?

Over the past decade, there has been a surge of interest in helping young people learn to code. With our Scratch programming language, for example, young people can use graphical coding blocks to create interactive stories, games, and animations based on their interests, then share their creations with one another in an online community. Through this 4P process, young people not only learn computational and technical skills, they also develop their abilities to think creatively, reason systematically, and work collaboratively, essential skills for everyone in today's world.

Many people are now wondering if generative AI technologies could end the need for people to learn to code. After all, part of the promise of generative AI is that people will be able to use everyday language to interact with computers. Why learn to write code in a programming language when you can simply engage in conversation with the computer, telling it what you want it to do?

I am skeptical that the ability of generative AI systems to produce computer programs will eliminate the value of people learning to code—just as I am skeptical that the ability of ChatGPT to generate essays will eliminate the value of people learning to write. But I do think that generative AI technologies could significantly change how young people program computers.

To evaluate the benefits and drawbacks of new AI-based approaches to coding, it is worth considering the goals of learning to code. For some young people, of course, learning to code can serve as a starting point on a path towards a career as a professional programmer or software developer. But I am more interested in why it is valuable for everyone to learn to code—just as it is valuable for everyone to learn to write, even if they aren't going to become a professional writer. As I see it, learning to code provides young people with opportunities to:

- create new types of projects and express themselves in new ways
- learn strategies for design and problem solving
- gain a sense of control over technologies that are ubiquitous in their lives
- describe, understand, and debug processes
- experience the joy of creating things they care about

If we use generative AI to introduce changes to the ways people code, will it enhance these benefits—or undermine them?

AI-based changes to programming environments can come in many different forms. For example, Eric Rosenbaum of the Scratch Foundation has been experimenting with ways to integrate AI-based image-generation tools within Scratch, so that young people can generate graphic characters and backdrops to use in their projects. If a child wants an anime-style purple frog in their project, they can type in “anime-style purple frog” and see what the system produces. If they are not satisfied with the results, they can refine the prompt to

get something closer to what they want. This new tool has limitations, and it certainly should not replace the Scratch paint editor or image library, but it can provide another option for creating images within a Scratch project.

Rosenbaum has also been developing new AI-based programming blocks for Scratch—for example, new blocks that enable characters in a project to engage in ChatGPT-style conversations guided by context provided by the programmer. Rosenbaum plans to explore a new hybrid form of coding that combines traditional coding blocks with AI-based blocks.

Several researchers are also experimenting with ways for young people to ask for advice and tips as they are coding their projects. Whereas earlier AI systems could provide advice effectively only if the project goals were clearly articulated in advance, new generative AI tools have potential for providing useful advice even when project goals are ambiguous or evolving. And as long as the student (rather than the AI system) maintains control over the flow of the conversation, this use of AI could align well with a 4P approach for learning to code.

Over time, there could be more fundamental changes to the ways that children tell the computer what to do. In the fifty years since children began programming computers, the biggest change so far has been from text-based coding (using languages like Logo and Basic) to graphical building-block coding (popularized by Scratch). Will generative AI bring a shift to conversational interfaces, in which children use everyday language to tell the computer what to do?

Professional programmers are already using tools like GitHub's Copilot to generate code. And several groups, including the Playful Invention Company and the App Inventor team, have produced prototypes of conversational coding systems for children. As with the shift from text to blocks, the shift to conversation could make it easier and more intuitive to tell the computer what to do. There are continuing questions of how well computers can deal with the ambiguities of everyday language, but new generative AI systems are making progress on this issue, especially as people learn how to iteratively refine their prompts to the systems.

For me, the bigger question is whether these new conversational coding approaches will preserve all of the traditional benefits of learning to code (as listed above). Even if children are able to successfully create projects through a conversational coding interface, will they still feel a sense of control over the technology? Will they still learn strategies for design and problem solving? Will they still experience the joy of creating? Also: Will it be possible for young people to remix one another's projects, as they do in Scratch? And will the systems be welcoming and engaging for learners across diverse backgrounds?

The answers to these questions are not clear. Looking ahead, it will be valuable to develop prototypes of new conversational coding interfaces and explore how children create and learn with them. One challenge is that

these interfaces might enhance some of the traditional benefits of learning to code while deteriorating others. We will need to figure out whether the tradeoffs are worth it.

Choices

There are many different ways that people can use generative AI technologies to support learning and education.

Some uses of generative AI systems will constrain learner agency, focus on “close-ended” problems, or undervalue human connection and community—and further entrench existing approaches to education and learning at a time when change is needed. I worry that inertia and market pressures will push the educational uses of generative AI in this direction.

But it is also possible to use generative AI technologies to support a more project-based, interest-driven, human-centered, collaborative approach to learning, enabling learners to develop the motivation, creativity, and curiosity that they will need to thrive in today’s complex, fast-changing world. The disruptions caused by new generative AI technologies are leading more people to recognize the need to rethink approaches to education and learning, so we could be at a cultural moment where fundamental changes are possible.

The choice is up to us. The choice is more educational and political than technological. What types of learning and education do we want for our children, our schools, and our society? All of us—as teachers, parents, school administrators, designers, developers, researchers, policymakers—need to consider our values and visions for learning and education, and make choices that align with our values and visions. It is up to us.

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Footnotes

1. Seymour Papert, *The Children’s Machine: Rethinking School in the Age of the Computer* (New York: Basic Books, 1993). <https://archive.org/details/childrensmachine00pape/page/n5/mode/2up> ↵
2. Natasha Singer, “Will Chatbots Teach Your Children”, *New York Times*, January 11, 2024. https://www.nytimes.com/2024/01/11/technology/ai-chatbots-khan-education-tutoring.html?ugrp=u&unlocked_article_code=1.gk0.AgZ2. bRlmH-e2haA&smid=url-share ↵

3. Jal Mehta, “Make Schools More Human,” *New York Times*, December 23, 2020.

https://www.nytimes.com/2020/12/23/opinion/covid-schools-vaccine.html?ugrp=u&unlocked_article_code=1.gk0.jZl8.eENMpVTIcV-1&smid=url-share ↵

4. Mitchel Resnick, *Lifelong Kindergarten: Cultivating Creativity through Projects, Passion, Peers, and Play* (Cambridge: MIT Press, 2017). <https://mitpress.mit.edu/9780262536134/lifelong-kindergarten/> ↵