

DOE may try to foster interstate collaborations, perhaps by marrying the Toledoled collaboration with Illinois, the state with the most commercial nuclear plants. Illinois's own proposal includes the University of Illinois at Urbana-Champaign and Argonne National Laboratory.

Although there is "tremendous demand" for hydrogen in industrial appli-

cations, he says, much will depend on the price. DOE's Hydrogen Shot program, launched a year ago, established a target cost for green hydrogen of \$1/kg in 10 years. That's an 80% reduction from its current cost of around \$5/kg, the agency says.

Ultimately, a hydrogen economy will require spokes as well as hubs. "We

shouldn't be looking at this as a competition between regions," Houston's Perlman told a panel discussion organized by the nonprofit Energy Futures Initiative. "Creating a real network is where the real power is going to come from, working together across the US to create a national market for hydrogen."

**David Kramer**

## College instructors adapt their teaching to prevent cheating

Pressures, isolation, and the temptation of easy online answers are changing why and how students cheat.

**H**ave your students used unfamiliar variables in test solutions? Have they followed bizarre chains of logic? Have multiple students submitted identical wrong answers on homework or tests? If so, chances are they turned for answers to Chegg or some other online education company.

Chegg offers libraries of searchable solutions and the option to post new problems with requests for solutions. Other companies, such as Quizlet, Bartleby, and Course Hero, provide similar services. Quizlet profits through advertising; the others charge monthly fees ranging from \$9.95 to \$39.99.

The companies bill themselves as tutorial services for many subjects, including physics. "Everything we do is designed to put students first and let them achieve greater success with less stress and less cost," Chegg president and CEO Dan Rosensweig says in a promotional video. But students can—and do—use the services to cheat.

Cheating isn't new, but university instructors say its incidence has grown significantly with the easy access afforded by the internet and with changes in social and study habits brought on by the COVID-19 pandemic. Teaching "in the time of Chegg" is challenging, says a physics and astronomy professor at a medium-sized university in the Southeast who requested anonymity because of departmental politics surrounding the issue of how to handle students' cheat-



**ANGELA SPECK**, chair of physics and astronomy at the University of Texas at San Antonio, teaches astronomy in a flipped classroom, in which students watch prerecorded lectures on their own time and solve problems together in class. When students work on problems in class, they have less incentive and opportunity to cheat, and instructors get a sense of students' grasp of concepts.

ing. "Students think I want to see the right answer. That's not true. I want to see that they have learned the material."

College instructors across the US and beyond are grappling with how to deter cheating and reassessing how they assess their students. "The educational system will break down if cheating is widespread," says the anonymous professor. "I regard it as a public health problem rather than a crime."

### Detecting foul play

Before the pandemic lockdowns, Mark Messier, a neutrino physicist at Indiana

University Bloomington, was grading exams for the introductory mechanics course he was teaching. It was obvious that some students had cheated, he says. "I saw idiosyncratic features repeated in the solutions that multiple students turned in." A quick Google search turned up five of the six problems from the take-home exam on Chegg. "I could see they were scanned versions of my exam problems," he says.

Samantha Kelly graduated this past spring from the University of California, Berkeley, with a double major in math and physics. After she finished an online

WEBS EDGE

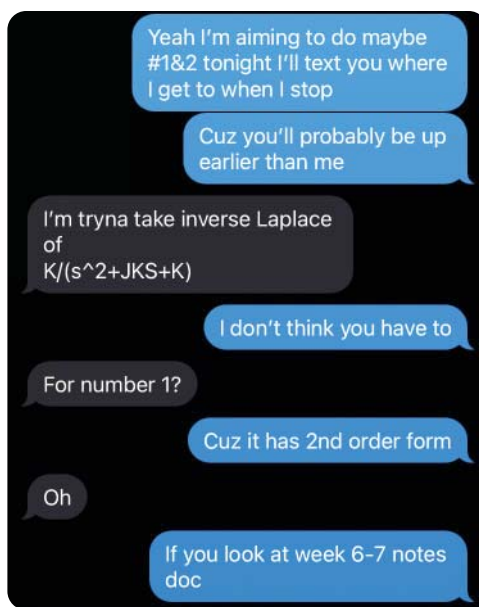
midterm exam for a junior-level quantum mechanics class in summer 2020, she “poked around online and found it had been uploaded to Chegg” while the exam was still in progress. She has also seen group chats online where students discussed how they would work together on an upcoming exam.

