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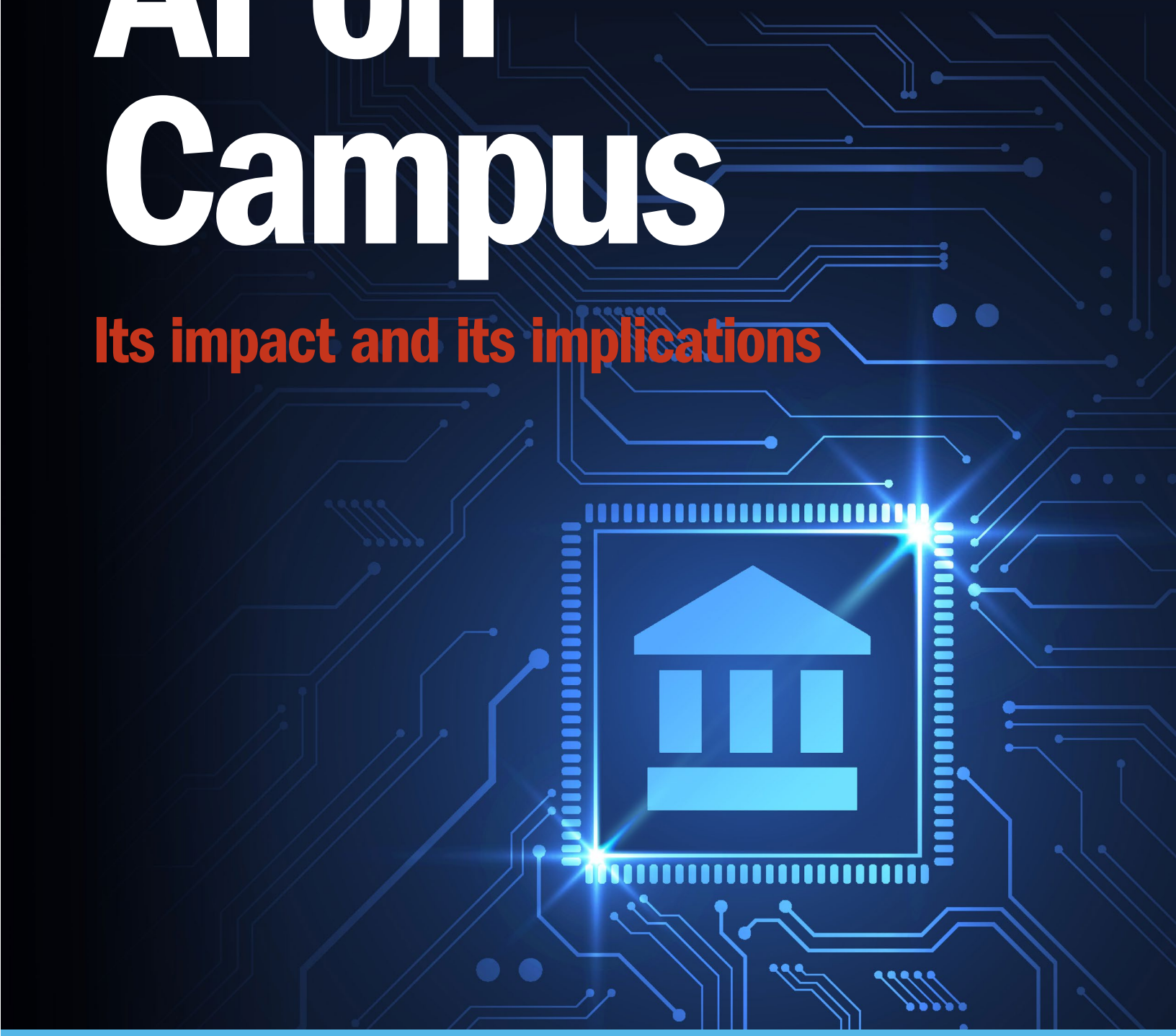
AI on Campus

Its impact and its implications



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The University of Florida is becoming an Artificial Intelligence-enabled university that will give students, faculty and researchers access to tools that advance learning and accelerate research across all disciplines. By weaving AI into the fabric of our University of Florida community, we will prepare students for an emerging 21st-century economy and empower researchers to find real-world solutions to social, economic and environmental problems.

We are adopting a new philosophy of "AI Across the Curriculum". In line with Florida's commitment to equitable, ethical and inclusive education, AI training and education will be integrated throughout our university. Our faculty, through the AI curriculum, will give students the opportunity to develop AI skills in the context of their chosen major—ranging from a basic understanding to true proficiency in the application of AI to healthcare, engineering, business, the social sciences and other areas. Researchers will use AI to tackle the most pressing issues, helping to support UF Innovate, a program that moves research discoveries from the lab to the marketplace.

We are swiftly changing the way the University of Florida delivers education helping to build the nation's next generation AI-enabled workforce, and leveraging the UF-AI Initiative to create positive economic impact throughout Florida and the Southeastern United States. Our university will serve as a model and a hub of AI expertise for innovators from academia, industry and governments local and worldwide.

This is a transformational time for the University of Florida. Thanks to our partnership with NVIDIA, our new supercomputer HiPerGator AI—the most advanced AI technology in higher education—will revolutionize every facet of UF's mission to provide the very best in teaching, research and service.

We look forward to sharing our vision, philosophy and capabilities with the academic community at large, as well as partnering with public and private entities around the world to advance AI as a critical element of humanity's collective future.

Sincerely,

Joseph Glover

JOSEPH GLOVER
Provost and Senior Vice President for Academic Affairs
University of Florida

"In line with Florida's commitment to equitable, ethical and inclusive education, AI training and education will be integrated throughout our university."

—Provost Joseph Glover

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AI on Campus
Its impact and its implications

Artificial-intelligence applications are transforming multiple facets of higher education, including teaching and learning, enrollment and student support, institutional efficiency, and facilities management. Based on machine learning, AI finds patterns in institutional information, correlations that then can inform data-driven decisions and smarter processes. Machines are not about to replace humans in most college operations, but today AI promises greater efficiencies and more effective practices — and a tantalizing and ever-expanding array of technologies to better serve students. The benefits can be striking, but there are pitfalls as well, including privacy concerns and ethical questions, as well as scaling obstacles and training challenges.

This collection of *Chronicle* articles and commentary examines AI's impact on college campuses, from new ways to attract, engage, and support students, to streamlining administrative and academic tasks and operating smart-building systems. It also takes a look at the growth in AI-related course content, and how colleges are preparing students for the many implications of the continued growth of AI in the 21st century.

Chronicle cover illustration, Getty Images

For questions or comments about the collection, email ci@chronicle.com

DUSTIN CHAMBERS FOR THE CHRONICLE

Austin Birchell, a first-generation college student whose family "didn't know anything about college as a system," he says, used Georgia State's chatbot to help him fix a financial-aid problem before his freshman year began.

You Can Help Make Sure Freshmen Show Up. Here's How.

By BECKIE SUPIANO

The summer before he started college, Austin Birchell ran into a major snag. He was counting on a state merit scholarship to cover a significant chunk of his tuition at Georgia State University. But the bill was due soon, and he still hadn't received his financial-aid award.

To figure out why, he'd have to tangle with an unfamiliar bureaucracy. Neither of his parents had attended college. His family "didn't know anything about college as a system," he recalls.

But Birchell did know where to turn for help. Georgia State had just rolled out a chat-

bot system, named "Pounce," after the university's mascot, a panther. Throughout the summer, Pounce sent incoming students text-message reminders. And it responded to their questions.

