Rensselaer

Department of Electrical, Computer, and Systems Engineering

Kenneth A. Connor, Professor and Chair

MEMORANDUM

DATE: 21 January 2002

TO: Ed Wheeler and Cliff Grigg

FROM: Ken Connor

RE: DUE Project

Items to be addressed:

1. Suggestions for classroom equipment including A/V equipment, etc.

    Standard Equipment list – I would suggest that you not get the counter, but rather purchase a good multimeter with this capability. A good counter is only useful if you intend to do a lot of high speed digital work, but activities of interest to ME students are usually at very low frequencies. We have never needed our counters. I should give them to some other classroom. The last item on your list needs some additional explanation. I assume that this is what you will use to record data, but I need to know more about it. It is indeed essential that there be a simple way for students to record their data, particularly if you want them to write good reports. They should be encouraged to record their data in a form that can be readily incorporated into a word document (actually, you choose the approach). We have found that having GPIB interfaces on our equipment works really well, since it is quite simple to record the data this way and also one can easily use something like LabView to create controlled experiments, such as generating a Bode plot or an I-V curve for a diode. I think you need one more DC power supply. We have regularly needed 4 or 5 DC levels or preferred to have students keep sections of their circuits as separate as possible. Finally, you should have one additional set of instruments setup for demos and one additional set as backups. We have found the Agilent (HP actually) instruments to be very reliable, but occasionally we need to borrow something while repairs are made. We have similar instruments in another studio, which helps.

    Supplemental Equipment list – A good impedance bridge is very useful. Many of the experiments we have the students do involve making coils, so it is good to have something to

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measure inductance and capacitance. It is also useful to know the exact values for some components or to check for parasitic effects. To play around with Lissajou patterns (always fun), additional function generators are necessary. We saved a bunch of old units from a previous version of the course. This also gives the students a little experience with some other versions of the instruments. They should not get too used to the particular components in the studio. It might be good to have at least one old style 'scope around and have the students try to use it – most will have trouble because they learn to rely too much on the nice features available on modern 'scopes.

Stockroom – You do not mention having a collection of standard components available for student use. We keep a relatively complete set of components in a cabinet available only to the instructors or teaching assistants. We do this, in spite of the fact that we require the students to purchase a parts kit that includes all the components they will need in the course, a protoboard and some simple tools. They produce a lot of smoke and run out of parts and they also need some components with different values that what we have included in their kits. (The kits are described on the course webpage, which you know is at http://www.rpi.edu/~connor/ElecInst These materials are being modified by someone else this year, but the basic information is still there.) We also keep magnets, magnet wire, flashlights and a few other things for the student projects. We do not provide batteries.

A/V Equipment – Simple put, you must not compromise on A/V equipment. We have never been totally satisfied with any of our choices of visualizers, projectors, video amplifiers, switches, cabling, etc. Thus, buy the best and make sure that you can easily replace anything, including the cables. Our faculty have problems in many of their courses when the A/V equipment is not up to the quality of their presentations. I sent an email out to find out whatever advice they might have. What follows is a short summary of their responses.

- We have an annex room where we use cameras and visualizers to connect back with the main Computer Studio room. There is some disagreement between faculty on whether it is better to have high resolution and slow response or vice versa. Most feel that the former is better. This is consistent with my feelings that one cannot have resolution that is too good in video images.
- Our studios all have VCRs, but our faculty would prefer it if we also had DVD players, especially those interested in images. Again, it generally appears that high resolution is best.
- The faculty feel that all of the projectors we originally installed in our studios should be replaced with better equipment.
- The setup we have in our studios with 4 projectors (two images duplicated on each side of the room) is very popular with the faculty. I think they would be happy with just two projectors would be sufficient if all students could see both images as it appears they can in your design.

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- The technical support person who maintains the Computer Studio is an excellent detail oriented person. He provided me with very good information on AV systems. I have attached his comments at the end of this memo. I have also attached the comments of the person who runs our computer system.