“The distributions of grades on exams have started to reflect cheating—whether by Chegg, group chats, or other means,” Kelly says. “Instead of a nice Gaussian distribution, you see a normal curve but with a smaller peak, plus a significant peak at the 95 to 100 mark.”

Chegg—whose name comes from combining the words “chicken” and “egg”—has been around since 2005. But the use of it and other virtual aids spiked with the wholesale switch to online classes early in the pandemic. For example, Berkeley’s Center for Student Conduct received some 202 reports of academic misconduct in fall 2019; that jumped to 858 in fall 2020 and then dropped to 217 in fall 2021, when instruction was again in person. “The threshold for copying and cheating [in online settings] is severely lowered,” says Austin Hedeman, an instructor and academic coordinator for the university’s physics department. “Temptation and pressure are both high.”

Another consequence of going online and living under lockdown is that students largely lost access to easy interactions and group study situations. Instructors say students have become more hesitant to come in for help. “Working together fosters teamwork,” notes Dominik Elsässer, a senior scientist at the Technical University of Dortmund in Germany whose research and teaching focus is in astroparticle physics and radio astronomy. “That got lost in the pandemic, and companies like Chegg jumped in.”

Juan Gutiérrez, chair of mathematics at the University of Texas (UT) at San Antonio, says that for online exams, he has “witnessed answers being posted on Chegg within five minutes of a test going live.” Companies like Chegg, he says, disproportionately attract students who enter college with less preparation—often from less affluent school districts, which tend to produce more Hispanic and African American students. “Every city has sections that are under-resourced, and often students from those areas have a



**DURING A TAKE-HOME TEST** in an upper-level physics class, students broke the rules to consult with each other. (Courtesy of a regretful cheater.)

harder time and feel more pressure to turn to companies like Chegg.”

When Hedeman discovers his own work on Chegg, he requests that the company take it down. “If they don’t, they become liable for copyright violation,” he says. “This is one of our most effective tools.” Berkeley has made scores of such requests, he says, and the problems are usually removed within a few hours. “It’s quick, but not quick enough to prevent cheating on an exam.”

Even with the return to in-person classes, many instructors continue to offer a choice of taking exams in person or virtually. “Students pick the environment most suited to their success,” says Jonathan Perry, a physics instructor at UT Austin. Some students may feel more comfortable at home listening to music, while others find that the higher-stress in-class environment enhances their performance. And, adds Perry, “COVID is still a thing.” This past spring, about a quarter of his students chose to take their finals asynchronously from home.

Michael Marder, a UT Austin physics professor, says he has more questions than answers about how to prevent and deal with cheating. Still, he says, “a lot of the flexibility and trust of students was overdue. I’m talking about the ability to continue to participate if you have a personal crisis that knocks you out for a

week.” The tools to handle such situations are a positive outcome of the pandemic, he adds, although it can be difficult to distinguish between “students who need the extra support and those who are taking advantage of the system.”

## Service or disservice?

Ramón Barthelemy is an assistant professor of physics at the University of Utah. “Chegg was around when I was an undergraduate,” he says. “Students also traded solution manuals to textbooks.” Given his experience, he sees such resources as neutral. “What matters is how you use them.”

Barthelemy emphasizes that cheating will catch up to students eventually. “I tell them they will be the future builders of bridges, makers of new chemical compounds, designers of biomedical devices. . . . I try to infuse in them good ethics, and I try to assume good intent. That’s what makes me want to be a teacher.” Still, he says, he does his best to “Chegg-proof” quizzes.

Tracy Hodge, an associate professor of physics at Berea College, a small liberal arts school in Kentucky, points to the availability of more reliable resources for physics help—often offered by academic institutions. “The biggest problem is the ethics these [for-profit] services teach students,” she says. “They teach that the goal is to get the right answer and get points rather than to master the material. They teach that it’s okay to cheat. Chegg gives students a shortcut that doesn’t help them. The company is out to make money.”