With Pounce's help, Birchell figured out that his concern about the missing aid award was well founded. In the end, he and his mother drove to campus, walked into the financial-aid office — Pounce told him where it was — and resolved the issue in person. Somewhere along the way, it turned out, Birchell's Social Security number had been written down incorrectly. As soon as they fixed the discrepancy and had the scholarship applied to the balance, Birchell and his mom walked across the hall to pay his bill.

"If it hadn't been for Pounce," Birchell says, "I don't know if I would have been starting that semester."

Each year, at just about every college, some fraction of the freshman class that has paid deposits never shows up. Admissions officials call the phenomenon "summer melt": Students "melt" out of the class between making their enrollment deposit in the spring and the start of the fall semester. The reasons for melt aren't always clear, but research suggests that the many administrative tasks that students must complete during the summer — often with little help — plays a role.

Summer melt is one more factor that makes it hard for a college to project an all-important number: how many students it will have in the fall. Bring in fewer freshmen than intended, and a college might not have sufficient tuition revenue to cover its expenses. For many colleges, then, courting students throughout the summer has become standard practice. This contact is both practical, helping students through a series of required to-dos, and emotional, nurturing a bond to the college they've chosen.

It's one thing to realize the importance of communicating with incoming students. It's another to do it well — especially for colleges that have a lot of them. Georgia State brings in close to 4,000 freshmen each fall. At least 35 percent of them are first-generation, and 58 percent are low-income. Those student populations are hardly monolithic, but on balance they're less likely to have access to college guidance during the summer.

Before Pounce, helping students navigate the summer fell to people like Bianca M. Lopez. A senior admissions counselor, Lopez is the primary contact for several thousand prospective students at Georgia State. Responding to their questions often consumed her lunch breaks and evenings, she says, and it was still a struggle to give everyone a timely response. "It seems like it wouldn't take a lot of time to answer similar questions over and over," Lopez says, but she found that it kept her from other parts of her job.

Not only did students have to wait to hear back from staff members, says Timothy M. Renick, vice president for enrollment management and student success, but the answers they got might not be consistent, or complete. There had to be a better way.

Summer melt is obviously a challenge for colleges. But until recently, its impact on students was less clear. For a long time, high schools assumed that students who graduated with specific college plans followed through on them. Colleges figured that expected students who never materialized had enrolled somewhere else instead.

That started to change about five years ago, when a pair of researchers set out to quantify the extent to which students with concrete college plans melted out of postsecondary education altogether. Earlier studies indicated that disadvantaged students were more likely to forgo college, even after being admitted and making a deposit. So the researchers, Ben Castleman and Lindsay C. Page, focused on pockets of the country with significant low-income-student populations. Their findings were striking: Around 20 percent of low-income students who were set to attend a four-year college do not actually enroll anywhere.

Castleman, now an assistant professor of education and public policy at the University of Virginia, and Page, now an assistant professor of education and a research scientist at the University of Pittsburgh, tested a couple of approaches for increasing

the number of low-income students who enrolled in college as planned. One took the form of a behavioral intervention, or "nudge," which seeks to address the cognitive, emotional, and social reasons people don't follow through on their intentions.

The researchers designed a series of text messages that counselors and advisers working with collegebound students could send to nudge them along on the tasks they needed to complete over the summer. The texts also provided students with an opportunity to connect with a counselor if they had questions. The text messages raised enrollment among students at several of the research sites, making the biggest difference where students had less access to college-planning help.

The summer-melt research caught Renick's attention. He read Castleman and Page's 2014 book, *Summer Melt: Supporting Low-Income Students Through the Transition to College*, and had the heads of all the offices he oversees read it, too.

Georgia State is well known in higher-education circles for the sophisticated way it collects and uses student data. But it didn't know what happened to students who melted out of its class. Inspired by Castleman and Page's work, Renick decided to investigate. Using data from the National Student Clearinghouse, university officials determined that 300 of the 900 students who melted out of its class in 2015 had not gone to college anywhere a year later. Worse, more than 70 percent of them were low-income students, and three-quarters were students of color. Fixing melt, Renick decided, wasn't just about raising enrollment or bringing in revenue. It was a matter of equity.

Georgia State worked with AdmitHub, a company that helps prospective students navigate the admissions process, to create Pounce. AdmitHub asked Page for help in designing the messages. She agreed, on the condition that when the new tool was rolled out, in 2016, there was a control group, so that she could study it.

Pounce's messages are more tailored than the ones sent in her previous experiments, Page says. Pounce sits on top of Georgia State's student-data systems, so it knows which students need which prompts. So, for instance, a reminder that housing deposits are due is sent only to those students who have not yet made theirs.

That kind of personalization, Page says, could reduce the chances that students begin to tune the messages out. But there is a potential drawback to this approach, she says. Colleges have a vested interest in not just if but where students enroll. That doesn't concern her in the case of Georgia State, Page says. But "you could think of sort of a bad scenario, where predatory for-profit institutions say, 'Oh, we're going to do this, too,' and it ending up being a great strategy for them to recruit students."

Students can also text Pounce with a specific question. When they do, the system uses artificial intelligence to match their query with one of 2,000 prepared answers — a number that grows as Pounce encounters new questions. In most cases, there's a good match. If there isn't an appropriate

Nudging Works

Lindsay Page, a scholar who has helped shift the conversation about summer melt, persuaded Georgia State University and AdmitHub, the vendor it worked with, to test Pounce, a chatbot meant to reduce melt. A randomized, controlled trial, conducted in 2016, allowed Page to evaluate Pounce's effectiveness. Based on her findings, the university decided to make the technology available to all of its incoming freshmen in the next admissions cycle. In the future, Georgia State wants Pounce to help current, as well as new, students navigate the university.

Summer melt among students who had access to Pounce was 12.1 percent. Summer melt in the control group was 15.4 percent.

If all the incoming students had access to Pounce, an estimated 116 more students would have successfully enrolled.

Paola Berrios, a freshman at Georgia State U., found the chatbot useful over the summer before she came to the campus. She knows it's an automated system, she says, but "personalized stuff always feels really nice."

DUSTIN CHAMBERS FOR THE CHRONICLE

answer in the system, the message is forwarded to a staff member, who responds by hand. That's necessary less than 5 percent of the time.

Pounce's early results are promising. It has significantly reduced how long students must wait to get an answer to their questions, Renick says. And Georgia State has learned that some students are more comfortable asking questions of Pounce than they are asking a staff member.

Student feedback also suggests that Pounce helps students maintain their sense of independence. Talking with a staff member on the phone, students reported, felt like having someone else solve their problems. "But with the chatbot, with Pounce," Renick says, "it was like I was using a tool, and I was solving the problem for myself."

Summer melt was about 20 percent lower for students who had Pounce than those in the control group, Page found. If it had been available to the whole incoming class, she estimated, 116 more students would have enrolled.

Based on that evidence, the university decided to make Pounce available to all of its incoming students starting last summer.

Paola Berrios, a freshman who plans to major in political science, is a fan. She has the contact in her phone saved as "Pounce" with an emoji of a robot.

Before she got to campus, Berrios asked Pounce a bunch of questions, including some she didn't think were important enough to ask a real person — like the dorm's policy on pets. She saved the message it sent on the first day of classes: "WELCOME," it said with a party emoji. "We hope you're as excited to be here as we are to have you on campus." Berrios is well aware that these messages are from a bot. Still, she says, "personalized stuff always feels really nice."

