Not so random thoughts about web-based homework

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Being a codeveloper of WebAssign, I am biased toward web-based homework, but not out of ignorance. Also, I believe that WebAssign is, in general, the best web-based homework system, again not out of ignorance. I understand the limitations and faults of WebAssign as well as anyone, but I also understand its strengths. I'd like to address some issues of web-based homework and then discuss the features of WebAssign that make it "the best" in my opinion. I am not officially on the staff of WebAssign, so please contact them (webassign@ncsu.edu) for official information.

When evaluating the pros and cons of a tool, it's important to realize it is a tool! A tool can be used effectively or ineffectively. I believe that when one discusses the "effectiveness of a tool," one must define the context in which the tool is used. Discussing the effectiveness of a hammer is useless. One must discuss the effectiveness of a hammer for nailing nails, removing nails, screwing a screw, etc. As important as the context, one must also describe how the tool is used in that context. For example, there are good ways and bad ways to use a hammer in the context of hammering nails.

Asking whether a teacher should use a web-based homework system is like asking whether one should use a calculator. Calculators do not, in and of themselves, create students who cannot solve a problem algebraically. Likewise, they do not equip students to solve difficult problems. Mathematics teachers, especially in the early grades, must teach students how to use a calculator effectively. That is, the student should be able to solve algebraic and arithmetic problems without the calculator and should only use the calculator to simplify certain procedures (for instance, taking the sine of an angle is a lot easier on a calculator than looking it up in a table). For instance, if a physics student must take the square root of a number, I think it is entirely appropriate for her to use a calculator. However, she should not be so dependent on the calculator that she trusts in the inerrant nature of the calculator (and infinite precision of whatever answer is displayed on the calculator). She should be able to interpret the answer and determine the appropriate sign, units, precision etc. In this case, the calculator is a tool. We can argue about whether a calculator is "good" or "bad" for students, but in actuality, it comes down to the context in which it is used and how it is used. The calculator is not bad or good in and of itself.

I believe that there are effective ways to use web-based homework. I also believe that there are ineffective ways to use web-based homework. So how is effectiveness measured? The most important criterion, in my opinion, is student learning. If a tool doesn't help students learn, we must evaluate how the tool is used and whether the tool should be used at all. If a hammer doesn't drive a nail into a board, then perhaps we are using the hammer in an ineffective way or maybe it's not well-suited to the task.

Here are some advantages and disadvantages of using web-based homework, as measured by student learning. They are theoretical in the sense that I know of no such studies which I can reference.

Advantages

1. Increased time on task. A very real constraint in teaching is that students are often motivated by grades and/or feedback (i.e. right/wrong answer/method), but teachers don't have enough time to grade all of the homework they would like to assign. Students may not have the internal motivation to practice answering questions and solving problems like they should. External motivation (e.g. grades, credit) is often needed. With web-based homework, you can assign more homework than you otherwise would. With increased time on task, learning should be increased (Obviously, many more factors can affect this relationship between time on task and learning, such as appropriateness of task, difficulty of task, etc., but in general, it is true.)

2. Multimedia-focused questions. Questions on a computer can be very different than questions on paper in the sense that they can include dynamic visuals such as animation and video. This allows for questions where students must collect data in order to solve a problem. If you would like more information on this type of problem, please go to

   http://webphysics.ncat.edu/webphysics/research/projects/AFCI/EffectOfAnimation.pdf

   You can see examples at

   http://webphysics.ncat.edu/webphysics/research/physletprob/physletprob.htm

   http://webphysics.davidson.edu/physletprob/

3. Teacher's time on task. If the teacher is saving time by not grading all homework problems, then she can spend more time in office hours working with challenged students, writing innovative problems for homework, designing new materials for lecture such as active learning activities in class, and grading projects or essays. The student may benefit greatly by the teacher spending more time in these other areas.

