

High School Mathematics Homework and WeBWork:

A Match Whose Time Has Come.

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“I like a teacher who gives you something to take home to think about besides homework.” --Lily Tomlin

Preface

This is the first installment of a three-part report for this journal. This first part offers a broad overview of the *WeBWork* software and of student use. Future issues will deal with how teachers use it and what the research on web-based homework suggests about the advantages and disadvantages of using *WeBWork*. For now suffice it to say that research has demonstrated favorable results: student achievement is higher and faster, when using *WeBWork*, especially when teachers redirect the grading time they save to other ways of scaffolding student learning.

Homework

Mathematics homework in high school mathematics has been a problem for at least one hundred years. General Francis Walker, a Civil War veteran and later president of the Boston school board, convinced board members to curtail mathematics homework because it was making his own kids anxious.¹ More recently, Piscataway, NJ, Tampa, FL, and other communities have placed a limit on the amount of homework teachers may assign. Some districts enforce Cooper’s “ten minute rule”² – no more than 10 minutes per day times the grade level (e.g., third graders would have 30 minutes of math homework per day). In part, these limits are driven by the knowledge that some students have more support at home than others when it comes to getting help with homework. For example, students in middle class households have a particular advantage when it comes to resources for completing homework – they are more likely to have parents who are well-educated, are at home from work in the evenings to foster homework completion, or who have the financial resources to hire a tutor.

¹ General Walker

² H. M. Cooper (2007). *The battle over homework: Common ground for administrators, teachers, and parents* 3rd edition. Thousand Oaks, CA: Corwin Press.

The mathematics homework pendulum, as with other issues in education, seems to take some rather wide swings over time, the reversals often coming because of national crises. Witness the Sputnik-driven changes in the 1960's (Modern Math) and the present realization—not as dramatic—that the United States is battling to maintain status as a world leader in science, technology, engineering, and mathematics (STEM).

In this article, we acknowledge the differences in beliefs and practices on homework while noting that most consider homework an important complement to the teaching-learning process. Indeed: “High school students who do their homework outperform those who do not by 69% on standardized tests.” (Cooper, 2007).

The flip side of homework assignments, even temperate and well-planned ones, is the extraordinary amount of time a teacher needs (a) to determine that students actually do their homework regularly, consistently, and conscientiously, and (b) to provide feedback. In a time of full teaching schedules, full classes, in and out of class management responsibilities, and heavy state assessment accountabilities, it is worthwhile to explore alternatives to teachers spending many hours grading—or even “checking” student homework. Many teachers do not spend time on grading homework, instead using various homework checking strategies that range from “spot checking” to having students “exchange papers” in ways that may have superficial pedagogical value.

***WeBWork* Overview**

WeBWork is a tireless, patient, web-based electronic homework drudge that grades every homework problem for every student in every class for the entire semester. The software also provides reports to the teacher, in spreadsheet form, on how each student performed on each assigned problem. Options in reporting include seeing the answers a student gave, number of tries made to get to those answers, and even the trail of attempts a student used. Homework can be submitted online at any time before the due date, from anywhere a student has internet access.

WeBWork is a free, open-source, web-based software program that does not purport to teach. It is a tool through which teachers access a national library of problems, choose and assign a collection of items as homework, and harvest scoring information. The student side of the tool offers assignments to students on-screen, one item at a time (and through an optional printout of all items), collects and grades student answers, informs students whether an answer is correct, and (if this option is chosen by teachers) allows the student to try again. The tool can be used for homework, quizzes, and practice exams. Learning to use *WeBWork*, for both teachers and students, takes less than one hour.

Students can be encouraged to work cooperatively, yet *WeBWork* can be set to offer individualized assignments in which each student is offered slightly different problems. Research indicates that across socio-cultural and gender categories, it is common for up to 90% of students who use *WeBWork* to do homework

assignments, and to do at least as well on tests as students who do homework by the traditional paper and-pencil method.^{3 4}

Among the pedagogical advantages of *WeBWork* are: (1) it is a free tool that delivers homework or quizzes on-line and grades and records the work for all students for the entire semester. (2) it supports the teacher by freeing time for use in instructional preparation, alternate forms of formal and informal evaluation of student understanding, etc. and (3) it is prompt in giving students immediate feedback.

WeBWork Features

An important website, hosted by the Mathematical Association of American (MAA) where you can learn more details about WeBWork is:

<http://webwork.maa.org/moodle/>

The information on the site includes a list of the features of *WeBWork*, key among these are⁵:

- √ Immediate feedback as to whether the answer is correct.
- √ Each homework assignment is available as a downloadable PDF file.
- √ Students can use any computer and browser combination that can access a web page.
- √ Every problem has a "Feedback" button that can send an e-mail message directly to the teacher
- √ Students get immediate feedback on the validity of their answers and have the opportunity to correct mistakes while still thinking about the problem. As one student said, "I can fix my mistakes while [the] problem is fresh in my mind."
- √ Individualized versions of problems means that teachers can encourage students to work together, while still requiring that each student develop an answer to his or her own version of the problem.
- √ Provides automatic grading of assignments.
- √ Provides information on the performance of individual students and the whole class.
- √ The teacher can find out where individuals and the whole class are in correctly completing the homework.

³ For example, see S. Hauk & A. Segalla (2005). Student perceptions of the web-based homework program WeBWork in moderate enrollment college algebra courses. *Journal of Computers in Mathematics and Science Teaching*, 24(3), 229-253; S. Hauk, A. Segalla, & R. Powers. A comparison of web-based and paper-and-pencil homework on student performance in college algebra. Manuscript submitted for publication.