Georgia State hopes to maintain students' connection with Pounce even after they enroll. The university is weaving into the chatbot the proactive academic advising it already offers, with an eye toward confronting challenges, academic and otherwise, that can lead students to drop out. That information, Georgia State hopes, will help close the achievement gap for students from disadvantaged backgrounds. The goal, Renick says, is to give students "timely information to make good decisions at every juncture along the way."

Beckie Supiano is a senior writer at The Chronicle of Higher Education

Originally published February 18, 2020

NATHAN LINDSTROM FOR THE CHRONICLE

How Artificial Intelligence Is Changing Teaching

By BETH MCMURTRIE

Two years ago, Craig Coates, an entomologist at Texas A&M University, was asked to take over a science course plagued by cheating. The previous instructor of the large lecture course, "Insects in Human Society," had tried to stay one step ahead, but in the class, oriented around online quizzes and tests, students would quickly share new material as soon as it went up. "It became an arms race be-

tween pushing out more questions faster and cheating," recalls Coates, an instructional associate professor who has taught on the campus for nearly 20 years. "It moved everything toward rote learning."

He wanted to reorient the course toward writing and discussion, convinced that the method would not only reduce cheating but also be a more engaging way to learn. But with 500 students — 200 in person and 300 online — grading would be a challenge. He experimented with one assignment, and it took days for him and three teaching assistants to complete the grading. "It was obviously going to be impossible," he said, to do it by hand.

Peer review was an option, but he and his TAs needed help sorting, assigning, and evaluating submissions. That led him to try a tool that uses algorithms and analytics. The switch was a success: Students enjoyed writing about current research, including keeping an insect blog and debating topics in entomology. The response, Coates says, has been "overwhelmingly positive."

Artificial intelligence is showing up more frequently in college classrooms, particularly at big institutions that are seeking to make large courses more intimate and interactive. A professor at Georgia Tech developed virtual teaching assistants and tutors. Researchers at Carnegie Mellon University are creating conversational agents to promote online discussion. And on a growing number of campuses, professors are using adaptive courseware that adjusts lessons according to students' understanding and deploying AI-driven tools, like the one Coates used, to promote writing and peer review.

As artificial intelligence enters our daily lives through smart speakers and chatbots, it's no wonder that academics are exploring its potential in teaching.

The technologies in these tools vary, of course. Some focus on sorting information to a help a professor organize and evaluate assignments. Others use automated text analysis to mine students' writing and fashion relevant prompts. Adaptive courseware is built around the sequencing of lesson plans, selecting content based on regular assessments of what students know. Advanced tools are based on machine learning, a form of AI that learns from user behavior. And many forms of AI draw on research in learning science, cognitive psychology, data science, and computer science.

This trend prompts serious questions. When you've got artificial intelligence handling work that is normally done by a human, how does that change the role of the professor? And what is the right balance of technology and teacher?

Some, like Coates, feel that algorithm-driven technologies can be useful aids in large classes. They automate some of teaching's routine tasks, so that professors can do what no machine can — challenge and inspire students to gain a deeper understanding of what they're learning. These technologies, advocates argue, are simply tools in service of creative forms of teaching.

But skeptics worry that if education is increasingly reliant on artificial intelligence and automated responses, it will put technology in the driver's seat and prompt formulaic approaches to learning. Some of the algorithms used in AI-driven tools are built on large data sets of student work, raising privacy and ethical questions. Turning to technology for solutions, critics say, may also short-circuit conversations about some of the structural challenges to effective teaching and learning.

That avoidance of structural issues troubles people like Kevin Gannon, a history professor at Grand View University, in Des Moines, and head of the campus Center for Excellence in Teaching and Learning. "We see a particular problem, whether it's retention rates for minoritized students or large class sizes and heavy grading loads," he says, "and our first instinct is to find something new and hot to address the problem rather than focus on the classroom and faculty and students."

Perhaps nowhere are those tensions more apparent than with adaptive courseware, sometimes called intelligent tutoring systems. The programs have grown increasingly popular as an alternative to large classes that emphasize lecture and memorization. They have also given rise to the specter of the robot teacher.

With adaptive courseware, students first

encounter material outside of class, often through short video lessons and readings. They take quizzes that assess their understanding of the material and, depending on the results, the courseware either advances them to the next lesson or provides supplemental instruction on concepts they don't yet grasp. Advocates say this lets students study at their own pace and frees up the instructor's time in class to shore up students' knowledge or help them apply what they have learned.

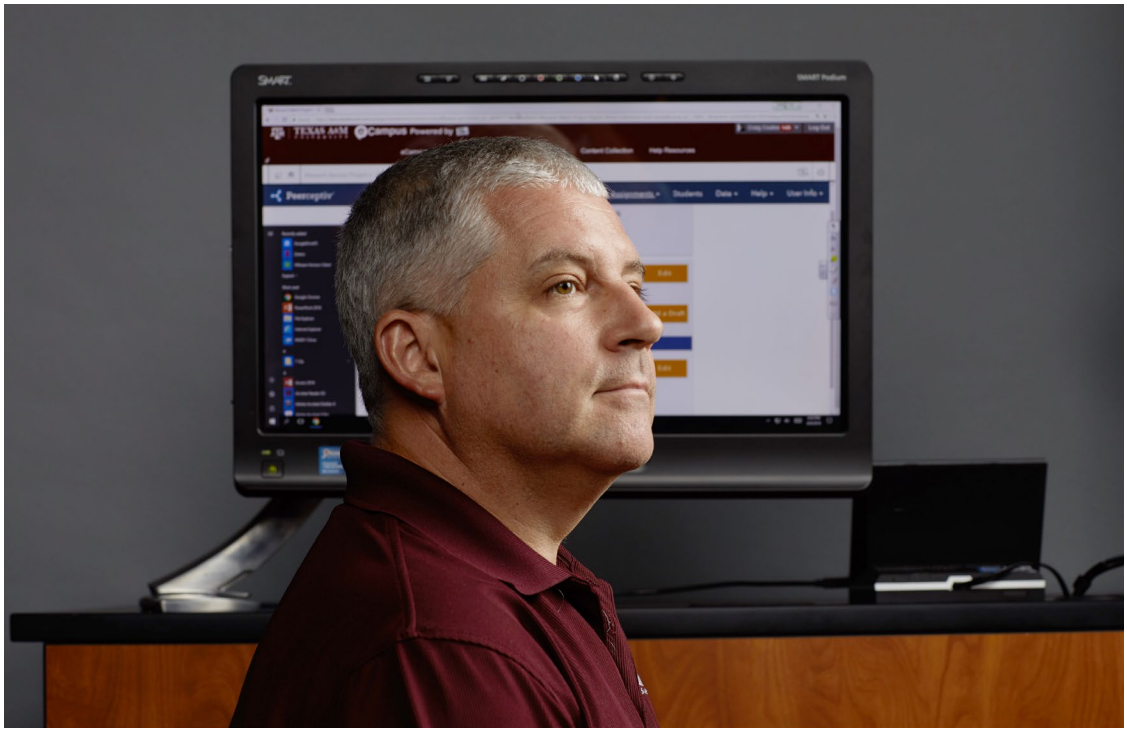
Adaptive courseware has made the most inroads in introductory STEM courses, particularly math, in which it is easier to sequence content and test understanding of concepts than in, say, a literature class. Administrators at several large public universities, including the University of Central Florida and Georgia State University, have seen positive results with the use of adaptive courseware, which are often accompanied by a rethinking of classroom time, to emphasize active-learning techniques.