4. New active-learning strategies. *Just-in-time teaching* (JiTT) by Gregor Novak, Evelyn Patterson, Andy Gavrin, and Wolfgang Christian discusses an approach that requires using web to collect student responses before coming to class. The lecture is then based on those responses and the responses are incorporated into lecture. Questions are open-ended (i.e. essay questions). A web-based homework system is simply a tool used by JiTT to collect and track students' responses.

5. Immediate feedback. By far, the feature students like most is immediate feedback. They no longer wait a day or maybe a week to receive their score on a homework assignment. But rather, they find out immediately what they missed and can even resubmit. Of course, the teacher may use WebAssign in different ways and may not give detailed feedback nor the possibility of resubmission depending on the context in which WebAssign is being used.

Disadvantages

1. Students might not get detailed feedback. That is, usually (without significant programming anyway) students do not find out exactly where they went wrong in a problem. Simply, their final answers are graded. If they get a problem wrong, they don't know why. Was it their reasoning, mathematics, units? I suggest collecting students' work to all homework and then grading one of the problems in detail. That will help enforce certain problem solving traits that you emphasize.

   WebAssign allows for feedback based on the type of error. Such problems are harder to script and many teachers prefer that students bang their heads against the brick wall rather than encode a helpfu hint. The problem for WebAssign staff is that some teachers feel like helpful hints are a short-circuit of the learning process. So the basic coding has been done to provide the simplest "right or wrong" feedback. This is not a limitation of the tool, but more similar to the end-of-the-book answers. Web-based systems are no more or less open to the abuse of "right/wrong" grading than was traditional paper-grading. Polls indicate that students prefer fast grading over partial credit, especially since traditionally the partial credit only came weeks later when it was too late to care. Evidence at NCA&T is that most students (55%) prefer METICULOUS, IMMEDIATE grading of paper-based homework. But where this type of grading is not possible, web-based homework seems to be preferable.

2. Technical errors may occur. For example, one evening our campus network went down. This caused some frustration for those submitting homework at the last minute. Another issue is that students need access to a networked computer. The issue of access will become less important in future years. For some students, technology may get in the way of learning simply due to a "hatred" of using computers.

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I focused on advantages and disadvantages for student learning. There are also advantages and disadvantages for the professor.

Advantages for the professor

1. Saving time (grading). The time that was previously allotted for grading can now be spent on communication with students, etc, as outlined above. How much time

is saved depends on a lot of factors. If you write your own questions, the time saved from grading is instead spent on writing questions. Certainly, in the long run, questions are reused, and the time spent authoring questions is recovered.

Disadvantages for the professor

1. Learning curve. As with any technology, there is an initial learning curve. To use WebAssign.net (which is the server run at NCSU), the teacher must learn, at a minimum, how to create a class, upload a class roster (basically usernames and passwords), create assignments, and download grades. WebAssign.net has a database of thousands of questions including those from major physics textbooks to choose from. However, you may want to write your own. If so, that's something else to learn. I believe that all web-based homework systems share these features, so you'll have to learn these things on whatever system you use. If you install the system on your own server, it's a major task to understand how to install all software and manage your server.

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Which homework system should you use?

First, you should understand the difference between a course management system and a homework system. Course management tools such as WebCT are used to organize course content, chat rooms, on-line office hours (again, via chat), bulletin boards, and homework. Although they have homework collection features, they are not as full-featured as those offered by WebAssign (or another quality homwork system). I recommend using a homework system over a course management system if collecting homework is your sole goal. If you are offering distance ed courses on-line, use both a course management system and a homework system. Both can be effectively used together. They work together, not compete. Course management systems do what homework systems don't do, and homework systems are better at distributing and collecting homework than course mangagment systems.

Second, consider whether you want to manage the server and software yourself. If so, you can install many quality free versions, such as WWWAssign or WebAssignNT. But understand, that you will have to manage all of the headaches yourself. Even versions that you install that are not free such as CAPA require significant computer knowledge and experience. People who choose this option should definitely have significant time, experience, knowledge, and interest in this option.

