



The Economics of Generative Artificial Intelligence in the Academic Industry

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Generative artificial intelligence (GAI) tools are diffusing rapidly in the academic industry. We evaluate how GAI tools are shaping the education technology industry and analyze the potential benefits to students and the broader economy.

Academic institutions and education technology (EdTech) companies are rapidly developing artificial intelligence (AI) strategies to effectively use generative AI (GAI) tools, especially large language models (LLMs), such as ChatGPT. The U.S.-based massive open online course provider Coursera, which has 118 million registered learners,¹⁵ is offering GAI-related courses, such as the University of Michigan's ChatGPT Teach-Out.¹⁶ Likewise,

EdTech company Udemy, which has more than 500,000 learners, offers several ChatGPT courses (<https://www.udemy.com/topic/chatgpt/>). Udemy has also used ChatGPT to develop language learning modules. The company has been marketing its products to language teachers to design their courses.¹⁷

Charitable and philanthropic EdTech organizations are also jumping onto the GAI bandwagon. For instance, the U.S.-based nonprofit educational organization Khan Academy is developing GAI-based solutions to help students with their coursework and give ideas for lessons to educators.¹⁸

ChatGPT's launch by OpenAI, in November 2022, triggered the rapid rise in the demand for GAI courses and the development of EdTech tools with GAI capabilities. ChatGPT's considerable media coverage also created awareness of the power of GAI, which is expected to help developers of GAI-driven learning technology to gain educators' support.¹

While GAI tools cannot completely replace teachers, these tools have the potential to offer a number of benefits

to students, teachers, academic institutions, and the broader economy. For instance, effective uses of GAI can increase students' learning engagement, which may lead to lower dropout and higher graduation rates and higher earnings. GAI can also potentially help address factors contributing to low learning outcomes, such as the teacher shortage.

In this article, we look at how GAI is rapidly shaping the EdTech industry and market. The article also analyzes the potential benefits of GAI's integration into curricula and EdTech tools to students and the economy as a whole.

GAI AND THE EDTECH MARKET

The digital learning market is growing four times faster than the general education market.¹⁹ Unsurprisingly, the EdTech market is becoming increasingly attractive for technology companies. On average, a school district uses 1,417 EdTech tools.²⁰ According to market research company SkyQuest Technology Consulting, the global EdTech market was US\$106 billion in 2021, which is expected to reach US\$303 billion by 2028.²¹

The corporate learning market also provides an attractive opportunity

for global EdTech players. This market is estimated to be around US\$320 billion.²² GAI tools are likely to play a crucial role in onboarding, sales training, leadership development, and compliance programs.

AI-based tools are being increasingly utilized in EdTech products. One estimate suggested that the potential global market size of AI in EdTech is about US\$80 billion.²³ More recently, an increasing number of EdTech products have been incorporating GAI capabilities. Five such cases are presented in Table 1. We provide a brief overview of these cases in the following.

Quizlet

The learning platform Quizlet has over 60 million monthly users. Quizlet users include two in three high-school students and one in two college students in the United States.²⁴ In February 2023, Quizlet launched AI tutor Q-Chat, which combines the ChatGPT application programming interface with Quizlet's educational content library.²⁵ The content library includes billions of questions and definitions. Q-chat automatically quizzes students and helps deepen their knowledge of concepts they are learning in a conversational and engaging way. Quizlet teamed up

with OpenAI in 2020 to leverage GPT-3 across various use cases, such as vocabulary learning and practice tests.

Khan Academy

Nonprofit educational organization Khan Academy has partnered with more than 500 public school districts and schools in the United States. Its Khan Labs platform uses AI to create personalized and interactive learning experiences for students and teachers. Khan Labs has recently developed GPT-4-powered learning guide Khanmigo, which can be used as a tutor and a teaching assistant. The guide can be used in the classroom with students in real time.²⁶ As of April 2023, Khanmigo was in a pilot phase.

Khan Academy hopes that GPT-4's adaptation to its tools will guide students as they progress through courses. The chatbot can ask them questions just like the way a tutor would.² As to the rationale for using GPT-4 instead of ChatGPT in Khanmigo, Khan Academy argued that GPT-3.5, on which ChatGPT is built, does not perform well in terms of stimulating a conversation between a learner and the system. It will give an answer when a prompt is entered. Khanmigo's goal is to help students find the answer themselves. It asks the

TABLE 1. EdTech organizations' incorporation of GAI capabilities: some examples.

