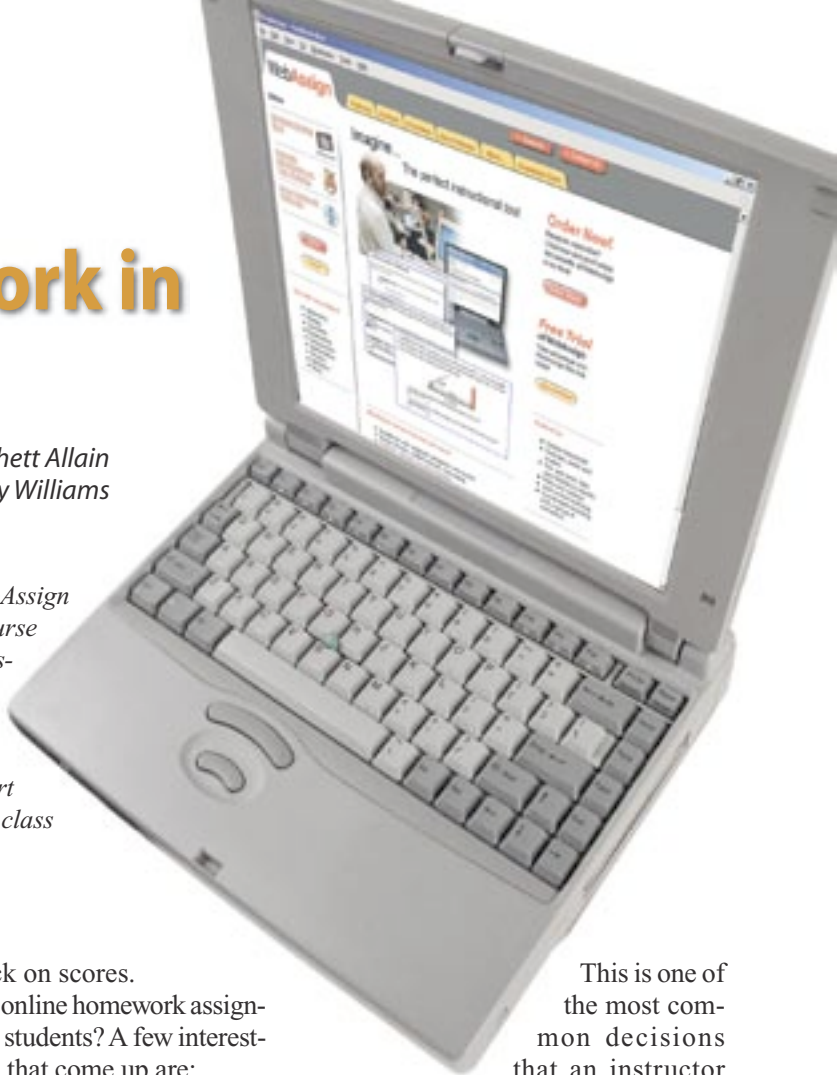


The Effectiveness of Online Homework in an Introductory Science Class

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Does the use of an online homework system such as WebAssign (<http://webassign.net>) in an introductory astronomy course affect student performance? Four sections of introductory astronomy were compared in various homework situations, from no graded homework to graded homework online. Results show that there are no significant differences in conceptual understanding or test scores. Students did report spending more time studying course materials outside of class when online homework was graded.



Many instructors of large introductory service courses are continually searching for new methods that will engage their students in the material. One option is to assign homework. For small classes, this is likely a straightforward and simple task. For large classes there are many issues associated with graded homework; even collecting it may take up a significant portion of class time, and of course grading can be a burden. To overcome these large-class homework problems, many instructors opt to assign homework, but not to collect or grade it. A recent option for these instructors is to use an online homework delivery system such as WebAssign, Blackboard (www.blackboard.com), WebCT (www.webct.com), and CAPA (www.lon-capa.org), to name a few. Most of these systems have similar features, such as allowing multiple submissions of assignments and in-

stant feedback on scores.