Susan Holechek became a convert several years ago as Arizona State University began testing adaptive courseware in a number of introductory courses. The biology instructor teaches a class for nonmajors — who probably wouldn't be there if they didn't have to be.

"It's a very, very, very tough crowd," she says. Holechek tried out a small class that used a combination of adaptive courseware and active learning, while also teaching her conventional 300-student lecture course.

For a lesson on DNA, for example, her traditional lecture focused mainly on conveying information, she says. Students in the smaller, pilot section might read the textbook, watch a video, and then take a short quiz the night before class to see how well they understood the material. If they scored poorly on some part of the lesson plan, the courseware would then send them back to review that concept, with new examples or additional information to help them grasp it better.

Using adaptive courseware enables Holechek to spend class time on exercises that encourage students to apply concepts that they encountered online. In one exer-



DUSTIN CHAMBERS FOR THE CHRONICLE

Craig Coates, an entomologist at Texas A&M, uses a peer-assessment tool called Peerceptiv to anonymize and distribute student work, allowing each writing assignment to be reviewed by several classmates.

cise, called "Who Kidnapped Sparky" (the university's mascot), they work with DNA samples to understand their use in forensics. "It allows me to be more creative," she says.

The adaptive courseware also helps her create opportunities for more points of contact — between her and her students, and her students with the material. A dashboard helps Holechek keep track of how well each student is doing on homework and quizzes, with a cumulative "mastery" rating attached to each. Every Sunday the instructor goes over the collective results from homework reviews to see which concepts her class struggled with. Then she builds a brief Monday-morning lecture around that material.

The proportion of students earning a C or better in Holechek's course rose from 76 to 94 percent in the pilot and has continued to remain strong now that she has switched entirely to adaptive learning.

Other experiences with adaptive courseware have been more mixed. A recent study looking at results from across a range of colleges found little to no difference in course grades. This points to a larger challenge with education technology, ed-tech experts say: If instructors expect tech to fix classroom problems but don't address underlying pedagogical issues, they are likely to see limited results.

After stumbling through some early experiments with adaptive learning, Arizona State found that training instructors in active-learning strategies increased the impact of the adaptive courseware they used. The university has also redesigned classrooms to promote collaborative work and offers a starter kit to those new to active learning that includes sample exercises focused on problem solving and critical thinking.

One of the best ways to help students develop their critical-thinking skills is to get them to write. That can be accomplished by writing more — and more often — and reviewing their peers' writing. This has been a particularly fertile area of exploration for AI in the classroom.

Kathleen West tried to encourage her students write more frequently and more meaningfully in her online psychology classes at the University of North Carolina at Charlotte. But she was stymied by clunky technology and large class sizes. Sometimes she would post a discussion question in her learning-management system and no one would answer it. Other times the conversation got so unwieldy it became impossible for her to follow.

West, who is a lecturer and academic adviser, began using an AI-driven tool called Packback to support online discussions. Each student is required to post a question relevant to the course once a week and then respond to two other students' questions.

Packback takes care of basic monitoring, like making sure the students are on topic and are asking open-ended questions that encourage discussion. It prompts students to supply answers that are backed up with sources and to write more in depth. And it uses an algorithm to give a 'curiosity score' to each post based on those and other measures. Because everyone can see all the scores, some instructors say students often try harder when writing subsequent posts.

West says the tool frees up her time to do more-engaged teaching. That might include joining an online discussion to press a student to elaborate on her ideas or show better evidence of her assertions. An additional benefit of doing more writing, she says, is that students' writing and critical-thinking skills have improved overall.

"Writing on exams has increased exponentially in quality because they're practicing writing," she says. "The quality is just night-and-day different."

The tool Coates uses, called Peerceptiv, works by evaluating the reviewer, not the writing itself, says Chris Schunn, a professor of psychology, learning sciences and policy, and intelligent systems at the University of Pittsburgh and the principal investigator behind the program. It helps instructors by anonymizing and distributing student work, allowing each writing assignment to be reviewed by several classmates. Then it monitors and graphs student feedback, including feedback on the reviewers.

If a student hands out high ratings to every classmate while others are writing more-nuanced evaluations, his rank as a reviewer will drop. If he gives feedback that

other students say is helpful, his score rises. Essentially the AI is looking for outliers, common ground, and dissension in the reviews, Schunn says, then feeds that information back to the professor in the form of a dashboard. If a particular assignment seems to be generating a lot of conflicting peer reviews, that might signal to the instructor that the topic itself is confusing.

"It shifts you from randomly looking at everything," he says, "to paying attention where work is problematic."

But writing is complicated; it can be resistant to standardized evaluation. Other researchers are using AI to better understand what kind of feedback improves writing and how it might vary by discipline. Valerie Ross, director of the Critical Writing Program at Penn, is working on a project, funded by the National Science Foundation, to build what she calls an "ecological model" in support of good writing. By that she means one not built on generic rules — which is often a criticism of writing tools — but specific to discipline, genre, and classroom environment.

To do that, she and her collaborators at the Massachusetts Institute of Technology, the University of South Florida, Dartmouth College, and North Carolina State University are mining writing samples and peer reviews from about 10,0000 students as well as instructor feedback. They will use predictive modeling to identify what seem to be

Cheating had been a problem in "Insects in Human Society," a large lecture course at Texas A&M. After Craig Coates took over, he integrated more discussion and writing, using an AI tool to help manage the increased flow of work.

ROBIN WILLIAMS

the most useful parts of the process and to answer some big questions: What are valid measures of writing development? Are there particular comments or feedback that lead to improved writing? "Good writing is so socially situated," she says. "That's part of the limitations of the AI-big data approach. All those rules are just tools for writers."

But even when it focuses more narrowly on evaluating writing in a specific discipline, artificial intelligence may still be of limited use. At the University of Michigan, concerns about the lack of writing in foundational STEM courses led faculty members to create an automated peer-review system in hopes of changing that dynamic. Created with support from the university and the NSF, the system, called M-Write, has been tested on 8,000 students to date.

Similar to Peerceptiv, M-Write anonymizes, sorts, and assigns work by students so that they can review one another's writing. An integral part of the system, says Anne Ruggles Gere, an English professor who helped create it, is the use of writing fellows. These trained undergraduates act as connectors between students and professor, stepping in, for example, when students get confused by a particular assignment. "They are really the human link that makes the whole system cohere and work well," says Gere, who heads the university's Sweetland Center for Writing.

M-Write researchers would like their system to be able to evaluate how well students understand the concepts they're writing about, but that goal has proved to be elusive, says Ginger Shultz, an assistant professor of chemistry and co-creator of M-Write. She and her colleagues have figured out ways to tailor messages to students based on, say, whether they've made substantial revisions in their writing.

But evaluating their conceptual learning through AI has proved far harder, in part because it is so specific to a discipline or even a particular course. To analyze short essay answers of a few sentences for conceptual learning, some software uses what's called a "bag of words" model, in which the program searches to see whether certain types of words are in the text and how often they appear. A question about chemical equilibrium, Shultz says, might prompt answers that include the words "increasing," "Le Chatelier's Principle," or "reactants."

But that approach doesn't work for essays of one or two pages, which might cover several ideas. "We've been poking at this for two years," she says, "but accuracy isn't where we want it to be."

Gere, who is also president of the Modern Language Association, sees AI-driven teaching tools as part of a spectrum of technologies increasingly prevalent in higher education, like advising apps and predictive analytics. Because faculty members are becoming more familiar with how technology is being used on campus, she believes they are more willing to experiment with it in the classroom. "There's a general awareness," she says, "that this is, in many ways, going to be part of our lives as academics as we move forward."