EdTech organization	Target market	GAI (to be) used	Tool (to be) developed	Status
Quizlet	60 million U.S. monthly users (two in three high-school and one in two college students)	ChatGPT	Q-Chat	Launched in February 2023
Khan Academy	>500 U.S. public school districts/schools	GPT-4	Khanmigo	Pilot (March 2023)
Duolingo	500 million registered users	GPT-4	Max	Launched in March 2023
Coursera	118 million users globally	ChatGPT	Coach for students and course building tool for teachers	Expected to be piloted in late 2023
Higgz	Hundreds of thousands users, mainly in the United States	ChatGPT/GPT-4	TutorEva (https://play.google.com/store/apps/details?id=com.xizhi_ai.xizhi_higgz&hl=en&gl=US)	ChatGPT incorporated in April 2023

student how they arrived at that solution and may point out how they might have gone away from what is correct in a math question. Khanmigo can ask the student to work on the problem again or ask for the reasoning. Since it is built on GPT-4, Khanmigo is reported to experience fewer factual hallucinations and math mistakes compared to ChatGPT.³

Duolingo

The U.S. EdTech company Duolingo has over 500 million registered users. Of them, 37 million use its language education app at least once a month. Duolingo offers 95 courses in 38 languages (<https://www.businessofapps.com/data/duolingo-statistics/>). Duolingo has leveraged AI models in its language education app since it was first launched in 2011.²⁷

More recently, Duolingo has started utilizing GAI in its app. Duolingo's partnership with OpenAI began in 2021, when the app first integrated GPT-3.²⁷ In March 2023, Duolingo launched Max, which gives learners access to two new GPT-4-powered features and exercises: Explain My Answer and Roleplay. A Duolingo Max subscription costs US\$30 a month (or US\$168 annually).²⁸

Explain My Answer offers the chance to learn more about a response in a lesson. Learners can tap a button after certain exercise types to open a chat in the app. The app provides a simple explanation regarding whether an answer was right or wrong. Learners can also ask for examples or further clarification. Roleplay allows learners to practice real-world conversation skills with characters in the app. The app guides a learner through different scenarios, such as discussing a vacation plan, ordering coffee at a café, and going shopping or hiking.²⁹

Coursera

In April 2023, Coursera announced plans to integrate ChatGPT into its courses.³⁰ ChatGPT-powered interactive EdTech tools to be incorporated into its learning platform include a

coach for students and an AI course building tool for teachers.

Coursera Coach is a ChatGPT-powered virtual coach,³¹ which can answer questions and give personalized feedback. It can also summarize a video lecture and provide recommendations of resources, such as a clip to help learners better understand a specific concept. It also gives career advice and prepares students for job interviews.³²

Instructors can use Coursera's GAI tools to autogenerate course content. They can use prompts to generate course content, including structure,

descriptions, tags, readings, assignments, and glossaries. The GAI also suggests other course materials. This tool is expected to be piloted to the company's selected education partners in late 2023.⁴

Higgz's TutorEva

Singapore-headquartered EdTech startup Higgz provides solutions to help users learn mathematical concepts and problems. It has hundreds of thousands of monthly users, mostly in the United States. Its TutorEva app was released in July 2022 to help students with math assignments. The learners receive detailed solutions in the form of text, illustrations, or voice instructions. Higgz's plan is to incorporate OpenAI's GPT-4 to enhance the user experience. Currently, students are required to use smartphones to scan textbooks to enter questions into TutorEva. The incorporation of GPT-4 is expected to make the app more user friendly and better suited to student needs.³³

Higgz also plans to train its app to teach all science, technology, engineering, and mathematics subjects.³⁴ As of April 2023, Higgz was reported

to be in discussions with investors for a new investment round to develop GPT-4-based apps.

BENEFITS TO STUDENTS AND THE ECONOMY

GAI's use in teaching and learning has the potential to benefit students and the economy as a whole. Some such benefits are discussed in this section.

Addressing the teacher shortage

Some analysts argue that GAI will soon be able to do the job that teachers currently do. For instance, in April 2023,

A study found that teaching positions are eight of the top 10 professions that are “most exposed” to the latest advances in LLMs, such as ChatGPT.

Microsoft cofounder Bill Gates was reported to say that within 18 months, GAI will be able to help students learn and improve reading and writing skills.⁵ Indeed, a study found that teaching positions are eight of the top 10 professions that are “most exposed” to the latest advances in LLMs, such as ChatGPT.³⁵

While the use of LLMs to replace teachers is not viewed as an ideal approach⁶ and is likely to face strong opposition from teachers, schools can use GAI tools to address the current skill shortage. Two key challenges associated with this shortage include 1) a lack of teachers with proper qualification and 2) schools' inability to cover teacher absences.

Regarding the first challenge, a 2005 study conducted by National Academy of Sciences Committee on Prospering in the Global Economy of the 21st Century found that 68% of eighth graders received mathematics instruction from teachers that lacked either a degree or certification in math.⁷ Recent GAI tools perform better than some teachers in explaining hard-to-understand mathematical concepts and formulas. Some students have reported that they use LLMs,

such as ChatGPT, to understand difficult mathematical concepts because these tools explain such concepts better than their teachers.³⁶

As to the second challenge, according to the U.S. Bureau of Labor Statistics, about 600,000 substitute teachers cover over 30 million teacher absences in K-12 schools in the United

States.⁸ One estimate suggested that in 2018–2019, schools were unable to cover teacher absences about 20% of the time. Minority students and those living in poverty are most likely to have to be affected by the lack of substitute teachers.³⁷ In some cases, the alternative has been to turn on a movie instead of offering instruction.⁹ Some schools believe that they can benefit from GAI tools' potential to replace substitute teachers.⁹ A view that is more realistic and potentially more likely to be accepted by a wider audience is that GAI can function as a teaching assistant and lighten teachers' workload. This, in turn, can lower the need for substitute teachers.¹⁰

