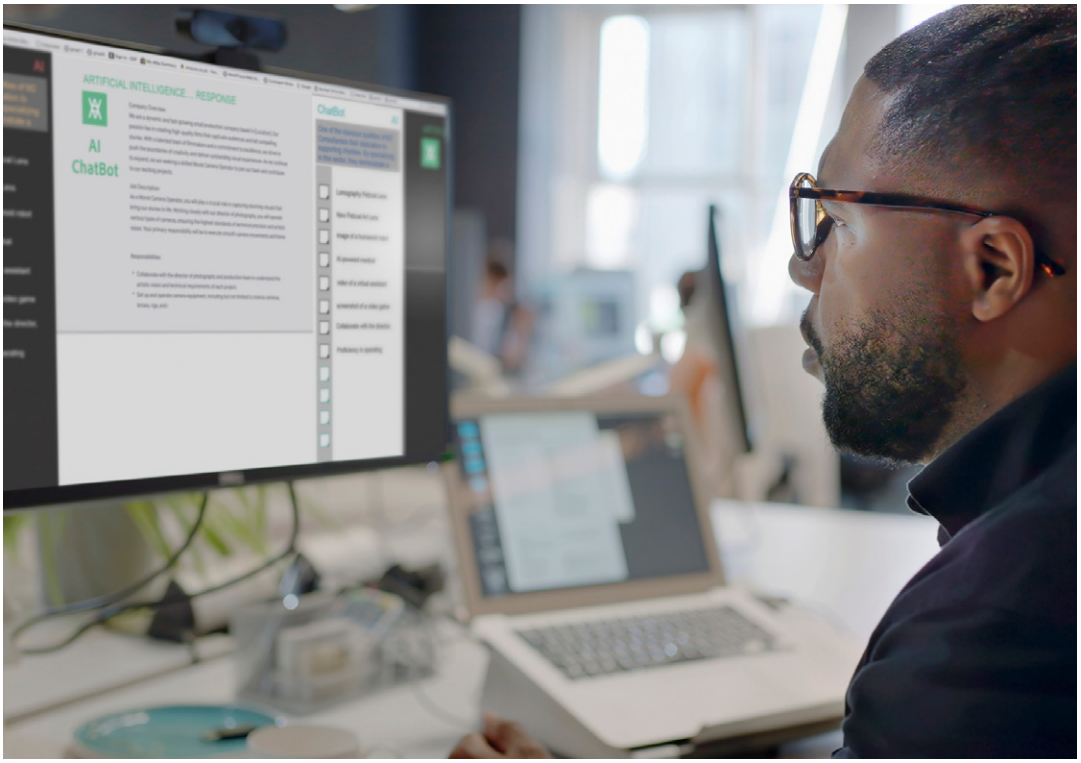
TRENDS SNAPSHOT

The Emerging Role of Gen AI in Academic Research



- Investigating society's big problems
- Aiding student learning
- Finding uses for new tools
- Planning for a tech-dominated future

Generative artificial intelligence may be the vessel into which the academic research world pours its hopes and dreams. And perhaps its anxieties, too.

Not long after the advent of ChatGPT 18 months ago, generative AI was hailed as a boon to researchers — a disruptive force able to crunch unprecedented amounts of data, crank out comprehensive literature reviews in minutes, and concoct accurate models of complex systems. ChatGPT and other tools that use large language models (LLMs) hold the promise of saving researchers time, the opportunity to get instant help in writing intricate research papers, and the ability to dig deeper.

Yet, while it is used widely across disciplines by academic researchers, generative artificial intelligence — or gen AI — has yet to burrow deeply into campus turf. Colleges have been tiptoeing, rather than running, toward it, experts say. Institutions are taking

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Having spent over a decade working in and with higher education institutions, I understand how critical it is that academic research is secure but collaborative, whether that collaboration is between departments, between local institutions, or across international boundaries. As the higher education and academic research leader at Amazon Web Services (AWS), I now have the opportunity to work with research executives, principal investigators, and leaders across academic disciplines throughout the United States as they build out infrastructure to help secure and scale research and transform what's possible in medicine, space exploration, engineering, and other fields of human ingenuity.

Research leaders in labs and in university and college administrations are increasingly seeking ways to ensure research innovation and collaboration is accelerating, but done in secure environments that protect intellectual property and maintain the trust of national funding bodies. Based on this movement and various research universities we are talking to, our advice to leadership is simple. Cloud computing provides the tools we need to collaborate securely at a global scale, where data is stored, governed, and available for analysis and visualization, and high-performance computation is readily available.

Universities and colleges increasingly recognize the importance of cloud computing in their research strategy and the need to quickly develop resources to empower their researchers. But for many, questions remain, including:

- How do we ensure we have the appropriate infrastructure for our community?
- Do we have the right resources to train and enable researchers in the cloud?
- How do we enhance security without compromising collaboration?

AWS works with many research universities like Old Dominion University to help build a cloud center to compete for larger research projects and increase research funding. Secure environments are key to advancing research and AWS stands ready to help you and your team to unlock your institution's full potential.