Kevin Gannon, the Grand View history professor, isn't sure that AI-driven teaching is a positive trend. He's no Luddite: he uses technology in his teaching, runs flipped classrooms, and keeps a blog called The Tattooed Professor. But if colleges are dropping thousands of dollars on tech-driven solutions, he argues, that's money they're not spending on hiring more faculty members and teaching assistants. If decision makers believe that AI tutors are effective teachers, he asks, why should they increase salaries and budgets? "I worry that this will be the cost-efficient solution to tuition-dependent systems. And we grow further and further away from conversations about, Is this a public good or not, because we have Auto Teach English 101."

He also worries that AI is creating an even deeper divide among the institutional haves and have-nots. No elite colleges, he says, will ever brag about using AI to automate teaching. Their gold standard will remain small class sizes and close contact with professors.

Deborah Beck shares Gannon's skepticism about the use of automation in the classroom. She teaches an introductory course in classical mythology at the University of Texas at Austin. Her class is large — about 200 students — but she gives weekly writing assignments and reads them all.

She sees that as integral to her job. Modeling good writing, thoughtful interaction, and respectful disagreement is part of the teaching process, says Beck, an associate professor in the department of classics. "That's really hard to outsource to AI."

She also believes that her students value her close attention to their work. They tell her the discussion boards were among the most valuable tools they used. In one assignment, she asks her students to analyze how the characters in a reading talk about the ethical issues surrounding the rape of Lucretia, a foundational story in Roman history. Then she shares with the class why she particularly liked one response, explaining how it was written in a lively manner, gave insights beyond what others had already written, and offered specific examples to support the writer's argument.

Beck wonders how automated writing prompts could be as specific, or work as well for students who may have come to college not really knowing how to study. "They need help in learning how to learn," she says. "And that's something we all need to think about. Especially in ed tech."

As academics experiment with AI in the classroom, privacy experts say more attention needs to be paid to big-picture issues of ethics and efficacy.

Technology alters teaching environments in critical ways, yet there is little public scrutiny of those changes, says Elana Zeide, a technology-law expert and fellow at the University of California at Los Angeles' School of Law. "It's being adopted without much thoughtfulness or much education of the people using the tools."

One factor is the reliance on algorithms and continuous data collection to make these tools work. Do professors really understand how those tools make their decisions? Probably not, Zeide says, since the algorithms are proprietary. Some tools also control content, determine how learning is measured, and define outcomes, which shifts pedagogical decision-making away from educators toward private, for-profit companies that sell these products, she says. "In contrast to the public and heated debates that accompany textbook choices," she notes in a recent article, "schools often adopt education technologies ad hoc."

Figuring out which tools might be beneficial, and how they work, is the hard part, of course. Vendors use the language of learning science to describe the benefits of their tools, but their promotional materials can make it difficult to distinguish between broad claims and solid grounding in science and experimentation.

Packback, for example, says it uses Bloom's Taxonomy to prompt higher forms of thinking that shift students away from simple recall and toward analysis and evaluation. The company also claims to help awaken "fearless, relentless curiosity" by encouraging students to ask open-ended questions.

Experts say vendors should show the research that backs up their products and agree to test runs so that instructors can see how well their programs operate. The technologies should also be adaptable to a particular professor's course design.

"Vendors say we literally can't tell you how the AI is making decisions on any given case, because the whole point is that it is learned and developed with a set of criteria we input at the start," says Martin Kurzweil, director of the educational-transformation program at Ithaka S+R, a nonprofit group that studies and supports the use of technology in higher education. "I don't totally buy that."

While the "intelligence" part of AI in teaching is still limited, experts envision a future in which the technology becomes broadly multifunctional. Artificial assistants could help design textbooks, deliver course content, develop quiz questions, evaluate the answers, monitor online discussions, adjust to students' learning styles, and advise students on their path through college.

Researchers are already making advances on these fronts.

Ryan Baker, of Penn, is one of many researchers studying ways to identify students' habits and attitudes in hopes of developing courseware that can strengthen study skills through tailored messages and tips.

Researchers at Pennsylvania State University are piloting a so-called distractor generator that creates the false answers needed to populate multiple-choice quizzes.

DEANNA DENT, ASUNOW

Susan Holechek (standing), an instructor at Arizona State U., uses adaptive courseware in her introductory biology classes. It allows her to use class time on exercises that reinforce the concepts students are learning.

They are also using AI and machine learning in a program called BBookX to help professors design textbooks.

And at Carnegie Mellon, researchers are experimenting with a technology to promote better discussion among students online. Known as a conversational agent, it aims to spur deeper interactions among students by prompting them to react to classmates' ideas.

Robot tutors aren't about to replicate the full array of teaching-and-learning behaviors that take place as a matter of course among people anytime soon. But artificial intelligence does raise a provocative question, one no doubt on the minds of educators worried about the decline in public higher-education funding: If administrators are willing to cut corners by paying low wages to adjuncts and giving them heavy courseloads, what's to stop them from trimming their costs even further by offering students some adaptive courseware and a teaching assistant instead?

Institutions inclined that way, says Baker, "are probably going to be willing to accept low-quality solutions."

He and other educator-advocates say AI can be of real value to learning. Algorithms can reveal patterns of student behavior not immediately noticeable to a professor. Adaptive courseware can nudge students toward effective learning strategies. Tools that can outsource lower-level tasks are worthy of consideration.

Just as long as the instructor remains in charge of the classroom.

Beth McMurtrie is a senior writer for The Chronicle of Higher Education

Originally published August 12, 2018

Can Artificial Intelligence Make Teaching More Personal?

By GOLDIE BLUMENSTYK

NOAH BERGER FOR THE CHRONICLE

Alegra Eroy-Reveles (right), an assistant professor of chemistry and biochemistry at San Francisco State U., uses Gradescope. "Getting feedback from a test you took two weeks ago is not going to help," says Eroy-Reveles, shown here with Anna Martinez-Saltzberg, an instructor. "It's important to get it in a timely manner."

Consumer products like Alexa and Google Home can tell us how to prepare a meal and answer dinner-party trivia questions about the Treaty of Paris. So how long before tools powered by artificial intelligence start assuming more of the classroom work that professors handle today?

The answer is simple: They already have. At the University of Michigan at Ann Arbor, students in a statistics class last fall had their writing assignments evaluated by an automated text-analysis tool. And in 2016, some of the students in a computer-science class at the Georgia Institute of Technology were surprised to learn that one of the TAs answering their questions remotely all semester was actually a chatbot powered by artificial intelligence.

The bigger question, however, is this: How does teaching change as these AI tools start assuming more classroom work?

That's harder to answer. A new grading tool called Gradescope — powered by AI and

now being used for more than 175,000 students at 550 colleges — offers one window on the possibilities.

The tool helps automate the grading process without requiring instructors to rely on multiple-choice tests. Several professors who use it say the automation has actually made it easier for them to personalize their teaching — although some of their students have needed some convincing.

Instructors also say the technology has made their grading fairer and faster — the latter an especially useful factor for courses like chemistry, in which students' mastery of new material depends on their understanding what came before. "Getting feedback from a test you took two weeks ago is not going to help," says Alegra Eroy-Reveles, an assistant professor of chemistry and biochemistry at San Francisco State University, now in her third year of using the tool. "It's important to get it in a timely manner."

