

New A.I. Chatbot Tutors Could Upend Student Learning

Proponents see the tools as a way to automatically customize academic support. They could also make children test subjects for A.I. experiments.

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Sixth graders at Khan Lab School in Palo Alto, Calif., recently began using Khanmigo, a new tutoring bot. A chatbox in their math software lets them converse with the bot. Ulysses Ortega for The New York Times

By [Natasha Singer](#)

Natasha Singer, who covers education technology, reported from Palo Alto, Calif.

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A dozen students huddled at communal classroom tables one morning this spring, their gazes fixed on math lessons on their laptops.

The sixth graders at Khan Lab School, an independent school with an elementary campus in Palo Alto, Calif., were working on quadratic equations, graphing functions, Venn diagrams. But when they ran into questions, many did not immediately summon their teacher for help.

They used a text box alongside their lessons to request help from Khanmigo, an experimental chatbot tutor for schools that uses artificial intelligence.

The tutoring bot quickly responded to one student, Zaya, by asking her to identify specific data points in a chart. Then Khanmigo coaxed her to use the data points to solve her math question.

"It's very good at walking you through the problem step by step," Zaya said. "Then it congratulates you every time it helps you solve a problem."

Khan Lab School students are among the first schoolchildren in the United States to try out experimental conversational chatbots that aim to simulate one-on-one human tutoring. The tools can respond to students in clear, smooth sentences, and they have been specifically designed for school use.

In Jaclyn Major's math class at Khan Lab School, sixth graders work on different problem sets at their own pace. If

they have a question, they can ask their teacher or the new tutoring bot. Ulysses Ortega for The New York Times

Based on A.I. models underlying chatbots like ChatGPT, these automated study aids could usher in a profound shift in classroom teaching and learning. Simulated tutors could make it easier for many self-directed students to hone their skills, delve deeper into topics that interest them or tackle new subjects at their own pace.

Such unproven automated tutoring systems could also make errors, foster cheating, diminish the role of teachers or hinder critical thinking in schools — making students test subjects for what amounts to an experiment in education by algorithm. Or, like a legion of promising tech tools before them, the bots may simply do little to improve academic outcomes.

Khanmigo is among the wave of new A.I.-powered learning tools. It was developed by Khan Academy, a nonprofit education giant whose video tutorials and practice problems have been used by tens of millions of students.

A New Generation of Chatbots

A brave new world. A new crop of chatbots powered by artificial intelligence has ignited a scramble to determine whether the technology [could upend the economics of the internet](#), turning today's powerhouses into has-beens and creating the industry's next giants. Here are the bots to know:

ChatGPT. ChatGPT, the artificial intelligence language model from a research lab, OpenAI, has been making headlines since November for its ability to respond to complex questions, write poetry, generate code, [plan vacations](#) and translate languages. GPT-4, the latest version introduced in mid-March, [can even respond to images](#) (and ace the Uniform Bar Exam).

Bing. Two months after ChatGPT's debut, Microsoft, OpenAI's primary investor and partner, [added a similar chatbot](#), capable of having open-ended text conversations on virtually any topic, to its Bing internet search engine. But it was the bot's occasionally inaccurate, misleading and [weird responses](#) that drew much of the attention after its release.

Ernie. The search giant Baidu unveiled China's first major rival to ChatGPT in March. The debut of Ernie, short for Enhanced Representation through Knowledge Integration, [turned out to be a flop](#) after a promised "live" demonstration of the bot was revealed to have been recorded.

Sal Khan, the founder of Khan Academy — and of Khan Lab School, a separate nonprofit organization — said he hoped the chatbot would democratize student access to individualized tutoring. He also said it could greatly help teachers with tasks like lesson planning, freeing them up to spend more time with their students.

"It'll enable every student in the United States, and eventually on the planet, to effectively have a world-class personal tutor," Mr. Khan said.

Hundreds of public schools already use Khan Academy's online lessons for math and other subjects. Now the nonprofit, which introduced Khanmigo this year, is pilot-testing the tutoring bot with districts, including Newark Public Schools in New Jersey.

Khan Academy developed the bot with guardrails for schools, Mr. Khan said. These include a monitoring system that is designed to alert teachers if students using Khanmigo seem fixated on issues like self-harm. Mr. Khan said his group was studying Khanmigo's effectiveness and planned to make it widely available to districts this fall.

Thousands of U.S. schools already use analytical A.I. tools like plagiarism-

detection systems and adaptive learning apps that are designed to automatically adjust lessons to students' reading levels. But proponents envision the new A.I.-assisted tutoring systems as education game changers because they act more like student collaborators than inert pieces of software.