Do these online homework assignments benefit students? A few interesting questions that come up are:

- ♦ Does online homework make a difference in students' performance on traditional tests?
- ♦ Does online homework make a difference in students' conceptual understanding?
- ♦ Does online homework change students' attitudes toward the course and learning?

A previous study (Bonham 2001) compared the performance of classes that used WebAssign for homework to those who used the traditional written format. In this study, classes that used WebAssign for homework delivery were compared to classes with the same assignments completed and graded by traditional paper methods. The study found no major differences between the classes except that the WebAssign class reported spending more time on the material outside of class. For our study, we are comparing the use of WebAssign homework to the use of no graded homework.

This is one of the most common decisions that an instructor must make. In most cases it is cheaper from an administrative standpoint to use a homework delivery system such as WebAssign rather than pay a graduate teaching assistant to grade papers. So, for many departments, the only options are to use WebAssign or not to give homework at all. It is these options we will compare.

Data

Four sections of introductory astronomy were used for this study, with an enrollment between 40 and 90 students per section. This course fulfills the general science requirement of the university, so the student population consists of a wide variety of nonscience majors. Due to the service nature of the course, it is conceptually based with little or no math expectations of the students. Class time is spent in a very traditional manner including PowerPoint presentations. Tests are composed of 50 to 100 multiple-choice questions.

Table 1 shows the ways that

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sections and instructors used online homework. It should be noted that one instructor (A) had two sections of the course and used WebAssign for one section and no graded homework for the other section. Instructors B and C both used WebAssign for one half of the

TABLE 1
Homework assigned per section

Section	Instructor	Homework
1	A	Graded WebAssign homework
2	A	Assigned but not graded homework
3	B	Graded WebAssign homework for the first half of the semester, then a research paper for the second half and assigned but not graded homework
4	C	Research paper and assigned but not graded homework for the first half of the semester, then graded WebAssign homework

semester. Instructor B used WebAssign for the first half of the semester, and instructor C used it for the second half. For the half of a semester that they did not use Web-Assign, sections 3 and 4 had the same assigned but not graded homework.

In sections that had graded homework, the homework counted for 10% of their grade. It should be noted that in WebAssign, students are given immediate feedback on the correctness of their submissions. With the feedback, students are given a chance to correct their answers and resubmit a number of times set by the instructor. Homework used in this manner becomes much less an evaluation tool and more of a part of students' learning process. The homework was counted as 10% of the final grade to encourage students to devote time outside of class to the course material.

Conceptual understanding

In order to explore the conceptual understanding of students, the Astronomy Diagnostic Test (Hufnagel

2002; Hufnagel et al. 2000) was given as both a pre- and posttest. Conceptual understanding was measured by examining the normalized matched gain (Hake 1998) as shown.

Equation 1: Normalized gain

$$\langle g \rangle = \frac{\text{PreScore} - \text{PostScore}}{\text{MaxScore} - \text{PreScore}}$$

Only students that took both the pretest and posttest were included in the calculation of the gains. As can be seen from Table 2, only section 4 had a significantly different gain.

One possible reason for the higher gain for section 4 is that there were fewer students that took both the pre- and the posttest. It may be the case that students

TABLE 2
Comparison of normalized gains (significant differences are in bold)

Section	Number of matched students	$\langle g \rangle$
1 (used WebAssign)	35	0.047
2 (no graded homework)	50	0.086
3 (WebAssign for the first half)	51	0.054
4 (WebAssign for the second half)	27	0.148

that do not attend class very often would be lower performers on the conceptual test. Since there was not a large overlap between students that took both pre- and posttests, possibly only the better students were counted in the gain for section 4. It should also be noted that the Astronomy Diagnostic Test focuses on observations of the night and day sky. This material is covered at the beginning of the semester. For that material, section 4 did not even do homework online.

Comparison of test scores

The first comparison of test scores was done with section 1 and 2, both of which had instructor A. Instructor A used the same tests, so the primary difference between the two sections was that one used WebAssign and the other had no graded homework. As shown in Table 3, none of the test scores for sections 1 and 2 were significantly different. Table 4 shows a comparison between

test scores for sections 3 and 4.