Because Gradescope has made grading tests easier, Eroy-Reveles is giving more of them. Instead of three major exams a semester, she now gives eight smaller tests. "It will take me about three hours to grade about 100 of them," she says. The tool can read handwritten answers and can group together all the correct formulas in one batch and each variation of the wrong answer in separate batches. Thanks to those AI features, she's able to quickly see what her students are missing.

The timesaving tool was developed by Arjun Singh and Sergey Karayev as Ph.D. students at the University of California at Berkeley. Working as TAs in a computer-science class on artificial intelligence in 2012, they felt buried by the tedium of having to grade 100 tests by hand and, as Singh recalls, "writing the same thing 50 times as your students make the same mistakes 50 times."

As student of AI themselves, they figured there had to be a way to deploy machine learning to make their own jobs easier. By the summer of 2014 they had written the code that could read students' names off a form and recognize patterns in handwritten answers, such as chemical formulas for acids, as long as they were entered in a designated area on standardized-test forms. Their software could also identify and cluster those answers into groups. "We built this because we wanted a tool for ourselves," Singh says.

With another college friend and Singh's faculty adviser, they established Gradescope as a company. They hoped that the tool's main AI feature — its ability to read patterns not programmed in ahead of time — would set it apart from the few other automated grading tools in use.

The tool doesn't do all the work. Instructors, using a standardized form, must still scan in all the tests and determine how much weight to assign to each answer. That's fundamental to the process, says Singh. For many professors, "the exam is the last line of defense" in a teaching environment increasingly influenced by standardized-course materials provided by publishers and other courseware developers. "They want to be involved in it."

Seth Anthony, an associate professor of chemistry at the Oregon Institute of Technology, tried Gradescope for a final exam last fall and is now using it for his general chemistry course, which has 40 engineering students. He says the tool has made him more attuned to the patterns of students' mistakes, which he can more easily spot in weekly quizzes. And because the tool requires him to establish the grading rubric upfront, he says, "I can tell that my grading is fairer as a result."

The AI features in Gradescope "are not profoundly deep at this point," he notes. The tool recognizes handwriting and can cluster answers, but it does not actually learn from previous patterns.

Still, he appreciates its benefits, even if some of his students have been a bit uneasy about receiving their grades from an automated system. For some of them, he's had to provide reassurance that he, as the instructor, was really determining their grades. Artificial-intelligence, Anthony says, "enables me to be more personal, but I can see how students would perceive it as more impersonal."

"They want the personal touch."

Goldie Blumenstyk is a senior writer for The Chronicle of Higher Education

Originally published April 8, 2018

How AI Is Infiltrating Every Corner of the Campus

In enrollment, advising, and campus facilities, the revolution is spreading fast

By LEE GARDNER

JULIA ROBINSON FOR THE CHRONICLE

Donald Markus Hogue, program coordinator for irrigation and water conservation at the U. of Texas at Austin, oversaw the design and installation of a networked and largely automated system to water landscaping. The campus has gone from using an average of 176 million gallons of water each year to about 35 million gallons, Hogue says, and saves about $1 million a year.

When Donald Markus Hogue first came to the University of Texas at Austin, in 2012, he spent eight hours a day monitoring and adjusting the landscape-sprinkler systems. Now, he says, it takes him about 30 minutes. If he happens to be out of town — even for a few weeks — the systems do fine without him.

Hogue and his institution are beneficiaries of an influx of artificial-intelligence technologies that are quietly, but inexorably, transforming college campuses. The explosion of data about almost everything that happens in higher education is being fed into new software products that respond with reports, predictions, even conversational answers. As such products pop up in the classroom, via computerized teaching assistants and tutors, chatbots and self-monitoring machines are also spreading throughout the campus.

Machines are unlikely to replace most humans in college operations, but they are making those operations more efficient — potentially freeing up people for other activities.

The new technologies, corralled under terms such as "artificial intelligence," "machine learning," and "the internet of things," involve ways in which machines are able to perform tasks hitherto associated with human intelligence. They can process sensory data, they can make decisions on how to act, and they can even learn. They have little in common with the autonomous, omniscient computer brains of science fiction. Certainly they lack the level of control of sinister futuristic entities like Hal 9000 (of *2001: A Space Odyssey*) or Skynet (from the *Terminator* films). But by crunching masses of data and using advanced computing to interpret the results, these new technologies offer expediencies in areas like enrollment, advising, and facilities.

Artificial intelligence is not, experts say, a flash in the pan that will remain confined to a few campuses. "It absolutely is coming quickly" across higher education, says John F. Bernhards, associate vice president of APPA, a national association of college-facilities administrators. "There's no question about that."

The Austin campus is already seeing the results. Hogue, program coordinator for irrigation and water conservation, oversaw the design and installation of a new system to water the landscaping on the main campus. The system, which is networked and largely automated, not only controls and monitors sprinklers but is also connected to instruments that measure evaporation and rainfall. If a certain lawn is baking dry in the sun, it automatically gets more water. If another is still damp in the shade, it gets none. If a pipe springs a leak, the software shuts it down and alerts Hogue and his technicians that a problem needs fixing. He can control the whole system through an app on his phone.

In 2009, Austin used an average of 176 million gallons of water each year. Now the campus is down to about 35 million gallons, Hogue says, and saves about $1 million a year "because the AI allows us to identify problems and make changes very quickly."

The artificial-intelligence revolution is rooted in advances in both data and technology. In decades past, colleges worked from paper files or isolated computer databases, accessed and interpreted by staff members. Glimpses into potential problems were infrequent and sometimes murky. Faculty advisers, for example, might check in with students only once a semester. Facilities-staff members might be alerted to the impending failure of a cooling unit only when they heard it making a funny sound.

Thanks to information-age advances, "we're all swimming in a sea of data," Bernhards says. There are more data available now about many aspects of college operations than humans can be expected to access, interpret, or act on effectively. But there are apps for that.

Georgia State University faced a problem of scale: It enrolls about 52,000 students, almost 60 percent of whom are eligible for Pell Grants. Leaders at the university knew that students from low-income backgrounds, many of them first-generation college attendees, benefit from individualized attention and support as well as financial aid.

But Timothy M. Renick, vice president for enrollment management and student

JULIA ROBINSON FOR THE CHRONICLE

When rodents chew through an irrigation line, leak-detecting software shuts it down till repairs can be made.

success, notes that the financial-aid office receives as many as 2,000 calls a day from students in the weeks before start of each semester. "We're not American Express," he says. "We don't have a call center with 200 people in it."

Georgia State became the first university to work with AdmitHub, a company that has developed chatbots to communicate with college students through texting.

AdmitHub's technology relies on a branch of artificial intelligence known as natural-language understanding, which takes a statistical approach to interpreting an incoming message and locating an appropriate response from a database of possible answers. The software has to do a lot of work. "No one ever says, How do I apply for financial aid? They say, I have no money," says Andrew Magliozzi, the company's co-founder and chief executive officer.

If the software determines that there's a high probability that it has chosen the correct answer from its database — the one at Georgia State includes the answers to the 2,000 most common queries — it responds to the student automatically. If it's less than 95 percent certain, it refers the question to a human staff member, and the correct answer is added to the database.

When it began, in the summer of 2016, AdmitHub's chatbot answered more than 200,000 questions from Georgia State students and helped decrease the university's "summer melt" by 20 percent among a control group of students. Not only did it keep students from bouncing from office to office in search of answers about admissions issues, but it also alleviated embarrassment they might have about not knowing an answer or asking about how, say, a divorce in the family might change filling out financial-aid forms.