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Reduced dropout rate and improved student achievement

GAI's role in improving students' academic performance can result in reduced dropout rates. For instance, as discussed in the preceding, GAI tools are being used in improving students' math problem solving abilities. In this regard, research has suggested that a one standard deviation increase in a math grade point average reduces the odds of dropping out by 32%.¹¹

As mentioned, GAI-based EdTech tools, such as Khanmigo and Quizlet, aim to enhance student engagement. For instance, it is reported that by

Economic benefits to students and the broader society

Students with GAI skills are likely to be in a better position when they enter the workforce. More broadly, AI and machine learning (ML) are the most important skills for job seekers today.³⁸ According to a 2021 report by ITCareerFinder, jobs that require AI/ML will grow by 71% by 2026, and employers will pay average premiums of US\$14,175 to successful applicants.³⁹ In a February 2003 survey of 1,000 U.S. business leaders conducted by the career site Resume Builder, 90% of respondents said that ChatGPT experience is a "beneficial skill for job seekers."⁴⁰

In the long run, GAI's use in teaching and learning may lead to a higher economic growth and increased tax payments. Some of the GAI tools discussed in the preceding are geared toward improving students' math and science skills. Substantial economic benefits can be achieved if these efforts are successful. A study reported that a one standard deviation increase in math and science skills results in more than one percentage point in average annual gross domestic product growth.¹³

Calculated as the present value at the age of 20 (net of all taxes), earnings of each additional expected high-school graduate will be US\$190,000 to US\$333,000 (depending on race) more

than those of a dropout for males and from US\$90,000 to US\$172,000 for females.⁷ Likewise, the earnings gains resulting from a 0.25 standard deviation increase in math scores ranges from US\$8,650 (Black) to US\$13,640 (White) for males and US\$6,250 (Black) to US\$8,200 (White) for females (lower than males due to lower labor market participation rates).⁷

LLMs to improve teaching and learning instead of replacing teachers

The anecdotes and studies reviewed in the preceding suggest that LLMs can potentially reduce dropout rates and improve student achievement, which should lead to important short- and long-term benefits to students and the broader economy. LLMs' ability to help students understand difficult concepts and increase their engagement can be realized only if the learners are motivated and interested enough to learn. However, the real world is far from ideal. Most of the problems that educators encounter with students today involve social and emotional issues that inhibit students' ability to learn and become successful professionals and make an impact on the world.⁶ Educators have to deal with and respond to anger, conflict, social inequalities, and other hard-to-resolve issues. Teachers also need to find ways to motivate unmotivated students. Teachers' social skills are critical in addressing these issues and contributing to students' personal, social and moral development. Economic analyses often fail to capture these mechanisms.

It has also been suggested for a long time that teachers should help students evaluate the credibility of information from many different sources. Such a role is even more evident in the GAI era. For instance, estimates suggest that about 15%–20% of ChatGPT's results are incomplete or misleading, which are also called "hallucinations."¹⁴ There is a lack of a built-in mechanism in LLMs to let users know that the results could be potentially


inaccurate or enable them to challenge such results.

Despite several benefits that LLMs present, they are not yet ready to completely replace the roles that teachers play in and outside of the classroom. However, there is a great potential for enhancing students' learning and engagement if students, teachers, and LLMs work together toward a common goal.

GAI's footprint is rapidly growing in the education sector. The utilization of GAI in teaching and learning can lead to important benefits. If GAI is effectively implemented to improve students' achievement in areas such as math and science, there will be significant positive effects in the short run and in the long run. Among immediate benefits to the students, GAI has the potential to play a key role in providing a successful learning experience. By appropriately combining human teachers and GAI, dropout rates can be reduced, and student achievement can be improved. In the long run, these effects will lead to economic growth and increases in tax revenue.

While concerns have been raised about the potential negative consequences of GAI in the education sector, such as job losses of teachers, there are also positive aspects of such effects. For instance, in light of the current shortage of teachers in primary and secondary schools, GAI may also be used to alleviate the adverse effects resulting from this shortage. GAI can also free up teachers' time, which can reduce the need for substitute teachers.

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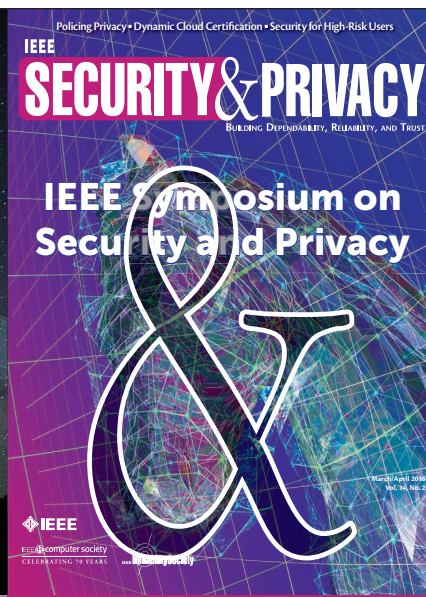
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