From Table 4 it can be seen that for both tests 2 and 4, the section that used WebAssign scored significantly different. Both of these tests promote

TABLE 3
Comparison of test scores for sections 1 and 2

	Section 1 test average (used WebAssign)	Section 2 test average (no graded homework)
Test 1	56.8%	60.1%
Test 2	60.0%	63.3%
Test 3	66.3%	63.5%
Test 4	61.6%	60.9%
Final exam	77.1%	76.4%

TABLE 4
Comparison of test scores for Sections 3 and 4 (significant differences are in bold)

	Section 3 test average (WebAssign for Tests 1 and 2)	Section 4 test average (WebAssign for Tests 3 and 4)
Test 1	56.8%	60.1%
Test 2	60.0%	63.3%
Test 3	66.3%	63.5%
Test 4	61.6%	60.9%

the idea that WebAssign improves students' test performance, but instructor A's test data do not agree with this.

Survey results

Sections 3 and 4 both took a midcourse survey. The survey was given after test 2; it was at this point that section 3 was finishing using WebAssign and section 4 had not yet used WebAssign. The survey consisted of three multiple-choice questions and one open-ended question. The purpose of this survey was to estimate how students use the WebAssign homework. One problem with the use of a survey such as this is that it relies on students to report on their activity outside of class. Moore discovered (2004) that students often do not accurately report on their activities associated with class, so these survey findings are skewed. However, if we assume that both sections respond similarly (say they both under-report the hours they spend outside of class), then we can still use this as a comparison tool.

The first question asked how many hours students spent outside of class studying astronomy. The

responses indicate that students who used WebAssign and had graded homework reported that they spent, on average, about two to three more hours per week studying astronomy outside class.

The second survey question asked students how they used the posted homework. The multiple-choice options were:

- I looked up answers in the text
- I used the homework as practice questions
- I used the homework to determine what areas I was still confused on
- I just tried to memorize the answers before the test
- I was not aware there was any posted homework
- I was aware that there was homework, but I did not look at it

The two sections reported different responses to two of the multiple-choice responses. Section 3, which used WebAssign, had 36% respond that they looked up the answers in the text, whereas section 4 only had 15% respond in that manner. The other different response was the indication that they did not use the homework. Only 2% of section 3 responded with this choice, but 30% of section 4 indicated they did not use the homework.

The last question asked students how they used the text. The multiple-choice options were:

- I read the text before the material is covered in class
- I read the text after the material is covered in class
- I use the text to look up answers to the homework
- I skim the text before the test
- I do not use the text

The only large difference in responses for the two sections was option c in which 22% of section 3 indicated that they used the text to look up homework answers. There were no students in section 4 that indicated that they used the text in this manner.

Conclusion

After looking at the data collected, the only conclusion that can be drawn is that WebAssign increased students' self-reported time spent outside of class. It is unclear exactly how students spent this time. It is very likely that the extra time outside of class was used inefficiently, which could explain the lack of increase in conceptual understanding and overall improvement of test scores. The data are inconclusive as to WebAssign's effect in these two areas.

Does this mean that it is pointless

to assign graded homework (whether online or on paper)? We do not think so, but rather this means that for graded homework to be effective, the implementation is important. For this study, we assigned multiple-choice and multiple-select problems that would be typical on a test. A likely student strategy for answering these types of questions is to first read the question

and then skim the text for paragraphs similar to the question. Homework in this fashion is more of a game than a learning experience.

There are a couple of factors that could play a role in the successful implementation of WebAssign. The first factor involves the inclusion of mathematical problems. When WebAssign is used for more involved homework problems, such as in a physics course, the student has the benefit of immediate feedback on more complicated problems.

A second factor that could perhaps change the effectiveness of WebAssign is how and when the homework is delivered. Homework assignments could be changed to encourage students to read the text before class. Lefcort and Eiger (2003) found that there was no significant difference in class performance for students that were given homework before class and those given homework after class. So, perhaps these ideas could be revisited in future research. ■

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FIGURE 1

Responses to survey question 1