For its part, Chegg is “committed to academic integrity, which we believe is fundamental to the learning process and core to our mission of providing students with the support they need to navigate their own academic journeys and succeed,” according to a spokesperson. For example, in its Honor Shield program, the company blocks a test’s questions from appearing in search results for a set period if an instructor has uploaded the test at least 48 hours in advance. But Chegg’s program doesn’t solve the cheating problem, say instructors. “What about the other similar sites?” says Messier. “There is no way to keep up with this arms race.”

Chegg also invites instructors to provide content. In a November 2021 letter

to one physics instructor, the company offered \$375 per practice exam, \$75 per practice quiz, \$120 for lecture notes, and so on. “The goal is to provide reliable study materials to college students authored by dedicated educators like you, while compensating you for your previous hard work,” the letter says.

## Slippery slope

The first intervention for cheating is often a conversation along the lines of “If you cheated, you will be found out. If you come forward on your own, the consequences will be less radical than if you don’t.” The penalty may be harsher for cheating on exams than on homework and for students who post problems requesting they be solved than for those who copy from archived solutions.

Depending on the instructor and school, misconduct cases may be handled by the individual instructor or be sent to a campus office. On a first offense, students who admit to having cheated may be asked to write a statement about why they cheated and why they shouldn’t do it again. Some, but not all, instructors assign a “0” on the homework or test a student cheated on. Subsequent offenses may lead to increasingly severe consequences, including academic probation and dismissal.

Even students who have signed pledges of academic honesty are often perplexed that their actions are construed as cheating. Karen Daniels, a condensed-matter physicist at North Carolina State University, says her students “don’t see using Chegg as cheating.”

UC Berkeley graduate Kelly says that the attitude among her peers about getting exam help from classmates during an exam seems to be “the professors know everyone does this,” and toward online services, it’s “I just use it as a backup to check my answers.”

## Learning and assessing

The uptick in cheating has triggered deep discussions among faculty about how to encourage learning, says Gutiérrez. “We have to plan our assessments knowing we have this pollution [of Google-able and on-demand solutions]. The technology is not going to go away, so we have to adapt and to create problems that cannot be solved like that. It makes instructors’ lives much more difficult.”

Some instructors link each exam copy

**THIS TEST PROBLEM** is one of several that an instructor discovered had been posted to Chegg during a remote physics exam in May 2021. Solutions are sometimes supplied in time for students to copy them—which, the instructor says, they sometimes do wholesale and sometimes more cleverly, making cheating harder to detect. (Courtesy of the problem’s author, who requested anonymity.)

to a particular student. Perry, for example, individualizes tests by customizing the values of variables. Hedeman embeds a unique watermark in each exam, which allows him to identify who uploaded any problem he finds on Chegg. Some instructors create new problem sets each semester so they won’t already be in the companies’ archives.

Another approach is to devote in-class time to solving problems tutorial style. “I can give tougher problems, and I can get a sense of how well they understand them,” says Barthelemy. For smaller classes, Daniels asks students to explain their work in detail. “It’s a ton of work for them,” she says, “and even if they get an answer from a friend or from Chegg, they are still responsible for explaining the steps. That mitigates the problem.” Other instructors pose essay questions or give oral exams.

Those approaches can work for assignments that are individually graded. But in introductory classes at large institutions, classes can have hundreds of students, and tests are typically multiple choice. For those classes, Perry has taken to shortening test times and increasing the number of possible answers.

Many instructors have lowered the

weight they give homework. “It should count, but not be so valuable that they care enough about getting 100% to cheat,” says Hodge. She now weights homework about 15% of the grade, down from 35%. Dealing with cheating has changed her philosophy about homework. “I don’t believe it’s about a grade anymore. I see it as developmental for students. If they are cheating on homework, they will do poorly on the exams. They are mostly hurting themselves.”

Similarly, Messier has adjusted his attitude toward both homework and tests. He devotes more class time to working on problem-solving skills, and he administers two-hour tests rather than take-home ones. Whereas before he viewed exams as teaching tools and an opportunity for students to be creative, “now they are purely for assessment,” he says. “The complexity and real-world applicability of problems is diminished.”

“What annoys me most is that the cheating puts teachers and students into an antagonistic relationship,” says Hedeman. “I don’t want to have to view students with suspicion. I work hard to maintain a cooperative and collaborative environment.”

**Toni Feder**