Computer/Network Equipment – Probably our biggest source of problems has been keeping our computers and the installed software working well. We have tried several approaches to rebuilding the computers using different schedules (every night, every week, every semester, whenever there is a problem), different systems (homegrown, PCRDist), etc. We have run into problems because our institute networking people have put too many users on the same switch or hub we are on. Make sure that you work out with your computer support people just how this will be done and make sure it can be done easily and reliably. One of our approaches required a technician to come in every morning to restart the computers because the software had a bug in Windows98. Never ever believe anyone when they say there will be no problems. Make them show you and be sure that the system is rebuilt a couple of times a month before the semester begins. (We never get to do this, but I figured you should ask for the ideal and see what happens.) Get the biggest and best computers you can afford. Someone will change their software next year (like Cadence buying OrCad which had just bought Microsim which makes the complete software package that comes with PSpice potentially huge) and it won't fit or run anymore. We have been lucky in that we have been able to keep up to date with computers. We also have now added 3 or 4 laptop connections per station so that students can use their own computers. We have them all download their own student version of PSpice so they can do activities at home.

1. Online Quizzes

We do not use online quizzes, so following your work will be very interesting. We do have people here in Physics using automatic homework generation software. I asked Karen Cummings to send me some information on her experiences and have attached her response. The materials she sent me are attached as appendices 3 and 4. Also, two friends at Wisconsin (John Booske and Susan Hagness) have been adapting the Precision Teaching work from Georgia Tech in their Electromagnetics classes. Since this is also a difficult and usually unpopular course, maybe their experiences will be of interest to you. I just checked and the Georgia Tech link does not work anymore and there is not indication of where the materials went. If you are interested, contact John or Susan.

2. JiTT Strategies

Timer chips (555) are great tools for teaching students about several practical aspects of circuits and electronics. Since they combine both digital and analog concepts, it is not possible to fully

explain their operation until nearly the entire course is completed. Yet, we are able to use them even in simple courses like our freshman Introduction to Engineering Electronics course.

3. Active learning strategies that might prove effective in studio format.

    Hands on work with real equipment with enough support to help students through their problems. Nothing is better than having the students try things themselves. All of our Engineering students take a course in Embedded Control. Those that take Electronic Instrumentation first are proving to be even better at this course than the EE students since they are completely comfortable building circuits.

4. Educational materials that have worked well in similar courses I have taught.

    The educational materials I have used in my Electronic Instrumentation course are available on the course web page http://www.rpi.edu/~connor/ElecInst. Please feel free to use any of them. Rather than discussing what has worked well, I will provide a short critical review of some of these materials. Many things have worked well, but many have also been less than satisfactory. I put copies of he word documents at http://hibp.ecse.rpi.edu/~connor/education/EI-Spring00/Word-Docs/

    Experiments 2 and 3: Instrumented Cantilever Beam – This beam is also used in the first project. This beam is a good basic piece of experimental apparatus that has been used in the Instrumentation course for a long time. It has a strain gauge to sense position and a magnetic pickup coil to sense velocity. We have also added an accelerometer (the same one made by Analog Devices for automobile airbags). To make good use of all of these devices, we use the Agilent Intuilink (formerly HP Benchlink) software with which it is trivial to download the data from the 'scope to a computer. The set of activities based on these resources provides a rich learning experience, as long as the instructors and teaching assistants fully appreciate what is being done. We have had less than optimal outcomes when the staff is not properly prepared.

    Experiment 7: 555 Timer – This, like other experiments, combines simple analysis, simulation with PSpice and (optional) hardware implementation. The hardware implementation is optional, since it is used in the project we do the next week. Usually, the students build it to get a head start. I think this combination is very good. I suspect, however, that your approach will work even better with your emphasis on basic skill development through online testing, etc. Something I do in the class is to add an output LED to the multivibrator circuit to produce a slowly flashing light. I find that the low frequency circuits make more sense to the mechanical engineers than circuits that pulse too fast to see. This combination gets used in experiment 10 when they build a counter circuit. We return to the 555 timer in Experiment 10: Digital Electronics. There we address the comparator, Schmitt Trigger and transistor switch, so we have everything found

inside the 555 Timer. Don Millard's Electronic Media Academy software then helps the students see all of the functionality of the timer circuit. http://academy.rpi.edu/modules/555_timer.html. One of the problems with the 555 timer is that PSpice does not simply simulate the same conditions seen experimentally, because of the default initial conditions. This is, in fact, a common problem with simulations.