"AWS is committed to support research leadership with cost-effective, scalable, and secure solutions that advance research and drive collaboration."

- Danielle Rowdy
Leader, Higher Education & Academic Research
Amazon Web Services

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time to assess whether the gen AI beaker is half empty or half full.

While 64 percent of college leaders told the *Chronicle* last summer that emerging AI tools will have a positive effect on research, a majority (57 percent) also said that gen AI poses a threat to it, as well as to how colleges educate and operate.

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Administrators continue to wrestle with ways to deal with gen AI and the concerns that come with it about best practices, ethics, faculty and researcher training, intellectual property, privacy, and research transparency. Anxieties about the cost and massive amount of energy needed to run data centers central to large gen AI operations are emerging.

Researchers often approach the technology with wariness. Many echo a majority of Americans who say they are "more concerned than excited" about the prospects of gen AI. Ongoing worries about bad actors using gen AI to create deep-fake images, the tool's propensity for churning out fiction rather than fact, and the gender or racial bias instilled in some algorithms make many researchers skeptical about its reliability. At its core, today's gen AI does not reflect two core scientific values: replicability and transparency.

Even as institutions move cautiously forward to define gen AI's role on campus, emerging trends indicate they are venturing beyond initial concerns about students cheating and toward the innovation this new tool can bring to research operations.

Investigating society's big problems

Previous iterations of artificial intelligence and machine learning helped lead researchers toward major breakthroughs, including some of the science behind the Covid-19 vaccine and an answer to the age-old "protein-folding problem" in determining a human molecule's shape.

The latest generation — gen AI —offers researchers an even-deeper understanding of complex problems and the ability to find uses for much larger sets of data. It can develop new content in audio, images, or text by using the pattern-recognition skills it has been trained on to create new models almost instantly, representing new possibilities for researchers.

Faculty members are testing its capabilities. Last year, scientists at Stanford University trained computers so they could learn biology on their own, from scratch. The gen AI-outfitted computers "discovered" a rare kidney cell that makes a hormone that is vital in maintaining oxygen levels in red blood cells — taking six weeks to accomplish what took humans 134 years to do.

Gen AI's ability to move quickly, along with new streams of funding, including $130 million in gen AI-focused grants from the National Institutes of Health, is gaining the attention of academic medical researchers.

Other disciplines that have already amassed troves of data, such as agriculture, computer science, and public policy, will find ready uses for gen AI, says Krystyn Van Vliet, vice president

for research and innovation at Cornell University.

Ornithologists and technologists who run a popular bird-watching app at Cornell are exploring ways to use crowdsourced data to learn more about bird behavior, such as how changes in the jet stream affect migratory patterns.

"Gen AI and increased computing power give us the chance to use data we accumulated earlier to make some leaps," Van Vliet says. "Gen AI gives us the capability to find patterns where we couldn't before."

Elsewhere, researchers are using the technology to find answers to uniquely human challenges. At the University of Southern California, scientists are creating models and applying what they learn to offer ideas on helping people struggling with addictions or housing insecurity.

At the University of Florida, researchers led by Bonnie J. Dorr, a professor of computer science, are using gen AI to try to increase understanding of two of society's most-pressing problems: cybercrime and the glut of disinformation in the digital realm.

An expert on LLMs, Dorr uses models derived from gen AI to learn about various hacking cultures. She probes the digital behavior of cybercriminals to learn what she calls their "hidden mental states" — clues to how they think — so their aims can be detected before they inflict damage.

Similarly, identifying online trolls and disinformation early on during a social-media discussion could lead to the development of an "automatic mediator" that filters out or alters misleading or angry language on social-media sites, she says.

"Detecting toxic language is a big research area in large language processing now," Dorr says. "We're not sure exactly how to apply it yet, but we hope to find some new ways to calm down these conversations people are having online."

At the same time, Dorr's team is testing gen AI not just to learn its strengths but where it falls short. Gen AI's hallucination problem, which can cause it to garble facts and create citations that are fictional, remains a major concern for researchers. LLMs could be augmented, Dorr theorizes,

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by adding statistical models that would offer not only an answer to a user prompt, but an explanation of how gen AI arrived at that answer.

"A user needs confidence that the answer is correct," Dorr says. "Gen AI might still hallucinate, but an explanation of the answer would at least give users a good idea of whether that's happening."

Aiding student learning

Researchers are also working with gen AI to help colleges fulfill their main mission: educating students as comprehensively as possible. Many see gen AI as a complement to classroom teaching — and not just at colleges but also in middle and secondary schools as well as many disciplines, including the humanities and STEM.

Using gen AI as "language partners and as learning companions" for students navigating challenging concepts in STEM courses could improve outcomes, says Ying Xu, an assistant professor of education at the University of Michigan.

With funding from the Corporation for Public Broadcasting, the National Science Foundation, and others, Xu and Xu Wang,

a professor of computer science and engineering at Michigan, are investigating how technologists can restrict gen AI tools to specific domains, such as STEM, thereby reducing its hallucinations. Developing an "intelligent tutor" that can guide students as they study video lessons will help them grasp complex scientific concepts, such as viscosity.