Otherwise, choose a service such as WebAssign.net. WebAssign.net staff keep the servers running 24 hr, 7 d per week. They also offer technical support and content (i.e. questions) so that you don't have to write the questions yourself (but you can if you want to). When something goes wrong, you can contact them instead of figuring out the

problem yourself. In addition, colleagues from various institutions use the same database of questions, so they can share questions among themselves.

Third, consider the features of the system and what you will use it for. For example, if you plan to give numerical problems, you definitely want the system to randomize numbers in the problems so that students working together share how to do the problem and not just the final answer. Does the system store questions so that they are easily retrievable? If not, then reusing questions can be difficult. That's why a searchable database backend is so useful. However, for searchability, a classification system should be in place. The most attractive feature to teachers so far has been organizing questions based on the textbook chapters. If you write your own questions, then you should classify the problems appropriately so as to make searching easier.

Fourth, consider price. Free systems are great, but support and long-term improvement of the software may be lacking. The reason that WebAssign.net is not free is that it takes money to offer technical support, fast servers, questions from all major textbooks, and a constantly improving product.

Why choose WebAssign.net?

As I see it, the following features make WebAssign.net an outstanding product. These are just some of my favorites.

1. Database of textbook problems for most major physics books (http://www.webassign.net/info/physics_textbooks.html).

2. Service. They manage the servers and offer technical support. If you textbook is not in the database, they may contact the publisher and tag the problems if they feel that there is sufficient interest.

3. Randomized numbers in numerical problems and randomized text (my chemistry colleague uses this to ask the same question but insert different elements or molecule names into the question).

4. Symbolic question type where students enter a function that is automatically graded (this will be officially implemented in about 2 months or so; it's in the testing phase now).

5. Interface for efficiently grading essay questions. WebAssign does not automatically grade essay questions although my codeveloper and the lead programmer of WebAssign, Larry Martin, is working on techniques to do this and has achieved some success. He uses a technique called Latent Semantic Analysis.

6. Multi-part questions; each part can even be a different type (e.g. part(a) is multiple-choice, part(b) is numerical, part(c) is symbolic).

7. Survey questions. Survey questions are questions for which there is no correct answer, but students are given credit for any response. I give my own end-of-course survey that is more useful to me as a teacher than the university's survey.

8. Post-processing of student responses. This allows one to process the student's response before grading it or to grade the student response against the "correct" answer which is calculated based on another one of their responses. For example, students could submit their lab reports via WebAssign. If the lab asks for a measurement of speed in one part of a question and a calculation of kinetic energy in another part of the question, students could enter the speed (which can be graded solely on whether it falls within certain limits or any answer can be marked as "correct") and the kinetic energy. The "correct" answer for kinetic energy would be based on whatever they entered as the speed.

There are many more outstanding features of WebAssign. For example, you can grade the first or last submission, you can provide individual deadline extensions, you can allow multiple submissions, you can set up peer grading of essay questions, and you can post students' grades, including other assignments such as in-class exams. And, anything you can write in HTML, you can put in a WebAssign question.

For further information regarding WebAssign, please see

http://www.webassign.net/info/

It should be noted that WebAssign.net is different than WebAssignNT or WebAssign.mycampus. WebAssign.net is a service. The others must be installed and maintain at your site. There is a free version of WebAssignNT which is at

http://www.webassign.net/info/WebAssign_NT_Lite_License.html

WebAssign.net and WebAssign.mycampus have a "per student" fee. I will pay this fee by having students purchase a "license" at the bookstore in addition to their textbook.

There are many issues regarding web-based homework. I wrote an article concerning these which is published in Computers in Physics (Titus, A., Martin, L., & Beichner, R. (March/April, 1998). Web-based Testing in Physics Education: Methods and Opportunities, Computers in Physics.)