

# Helping Teachers Generate Better Homework: MAA Makes Time for WeBWorK

By Lois M. Baron

WeBWorK, an open-source homework-generating program, has been steadily gaining users since it was introduced in 1995 by two University of Rochester professors.

In WeBWorK, faculty can write their own problems to post online to a class or choose from the ones already in the WeBWorK National Problem Library. Different problems can be selected for each student to allow students to work together but ensure that each student completes his or her own work. Up-to-the-minute statistics can help a faculty member plan lessons that meet the progress of a specific class. Students know immediately if they've solved a problem correctly. And WeBWorK lets a student keep working until a problem is solved.

Faculty and students at more than 300 institutions use WeBWorK. Because there is no required registration and some mathematics departments set up servers independently, it's hard to know how many institutions maintain their own WeBWorK server.

In looking for a way for WeBWorK to continue beyond their own careers, developers Mike Gage and Arnie Pizer approached the MAA for help. At first, the MAA helped by supporting the WeBWorK wiki—an online description of the program where people could share comments. Then the cofounders asked if the MAA could run the whole thing.

The association saw that WeBWorK could be very useful to the mathematics teaching community and worked with Pizer and Gage to develop a proposal for funding. In 2009, the National

Science Foundation gave the MAA a five-year, \$1.5 million grant to make WeBWorK more appealing to universities and colleges; to host the program for departments that lack adequate on-campus technical support; to find a way to make the program self-sufficient financially; and to research the value of online homework programs.

## Case Study

With WeBWorK, it is not always love at first sight.

Hal Sadofsky, mathematics department head at the University of Oregon in Eugene, heard about a homework-generating program a few years after Pizer and Gage rolled it out in 1995. "Interesting," he thought, but without a pressing need to make a change, he let it slide.

Five or six years ago, when a labor dispute made it impossible to use undergraduates to grade homework, the department took another look. But the faculty went with a commercial program.

Frustration with that program had the department trying WeBWorK in a few courses and gradually expanding its use. Starting in winter quarter 2009, the program is now being used by 1,500 to 2,000 students in about 50 classes.

Sadofsky says WeBWorK has two main pedagogical advantages: instant feedback and more useful interactions with students.

He explains that under the paper grading system, students would turn in their work, look at their grade when they got it back a week later, and throw it in a pile. "Students didn't look at what they got wrong," he says. "By the time they got it back, they didn't care." It was frustrating for the teacher.

Now, he says, it's frustrating for the student—but for the right reason. Because the program tells them instantly what they get right or wrong, students' goals change from getting through a certain number of problems to figuring out how to do them right.

"I encourage instructors to give the students as many tries as they want to get it right [on WeBWorK]," Sadofsky says.

The second big pedagogical plus is that, when they're using WeBWorK in their classes, instructors have more "really valu-

The screenshot shows the WeBWorK interface for a calculus problem. The problem text is: "(1 pt) Use the graph of  $f(x)$  shown below to find the following integrals." Below the text is a graph of a piecewise linear function  $f(x)$  on a coordinate plane. The x-axis ranges from -6 to 7, and the y-axis ranges from -2 to 1.0. The function has a peak at  $x = 0$  and a trough at  $x = 7$ . A red shaded area is shown under the curve from  $x = -5$  to  $x = 7$ . The problem asks for two integrals: A.  $\int_{-5}^0 f(x) dx =$  [input] and B. If the vertical red shaded area in the graph has area  $A$ , estimate  $\int_{-5}^7 f(x) dx =$  [input]. There are buttons for "Preview Answers" and "Apply Options".



able teachable moments” with students, Sadofsky says. “When I see the answer that a student has put in, I can almost always deduce the error in their thinking. Then I can guide students in how to fix the problem.” He finds many more students approach instructors through WeBWorK than before this route was available.

He points out two weaknesses in the program, both of which the MAA is working to address.

The first is that there aren’t enough good problems across math topics in WeBWorK’s database. Its National Problem Library has 16,000 problems in it, but it might come up with only a few for some specific application in business calculus, for example.

“I’m grateful for the existence of the National Problem Library (it is a very useful resource),” he writes in a follow-up email. “But it is chaotic and of uneven quality and covers some topics decently, and not others.”

The second weakness he admits is a very complicated issue to handle: indexing. “It’s a question of how to organize the data so that people can find relevant questions,” he says. “Even if you assign keywords, not everyone is going to use the same search terms.”

He says he’d be willing to pay a fee for WeBWorK services if it means someone else runs and maintains the server.

Michael Pearson, charged with heading up the WeBWorK transition at the MAA, is happy to hear that. “Don’t use the word ‘free’ when you refer to this project” even though there has been no cost to the user, Pearson says, only half-joking. “There’s a lot of work involved.”

### A Little Rearranging

One year into the five-year grant, MAA has been concentrating on recasting WeBWorK into a more institution-friendly format.

The MAA has been reaching out to a group of intensive users to help develop new features. A larger, less formal user group also gets together at MathFest each summer to talk about issues and development. It’s up to the system administrator—now the MAA—to set up ways for teachers to use it and for students to find the problem sets. Toward that end, the MAA has been doing a few workshops to teach faculty and students about WeBWorK.

Pearson admits he might have argued against taking on WeBWorK if the MAA weren’t so intensely focused on supporting faculty and teaching at the undergraduate level.

“We haven’t done anything like this,” he says. “But the we felt strongly that [WeBWorK] brings real value to members and to the broader math sciences community.”

The MAA hasn’t done much promotion and probably won’t until the technical people are sure the WeBWorK server at MAA is stable. “The last thing we need,” Pearson says, “is to get close to the last assignment of the semester for 10,000 students and have our system go down. That would not be good.”

### A math question:

◀ Previous ▲ Prob. List Next ▶

(1 pt) introduction/s2\_2\_1\_mo.pg

If  $f(x) = 3x^2 - 3x - 6$ , find  $f'(x)$ .

Find  $f'(1)$ .

Find  $f'(1)$  -- this time WeBWorK will not do calculations for you.

### First attempt:

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Entered	Answer Preview	Result	Messages
6x-3		incorrect	Missing close parenthesis for '('
3	$6 \cdot 1 - 3$	correct	
6*1 - 3		incorrect	Can't use '*' in this context

At least one of the answers above is NOT correct.

(1 pt) introduction/s2\_2\_1\_mo.pg

If  $f(x) = 3x^2 - 3x - 6$ , find  $f'(x)$ .

6x-3  
Find  $f'(1)$ .

6(1)-3

Find  $f'(1)$  -- this time WeBWorK will not do calculations for you.

6\*1 - 3

### Now, I've got it!

◀ Previous ▲ Prob. List Next ▶

Entered	Answer Preview	Result
6*x-3	$6x - 3$	correct
3	$6 \cdot 1 - 3$	correct
3	3	correct

All of the answers above are correct.

(1 pt) introduction/s2\_2\_1\_mo.pg

If  $f(x) = 3x^2 - 3x - 6$ , find  $f'(x)$ .

6x-3  
Find  $f'(1)$ .

6(1)-3

Find  $f'(1)$  -- this time WeBWorK will not do calculations for you.

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Here’s a sequence that shows how WeBWorK responds to student entries.