"These were students who might not have even raised these questions had it required them to go in and talk to some stranger," Renick says. And unlike human counselors, the chatbot is ready to text back at 2 a.m.

Artificial intelligence is being applied to students' course-planning and advising, too. Elon University had used software to help students track the courses they were taking and plot their path to graduation, but the technology had trouble integrating study abroad, internships, research, and other important co-curricular activities. "We want to do so much more than plan for four years of college," says Rodney L. Parks, the registrar.

Elon recently started testing new adaptive planning-and-advising software created by a company called Stellic. The software was created by Sabih Bin Wasi, a recent graduate in computer science from Carnegie Mellon University, who was motivated by his own frustrations as a sophomore trying to figure out how dropping a course might affect his path to graduation. It was difficult to parse the ramifications, he says, "unless I had seven tabs open on my browser." He envisioned "a personalized pathway platform for students where they can take control of what they want to do in upcoming semesters, but also let the administrators and advisers see that experience."

Drawing from databases of requirements, course schedules, and students' own data, Stellic allows them to see into their futures, scheduling courses and adapting plans as their paths develop. "When they put a course on there, it alerts them it has a prerequisite, it has a corequisite, or it's only offered once every two years," Parks says. At smaller colleges like Elon, which may offer fewer course sections, the program may help keep students from the perennial problem of needing one more class to graduate that they can't actually take. (Stellic won't replace traditional advising — Elon students still need someone to sign off each semester.)

The new technologies involve ways in which machines are able to perform tasks hitherto associated with human intelligence.

The technology can offer insights to administrators as well. Rather than send any student with more than 90 credit hours an invitation to apply for graduation, Elon will be able to generate reports showing who's ready and who needs more time. Stellic can also feed administrators clues about scheduling courses, depending on student interest. "Looking at the metrics gives us a lot more power," Parks says.

Turning over admissions FAQs or course planning to artificial intelligence involves marshaling data points that may be spread across a number of offices and departments. In the campus-facilities sector, however, data points now come installed in almost

JULIA ROBINSON FOR THE CHRONICLE

Markus Hogue shows Blane Dabbs, an irrigation technician, how the watering system can be controlled using a smartphone app.

everything. Equipment in buildings today "shows up with integrated monitoring points that are ready to go," says Peter Zuraw, vice president for market strategy and development at Sightlines, a company that advises colleges on facilities. "That makes it easier to contemplate connecting it to systems, and therefore more reasonable to think about instituting artificial intelligence on top of that."

In fact, most colleges are still playing catch-up on the level of data available to them. Don Guckert, vice president for facilities management at the University of Iowa, says "buildings' sensing capabilities have run ahead of the organizations' ability to leverage those capabilities."

Over the past few years, Iowa has been connecting its campus buildings to computer systems that monitor them for breakdowns and energy efficiency. That has involved a substantial learning curve. A new medical-research building had more than 23,000 data points, and Guckert and his team found that most of them were not worth monitoring. But after some adjustments, the software, devised by Microsoft for its corporate campus in Redmond, Wash., allows him "to look at a building's operation from a system standpoint rather than a symptom standpoint," Guckert says.

Now, if there's a hidden steam leak or a malfunctioning part in a cooling unit, it's noted in a daily computer-generated report so repairs can be scheduled before a professor calls to complain that a classroom is too hot or cold. "It's like the light going on in your automobile telling you that you need to see a service technician," Guckert says.

Iowa has already converted 20 of about 100 buildings to computer monitoring, and it plans to bring about 25 more online next year. Thanks to the abundance of built-in monitoring equipment, the cost to connect a building to computer monitoring comes out to "a fraction of a percent" of the structure's total cost, Guckert says, observing that energy savings should more than pay for it.

Asked about the prospects for artificial intelligence to spread in higher education, Bernhards, the college-facilities consultant invokes smartphone technology. At first it was a cool toy for early adopters. Twenty years later, "everyone has a phone."

But artificial intelligence brings challenges along with its benefits. As more campus buildings are operated at least in part through such systems, facilities staffs will require more workers with computer and data skills, not just basic mechanical know-how. "There's going to be a skills gap that we're all worried about," Guckert says.

Colleges that use artificial intelligence fed by masses of student and institutional data must also wrangle that data into a form usable for databases. The Georgia State chatbot was such a hit that some students who made it through their first semester with the help of the AdmitHub software wondered, "Where did the chatbot go? I still want to ask it questions," Renick says. Creating a database of answers that can tackle any question a college student can throw at it is "a heavy lift," he says, but the university has won a grant from Dell, the computer company, to begin expanding the chatbot to meet that need.

As the technology expands and develops, so do the possibilities. Hogue, the landscape-irrigation specialist at Texas, is using the time that he's not spending on tweaking sprinklers to devise more innovations. He is working with colleagues on components of a system that could use microphones to listen to aging building machinery to detect frequency changes that indicate a failing part. The building's computer system could then alert the school of engineering's 3D printers to create a new part from a library of scanned replacements, consult the building's class or office schedule to find a good time for a repair, and create a work order to alert a staff member to install the replacement.

Such a system is at least two years away. By that time, Hogue says, maybe autonomous vehicles will be able to deliver the parts.

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Originally published April 8, 2018

MIT Plans a $1-Billion Project to Develop Artificial Intelligence — and to Tackle Challenges the Technology Will Create

By LEE GARDNER

ALAMY STOCK PHOTO

Fueled by $650 million in gifts so far and 50 faculty hires, a new college at the Massachusetts Institute of Technology will break down interdisciplinary silos and explore both the future and implications of the growing field.

The Massachusetts Institute of Technology announced on Monday that it would spend $1 billion on a new college within MIT to study artificial intelligence.

Artificial intelligence, or machine learning, involves the development of software that, just like the human brain, takes in data, weighs it, makes a decision, and, often, takes action, all without human intervention. Commonly known as AI, it is already revolutionizing such fields as customer-service calls and transportation, though it also carries concerns over the implications of machines' taking the place of human beings.

In addition to furthering the practical progress of AI, the institute's project will support the search for solutions to two other daunting challenges: how to handle the ethical and philosophical implications of AI for the societies it will transform, and how to break down institutional silos in academe.

The commitment to the new college is, MIT says, the largest expenditure on AI in American higher education. Stephen A. Schwarzman, co-founder and chief executive of Blackstone, a private investment firm, donated $350 million to MIT to seed the new college, which will be named in his honor. An additional $300 million has already been raised from other philanthropic sources.

The college will hold its first classes next fall, with a new building scheduled to open in 2022.

MIT plans to hire 50 faculty members for the new college, and they won't all be computer scientists, or even situated completely at the college. About half will hold joint appointments with other colleges. For example, the institute might hire a scholar with a background in political science or philosophy, but he or she would also be "conversant and strong in these cutting-edge computational tools," said Martin A. Schmidt, the provost.

True Interdisciplinary Work

MIT hopes to accomplish several things with the joint appointments, Schmidt said. For one, having a cross-disciplinary faculty will allow professors to apply AI to other disciplines, and then bring what they learn from that work back to the college to help improve AI. For another, connecting AI to other disciplines and vice versa will help break down some of the silos that prevent truly interdisciplinary thinking and research.

Generally speaking, Schmidt said, faculty members who hold joint appointments now too often get caught in the breach between the two disciplines, and professors hired to consider the impact of technology sometimes end up isolated from the technologists.

"We're going to need to rewire the promotion and tenure process," he said, to recruit and support faculty members who can help the college pull off its ambitious goals.