"Students show learning improvement with AI-assisted dialogue," Xu says. "There's a lot of interest in improving how we teach STEM, not just from education and technology researchers, but from teachers in the traditional classroom."

Those teachers have a variety of views on gen AI. How might their attitudes affect how — or if — they use gen AI in their classrooms? A USC study published in February found gender differences in how middle- and secondary-school teachers put gen AI to work. Male teachers were more concerned about the consequences of using AI, while female teachers focused more on carrying out the rules governing students' AI usage. Understanding those differences will become more important as schools increase their use of gen AI learning tools, the authors concluded.

At the college level, humanities scholars and instructors are also investigating whether gen AI can help students develop creative ideas and write clearer sentences. A pilot project at the Humanities Institute at Arizona State University has infused gen AI in three basic-composition courses. At USC, 17 writing fellows use a software tool developed there to help composition

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students sharpen their theses and enliven their writing. Both universities plan to publish study results from those courses.

Meanwhile, as concerns about students using gen AI tools to cheat or take shortcuts begin to ease, new research has emerged on how the technology might help students perform better on their coursework.

"If we can learn more about gen AI's limitations, as well as ways to forestall student cheating as they use it, we can teach students to use the tool to fine-tune their coursework," says Danda B. Rawat, associate dean of research and graduate studies for engineering and architecture at Howard University.

Finding uses for new tools

Along with assessing the role gen AI might play in aiding vital research and improving learning, academic scientists are still spending a good bit of time figuring out what exactly they can do with it.

While some researchers develop or hone the algorithms and LLMs that drive gen AI, others use its tools to analyze data, generate computer code and graphics, write grant applications and manuscripts, conduct literature reviews, and develop presentations.

Ying Xu, at Michigan, uses it to edit and reshape sentences. Most gen AI software has been trained solely on English texts. Gen AI has become a valuable writing aid to researchers, like Xu, whose first language is not English.

Some institutions are developing specialized uses for the technology — ones that aim to expand the capacity of their researchers.

The University of Virginia is working to create a central grant-application clearinghouse with other institutions,

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putting gen AI to work scanning thousands of applications. Researchers could use that data to better understand what is going on in their field, form new cross-institutional collaborations, and develop fresh experimental subjects and approaches.

Others argue that because gen AI is limited by its biases and hallucinations, it should be viewed mostly as a sounding board.

"Your gen AI is like your undergrad assistant," says Jenay Robert, a senior researcher at Educause, an organization that advocates for the use of technology at colleges. "It's coming at you with a comprehensive, if surface-level, view of all that is available. The tools need to get better before they can be of great use in each discipline. Still, it helps to engage with these tools as conversation partners."

Planning for a tech-dominated future

Though some institutions and their researchers may retain some anxieties about gen AI, few of them are discounting its importance.

"What I'm hearing is, 'If I don't figure out how to use this in my research, I'll be obsolete in 10 years,'" Robert says.

Several public institutions, including the Universities of Florida, Michigan,

and Virginia, have made large financial investments in the research potential of gen AI, including increasing the number of researcher positions on the faculty and the power of their technology.

Some experts say that isn't enough. Faculty members untrained in gen AI, including academic researchers, remain largely in the dark. Those investments could fall flat if colleges don't also finance a plan for faculty development.

"AI tools are coming so fast, but most faculty members don't know how to use them," says Jing Liu, executive director of the Michigan Institute for Data Science at the University of Michigan. The institute ran a survey that found that fewer than one-third of Michigan researchers can effectively run LLMs or adapt them to their own uses.

Liu is an author of a recent paper that argued institutions need to do more than wait for each individual researcher to learn the uses of gen AI. She worries that the accelerating pace of AI innovation will pass academic researchers by, even as tech-industry scientists thrive.

As a first step toward educating researchers, the Michigan Institute published an online primer for researchers looking to use gen AI. But institutions need to expand such efforts, Liu says.

"It's too much to expect from researchers — they can't do this on their own," she adds. "We're kind of at the agrarian stage. Universities need to develop a community to build the capacity for this." To get training up to speed, institutions should form more partnerships with tech companies, some experts argue.

Some institutions are responding to those concerns or are at least taking baby steps. The University of Texas at San Antonio is working to pair their researchers with gen AI-savvy students. Cornell encourages informal gatherings where faculty, staff, and students can share ideas on how best to use gen AI. By the fall of this year, when gen AI research issues are better understood, Cornell administrators hope, the university will look to start regular seminars.

Last December, Cornell published some guidelines for researchers using gen AI, in part to create a discussion around the potential of gen AI in science, says Van Vliet, the university's vice president for research and innovation.

"Leaders and faculty felt we needed to get out in front of it," she says. "We want to shape the future and not have it get ahead of us. This isn't just another tool."

"The Emerging Role of Gen AI in Academic Research" was produced by Chronicle Intelligence. Please contact CI@chronicle.com with questions or comments.

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