Delivering Instant Feedback For Math And Science Students For Instructors And Students

North Carolina State University
WebAssign

Years ago, university math and science students often saw their homework fall into a predictably sluggish pattern. With hundreds of students in a single class, professors could take more than a week to return graded assignments.

Today, technology can help alleviate the grading backlog, and one service that makes it possible is WebAssign, from Advanced Instructional Systems Inc. in Raleigh, N.C. With this online service for math and science courses, students each year receive instant feedback on their homework at nearly 2,000 universities, colleges and high schools around the world (mainly in the United States, but also in other regions including the U.K., Israel, Australia, China and Saudi Arabia). WebAssign doesn't just allow teachers to spend less time on grading and administrative tasks. It features online tools to help students prepare for tests — and may ultimately provide teachers with data to boost effectiveness in the classroom.

Building a Better Grader

Aaron Titus, Ph.D., remembers how onerous homework grading used to be. "In the past, when professors were hand-grading everything, that was the biggest time constraint," he says. "And by the time students got homework back, they might not even remember why they got an answer wrong."

> *During the 1990s, Titus attended North Carolina State University. He wanted to study physics students' learning patterns and best practices for teaching. Titus began working as a teaching assistant for John Risley, Ph.D. — a NC State physics professor with a passion for science education and a vision for technology's role. That included organizing workshops to help high school teachers use computers in their physics classes. "Early on, he was really a pioneer in using computers to teach physics," says Titus.*

Titus shared Risley's interest in computers as teaching tools. In 1996, Titus developed a Web-based homework system. It was a welcome alternative to hand-grading, but it could only handle multiple-choice questions. That changed after Titus attended an American Association of Physics Teachers meeting in 1996 and met Larry Martin, Ph.D., a physics professor at Chicago's North Park University, who created a Web-based homework system. Martin had coded his software to generate randomized numbers for homework questions. That meant all of the students in a class could get the same types of problems to solve, but wouldn't be able to share the final answer. "We love when students work together," says Titus. "We just don't want them getting the answer from someone else, typing it in and getting credit."

Titus was impressed with Martin's work, and so was NC State. In 1997, the university brought in Martin for a two-year sabbatical to refine the Web-based homework system. Risley oversaw the project, which combined Titus's database structure with Martin's code. That collaboration yielded the first version of WebAssign. (NC State holds the copyright for some of the underlying software code for WebAssign.)

About a million students use WebAssign annually. When students log in, they can see if homework is due. When they enter answers for those assignments, WebAssign lets them know immediately if the answers are correct. That's a significant improvement over hand-grading, which required students to wait days or even weeks to see how they performed on assignments. The delay could put students at a serious disadvantage in math and science courses, where concepts build off each other — if students unwittingly make mistakes early in a course, those misconceptions become ingrained.

With WebAssign, instructors can focus more time and energy on teaching, not grading.

But it does more than just indicate a right or wrong answer. If students have trouble with a question, they can use WebAssign to access online tutorials for similar problems. They can also get help reviewing concepts to ensure comprehension. Before taking a quiz, students can redo homework questions as practice. WebAssign will automatically change the values in each question, so students work with different numbers the second time around.

WebAssign provides free accounts for instructors, but charges for student accounts. For higher education, individual students usually purchase subscription access. (Some college and university courses list WebAssign as part of the required materials for students.) The cost starts at about $23 per course, per term — but the rates vary depending on the content selected by instructors, such as interactive tutorials and videos. For secondary education, a school or particular department often purchases access for its students. (The basic rate for secondary education starts at about $10 per student, but varies based on the type of content provided.)

When it initially rolled out in the fall of 1997, WebAssign only had about 1,000 questions to use for assignments (instructors could create their own questions, but that usually proved too time-consuming.) Teachers were warned that the system would be buggy. In spite of those caveats, plenty of math and physics teachers at NC State were eager to test WebAssign.

Those early adopters helped Titus and Martin (who died in 2002) correct some flaws. In the initial version of WebAssign, students had unlimited tries to answer a question. That changed after Titus and Martin discovered a student had submitted 130 answers to the same question. "When his first answer was wrong, he literally added 1 and resubmitted, again and again," says Titus To discourage that kind of gaming behavior, WebAssign's default now limits students to several tries for each question (although instructors can change that default).

One year after the initial rollout, WebAssign became commercially available, in 1998. It was officially spun off from NC State in 2003, when the technology transfer office licensed the copyright for some of WebAssign's underlying software code to Advanced Instructional Systems Inc. (Risley served as the company's CEO — after he died in 2013, NC State renamed its Entrepreneur of the Year award after him.)

"The office of tech transfer was instrumental in helping WebAssign spin off from the university," says Peg Gjertsen, vice president of special projects at WebAssign. "They helped refine the agreement over a seven-month period by actively participating in the negotiations to ensure the interests of all parties were represented."

WebAssign gives students another way to review concepts until they've mastered them, says Kelly Sexton, Ph.D., director of NC State's office of technology transfer. "I think it's really useful in these large classes for students to have something in addition to just the notes from class and a textbook."

The company now works with about 20 textbook publishers (and organizations like the American Association of Physics Teachers) to provide content from about 1,000 math and science books. That spurred wider adoption: Since 2007, annual revenue has increased by about 20 percent annually.

Digging in the Data

Of the approximately 200 employees at WebAssign, about 60 percent have a teaching background. In the coming years, the company will look for new ways to help teachers in the classroom. It plans to use data analysis to better understand student learning and enhance WebAssign.

NC State's technology transfer office has played a vital role in connecting the company with data scientists on campus, says Mark Santee, vice president of product and marketing at WebAssign. "It's helped us look at data we've collected during the past 15 years and see how we can improve WebAssign and the way people interact with it," he says. That includes data about the questions that commonly trip up students. It could help anticipate the need for additional online support when students tackle challenging math and science concepts.

Within the next three years, Santee envisions enhancements that would give instructors updates on students' comprehension throughout a semester — highlighting concepts that still posed a struggle for many in class and recommending exercises to help them, for example. At the end of the term, WebAssign could provide a summary of students' performance, says Santee. That would provide guidance as faculty adjusts assignments for the next term.

From the start, WebAssign was designed to aid student comprehension and also provide a tool to study learning. Titus is now chair of the Physics Department at High Point University in High Point, N.C., and he takes pride in the development role he played. But that takes a backseat to his constant reevaluation of education techniques. After

years of using WebAssign with his students, he made a change last year. "I'm always experimenting in the classroom, so I decided to go old-school one semester," Titus says. Instead of using WebAssign, students did homework from the textbook, and Titus posted the solutions on a wall outside the classroom.

He gives that experiment a failing grade. "It was a disaster," he says. The most highly motivated students performed extremely well, but the rest of the class did not. "I felt they weren't spending the time on homework that I wanted. Students were telling me, 'I wish you would use WebAssign, because it really is motivational, and it makes us do our homework.'"

Says Titus: "I went back to WebAssign."

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