Andrew McAfee, a principal research scientist at MIT's Sloan School of Management who studies information technology's impact on business, said that true interdisciplinary work is rare in academe. But he's encouraged by the possibilities for the Schwarzman College of Computing because AI has already inspired so much interdisciplinary discussion.

"As these questions around AI capability and AI progress have deepened, a truly cross-disciplinary, a truly diverse set of people at MIT and elsewhere have naturally started coming together and getting around the same table and trying to learn from each other and talk about these things," he said.

AI would not represent the first time a new discipline required colleges and universities to rethink their structure and approach. Computer science itself was once squirreled away inside mathematics departments, said Jerry Kaplan, a tech entrepreneur and a lecturer and research affiliate at Stanford University.

Biotechnology, to name another example, not only has created new collaborations across established disciplines, but also has raised questions about what kind of research should be restricted, and the potential benefits and dangers of altering genetic code — concerns similar to some of the dilemmas facing AI researchers.

Considering how transformational AI could be for so many aspects of life, Kaplan said, "the need to integrate with lots of other disciplines is very significant."

'Classic Shiny Object'

Along with academe's silo problems, MIT's new college is designed to tackle the bigger questions about the advent of AI. It's baked into the college's reason for being.

In a written statement, Schwarzman said that society faces "fundamental questions about how to ensure that technological advancements benefit all — especially those most vulnerable to the radical changes AI will inevitably bring to the nature of the work force."

McAfee believes that, like other powerful technology innovations, AI promises to make society more prosperous. But, he added, the distribution of that prosperity might change "in ways that we might not like, or in ways that might not strike people as fair or in keeping with the bargain they signed up for."

If a certain piece of software could automate some critical function and put tens of thousands — or hundreds of thousands — out of work, he said, "there are policy questions that come up, there are really open economic questions that come up, there are ethical questions that come up."

AI is "a classic shiny object," said Malcolm Brown, director of learning initiatives at Educause, a nonprofit organization concerned with information technology in higher education. Many have rushed to embrace a cool, new technology without thinking too deeply about what it might portend. There are huge issues at stake, Brown said, and he's glad to hear that MIT will be grappling with them.

As more companies develop AI technology, it falls to MIT and other universities to do the work of considering the broader implications of AI. "To be perfectly honest, nobody was thinking about them before," said Daniel N. Rockmore, associate dean of sciences at Dartmouth College. "The companies didn't care."

"We're going to need to rewire the promotion and tenure process."

If the Schwarzman College of Computing devotes substantial faculty resources to pondering, and teaching, the ethical dilemmas involved in the technology, he added, "maybe more of these future engineers and start-ups one day are going to remember their lessons, and that's going to be part of their pattern of thought as they spin up new ideas and send them out into the world."

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Originally published October 15, 2018

LINCOLN AGNEW FOR THE CHRONICLE

Preparing Today's Students for an AI Future

By JOHN VILLASENOR

Today's college students can expect to be professionally active into the 2070s. Their careers will span an era in which artificial intelligence will have profound and transformative societal impacts. And they, as well as the generations that follow them, will have the responsibility of making the key choices shaping the future of AI. Colleges need to ask themselves what they can do today to prepare students to help build a future in which the power of this extraordinary technology is used in maximally beneficial ways.

While artificial intelligence isn't new — in 1950, Alan Turing published a paper asking "Can machines think?" — recent years have seen extraordinary growth in AI investment and commercial impact. In the future, AI will be the driver for a long list of benefits, including improved crop yields, safer roads, more-effective medications, new tools to help identify and stop the spread of diseases, more-accurate forecasting of dangerous weather, streamlined transportation systems, and improved access to education.

But AI also brings risks. It can amplify the racial, gender, and other biases that are so deeply interwoven with much of the data that AI systems use as input. It can also be used by malicious actors to create "deepfake" videos aimed at influencing an election. More generally, because AI algorithms evolve on their own, they can behave in ways — including potentially problematic ways — that their human designers may not have anticipated.

While AI is a technology, we can't expect technologists alone to identify its opportunities and face its challenges. Getting the most benefit from AI will require contributions from people trained in a wide range of academic disciplines.

We need philosophers, lawyers, and ethicists to help navigate the complex questions that will arise as we give machines more power to make decisions. We need political scientists to help us understand the geopolitical implications of AI, urban planners who can explore opportunities to bring it into smart-cities initiatives, economists to help us understand how it will change labor and manufacturing, and public-policy experts to formulate the frameworks that will create incentives for its positive uses and mitigate its negative consequences.

We also need scientists to explore how AI can provide improved climate models so we can better understand and fight climate change, and we need physicians and public-health experts to examine how AI can help expand the reach of medical care and reduce the spread and impact of disease.

To accomplish all of these things and more, colleges need to be full participants in preparing students to contribute to the growth of a beneficial AI ecosystem. This doesn't mean converting colleges into institutions that see everything through the lens of AI. And it doesn't mean that we should require every student to take a series of courses on how to code machine-learning algorithms. But it means colleges should offer all students, regardless of field of study, opportunities to learn about AI in a manner contextualized for their disciplines and interests.

In recent years, engineering schools have ramped up their AI course offerings. That's a good start, but it isn't enough. Colleges need to provide courses that focus on this technology more broadly.

One way to do this is through interdisciplinary courses, either at the graduate or undergraduate level, that focus on the intersection of AI with other fields.

For example, the Pritzker School of Law at Northwestern University has recently offered courses on "Law of Artificial Intelligence and Robotics" and "Artificial Intelligence and Legal Reasoning." The UCLA department of communication offers an undergraduate course in "Artificial Intelligence and New Media."

In addition to classes focused on AI, a growing number of examples of more broadly focused courses incorporate AI-related content as a subtopic. Among them: A University of Michigan at Ann Arbor undergraduate philosophy course titled "Minds and Machines" considers "minds, machines," and "the relationships between them," including the "promises and perils of artificial intelligence." A Stanford course in economics (and also cross-listed with multiple other departments) on "The Future of Finance" considers, among other topics, the use of AI in lending, investing, and algorithmic trading.

Much of the growth in AI-related course content is occurring organically as instructors propose new courses and update existing curricula in response to the increased visibility of AI in both academic and broader public discourse. As valuable as this is, it will inevitably leave some gaps. Thus, faculty leaders and administrators also play an important role, as advocates for rethinking curricula in anticipation of what is certain to be a surge in student interest in opportunities to learn about AI.

It is no easier to predict exactly how AI will evolve over the next half century than it would have been to predict the post-2000 rise of social media back in the 1960s. What is certain, however, is that artificial intelligence will be one of the defining technologies of the 21st century. To help promote the productive growth of AI and to mitigate its risks, colleges should provide students with opportunities to engage with its technological, legal, ethical, economic, social, and political implications.

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Originally published October 13, 2019

Realizing the Vision for an AI-University:
The University of Florida leads the way

Artificial intelligence is transforming our society. Is higher education transforming itself to keep up? The University of Florida is.

In 2021, UF will have the most powerful AI supercomputer in U.S. higher education. This technology will dramatically change how the University of Florida delivers education with boldly sparking the fourth industrial revolution. Our graduates and faculty will serve as a model of AI expertise nationally and globally, and the initiative will provide crucial support for all computer-based research at the university.

We know that leadership in AI is about more than the technology. It's about re-imagining the curriculum, not just in computer science but in medicine, humanities and the social sciences, too. It's about enabling a workforce for Florida, the U.S. and the world that understands how to incorporate AI into everything we do. Our vision and commitment is at a scale only possible as one of the nation's leading public universities – the University of Florida.

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