Students at Khan Lab School are among the first students in the United States to try the Khanmigo bot. Ulysses Ortega for The New York Times

The A.I.'s facility with language has prompted some enthusiasts to declare that simulated tutors could soon be as individually responsive to students as human tutors.

"The A.I.s will get to that ability, to be as good a tutor as any human ever could," Bill Gates, the Microsoft co-founder and philanthropist, [said at a recent conference](#) for investors in educational technology. (Khan Academy has received more than \$10 million in grants from the Bill & Melinda Gates Foundation.)

Whether the bots can provide the kind of empathetic support and genuine encouragement that can make human tutors especially effective is not yet known.

For more than a century, education entrepreneurs have envisioned classroom devices programmed to automatically test students and deliver instruction.

As the education writer Audrey Watters recounts in her book ["Teaching Machines,"](#) researchers in the 1920s began claiming that automated teaching devices would revolutionize education. The machines, they promised, would free teachers from drudgery and enable students to work at their own pace and receive automated feedback.

Over the decades, schools that rushed to adopt the latest automated teaching technologies often found the [systems finicky or faulty](#). Some concluded that the automated tools did little improve student outcomes.

Now, new chatbots are prompting a renewed campaign for automated teaching aids. Khanmigo underscores the educational promise, and potential drawbacks, of the technology.

Khanmigo was developed by Khan Academy, an education nonprofit known for its online lessons. The chatbot uses the Socratic method, often asking students to explain their thinking. Ulysses Ortega for The New York Times

Khan Academy began developing chatbot tutoring software last fall with the aim of assessing A.I.'s potential to improve learning. The system uses GPT-4, a large language model created by OpenAI, the research lab behind ChatGPT.

Mr. Khan said he wanted to create a system to help guide students, rather than simply hand them answers. So developers at Khan Academy engineered Khanmigo to use the Socratic method. It often asks students to explain their thinking as a way of nudging them to solve their own questions.

Khanmigo offers help on a broad variety of subjects: elementary school math, middle school American history, high school civics and college-level organic chemistry. It also has features that invite students to chat with fictional characters like Winnie-the-Pooh or simulated historical figures like Marie Curie.

A.I. systems based on large language models can also concoct false information. That is because the models are engineered to predict the next word in a sequence. They do not stick to facts.

To improve Khanmigo's accuracy in math, developers at Khan Academy created a multistep process: The system works out answers to a math problem behind the scenes and then checks it against a student's answer. Even so, the Khan Academy tutoring system displays a warning at the bottom of the screen: "Khanmigo makes mistakes sometimes."

Khan Lab School, where annual tuition costs more than \$30,000, offers an ideal test bed for tutoring bots. The Silicon Valley school has small classes and an entrepreneurial philosophy encouraging children to pursue their passions and learn at their own pace. Its tech-savvy students are accustomed to tinkering with digital tools.

One morning this spring, [Jaclyn Major](#), a STEM specialist at Khan's elementary school, looked on as her students playfully tested the bot's limits.

One student asked Khanmigo to explain a math problem using song lyrics. Another requested math help in "Gen Z slang."

"Will you do me one more favor and explain everything in Korean?" a third said in a text conversation with the chatbot.

Khanmigo dutifully obliged. Then it nudged each student back to the math task at hand.

In math class, the sixth graders tested the capabilities of the tutoring bot, asking it to explain math ideas in the form of rap songs or in Gen Z slang. Ulysses Ortega for The New York Times

Ms. Major said she appreciated how the system interacted with her students in engaging ways.

"Khanmigo is able to connect with them and be on their level if they want it to," she said. "I think it could be helpful in any classroom."

It is too soon to tell whether Khanmigo will be equally engaging for other audiences — such as public schools with larger classes or students who are not used to driving their own learning.

In the classroom, Zaya, the sixth grader, had run into a glitch. Khanmigo had asked her to explain how she came up with the answer to a data set problem. Then the bot incorrectly suggested that she might have made a “small mistake” in her calculations.

She promptly admonished the A.I. chatbot: “19 + 12 is 31 khanmigo,” she wrote.

“Apologies for my mistake earlier,” Khanmigo responded. “You are indeed correct.”

That may prove to be one of the most important lessons for schoolchildren using promising new tutor bots: Don’t believe every A.I.-spawned text you read.

“Remember, we are testing it,” Ms. Major reminded her students. “We’re learning — and it’s learning.”

Natasha Singer writes about technology, business and society. She is currently reporting on the far-reaching ways that tech companies and their tools are reshaping public schools, higher education and job opportunities.

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