⁴ Rochester, Rutgers, CSULB

⁵ Source: http://webwork.maa.org/wiki/List_of_features

- √ The teacher can use any computer and browser for management of the assignment.
- √ The teacher can answer student questions by e-mail.
- √ Grades from assignments are easily integrated with spreadsheets such as Excel.
- √ *WeBWork* remembers each student's problems, so they can connect to WeBWork, attempt a problem, receive immediate feedback about the validity of their answers, try again or logout and give the problem more thought if necessary, and then reconnect to WeBWork to attempt their own individualized problem again. Students can attempt a problem as many times as they wish until the due date unless the teacher desires to place a limit on the number of allowed attempts. Each problem in a set can have a different limit on the number of allowed attempts. For example, teachers may wish to limit the number of attempts on True/False questions while allowing unlimited attempts on problems requiring numeric and symbolic answers.
- √ After the due date, students can review the homework, including the answers expected by the teacher.

How Students Use WeBWork

After logging in much in the same way one logs into any website program, the effective use of *WeBWork* means each student will:

1. Print a copy of the assignment.
2. Work the problems on paper, away from the computer.
3. Enter each answer into *WeBWork* and get a validation response (correct or not).
4. If set up for multiple tries, redo any problem identified as having an incorrect answer.
5. Get immediate feedback on whether the re-try is correct or not. Note: Retries can be with or without penalty (e.g. for a quiz).
6. Turn in homework at any time, and from anywhere with web-based internet access.
7. Work in groups. Note that each student can have individualized problems, e.g., *WeBWork* gives Tim the problem "Solve for x : $6x^2 - 13x + 5 = 0$," while Sandy gets "Solve for x : $4x^2 - 11x + 9 = 0$ "

An example

The figures below outline “Ryan” as he does Homework Set 4 using *WeBWorK*. Perusal of the figures, even with some details left out, should give the reader a good idea of the interactive “dialogue” between WeBWorK and student. More details will be included in the second and third installments of this article to be published in this journal. We will examine how the teacher can monitor an individual student’s and entire class’ progress, concomitant implications for teaching using WeBWorK, and research results.



Figure 1: Today Ryan will work on HW 4. In the “Course Info” the teacher can insert directions, suggestions, and hints.

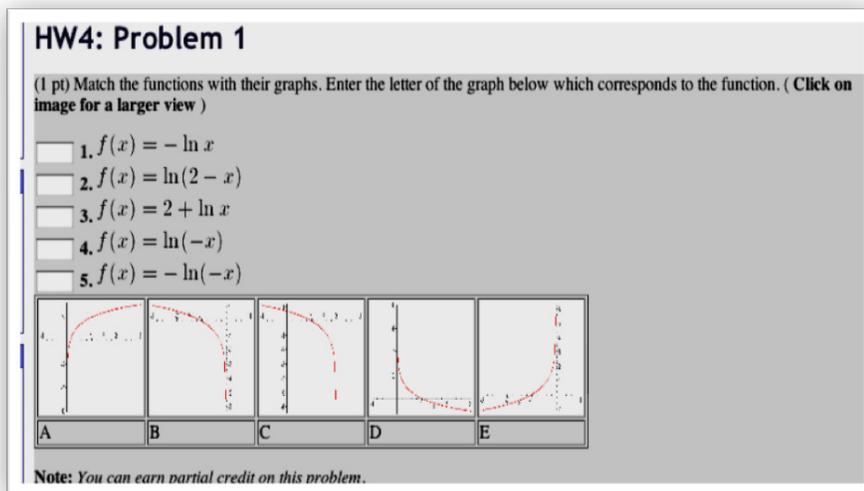


Figure 2: Ryan clicked on Problem 1 of HW 4 and got the following screen.

HW4: Problem 3

Entered	Answer Preview	Result
$(P*V)/(n*T)$	$\frac{PV}{nT}$	correct

The above answer is correct.

(1 pt) Solve the equation $PV = nRT$ for R .
 Your answer is :

Note: The answer is case sensitive. P, V and T are capital letters!

[Preview Answers](#) [Submit Answers](#)

Your score was recorded.
 You have attempted this problem 1 time.
 You received a score of 100% for this attempt.
 Your overall recorded score is 100%.
 You have unlimited attempts remaining.

[Email instructor](#)

Figure 3: Ryan continued working in HW 4 and solved Problem 3 correctly. Note the summary below the problem.

HW4: Problem 4

Entered	Answer Preview	Result	Messages
2	2	incorrect	
x	x	incorrect	Your answer isn't a number (it looks like a formula that returns a number)
x	x	incorrect	Your answer isn't a number (it looks like a formula that returns a number)
2	2	incorrect	

At least one of the above answers is NOT correct.

(1 pt) Express the equation in exponential form
 (a) $\ln 2 = x$ is equivalent to $e^A = B$.
 A=
 and
 B=

(b) $\ln x = 2$ is equivalent to $e^C = D$.
 C=
 and
 D=

Note: You can earn partial credit on this problem.

Figure 4: Ryan made an error on problem 4. Note the "Messages."

Conclusion:

That students “do” their homework regularly and consistently is an essential part of the teaching-learning process in mathematics. While *WeBWork* is not a cure-all, it offers a valuable tool to teachers and students. It has been shown to increase the amount of time students spend on homework, and it frees up some time for the teacher to devote to other important aspects of teaching, like planning and giving feedback on more extended efforts by students to make sense of mathematics.