Appendix 1: Comments of Steve Dombrowski on AV Equipment

I would suggest AV equipment that we have in the Computer and Extension Studios. Everything has been highly reliable. A minimum of 1000 lumens is recommended for good reading in well-lit rooms. At least 1024 x 786 resolution is necessary for PCs. For the Sun workstations, you need at least 1280 x 1024. The JVC projectors have a native 1365 x 1024 and work very well with the Sun systems.

A good computer output document camera (visualizer) that matches the best resolution of the projector is suggested. For use as a writing surface, the Elmo EV500AF is excellent.

A good touch screen control system makes switching video and computer output to the displays makes life simple.

A good camera system is necessary if you are going to control 2 or more rooms.

The following is a list of what we have in our studios:

> JVC DLA-G11U 1365x1024 video projector
> Sharp PG-D210U 1280x1024 video projector
> Samsung SVP-6000 1280x1024 document camera
> Elmo EV500AF s-video document camera
> Crestron CT3500 touch screen video control system
> Panasonic PV-VS4820 video cassette recorder
> Sharp LC-121M2U LCD AV monitor
> Extron DVS-100 digital video scaler
> Canon VC-C3 communication camera
> Extron Matrix 50 s-video switcher
> Extron sw4vga video switchers
> Shure UT series wireless microphone system
> Soundcraft Powerpad sound mixer

The Extron video equipment/cable is a bit higher priced than most; but the specs are more conservatively rated. When dealing with video, good cables/equipment make the difference between

great video and poor video. Specs are very important. You need greater bandwidth than just the minimum recommended.

Appendix 2 – Comments of A.J. Lacomba on AV Equipment

You get what you pay for.

For classroom type use, durability, bulb life/cost and ease of maintenance are very important issues.

When the studios were setup maintenance/upgrades isn't/hasn't been usually figured into the budget. Since funds for expensive A/V equipment comes far and few in between, it's best to get a better projector with a long mean time between failure (mtbf) with better resolution. Following this practice usually extends the useful life span.

When selecting a projector keep in mind the video source (camera/computer/svhs) and make sure to test it under the modes it will be operated on. Some projectors don't equally display moving video and computer display.

Try to choose the highest quality display choices. For examples, svhs over ntsc - component RGB over svhs.

Input options can possibly be used to reduce video switching requirements.

Remember that the projector is only part of a system. A cheap video distribution amp (or worse, non at all) can really degrade a signal. Cheap switches would have similar results.

Appendix 3: Comments on by Karen Cummings (Clinical Professor of Physics)
The Impact of Global Learning on the Local Classroom, K. Cummings, American
Association of Women in Science Magazine, No. 3, pp 33-35, (2000).

You don't have to look far to see that widespread electronic connectivity is bringing the people of the world into closer contact every day. We can collaborate with our international colleagues with nearly the same ease as we can collaborate locally.

On the educational front, many institutions have worked toward "any time, any where" learning. In such models of learning, there is no longer a local classroom in which class is held at a specific time with both teacher and students physically present. Instead, a technology-enabled environment allows students at far-flung locations to interact in meaningful ways with each other and their teacher regardless of whether the people involved are available synchronously or not.

Asynchronous, distance education may never replace warm, safe classrooms filled with people. However, pieces of that world already infiltrate mainstream education. For example, some teachers find

that they can reach out to their students effectively by supplementing traditional office hours with "virtual office hours" using America on Line's Instant Messenger Service or a similar system for spontaneous, two-way communication. Other educators find that web-based bulletin boards enrich their courses by allowing for asynchronous, non-localized group communication.

Another aspect of the "brave new world" of technology enhanced education that is beginning to impact mainstream educational practice in significant ways is the use of computer based systems for homework assignment, grading and recording of grades. Computer based homework systems can, among other things, facilitate the distribution of personalized homework problems, allow students to input a numerical solution to the problem, instantaneously evaluate the solution for correctness, allow resubmissions if initial responses are incorrect and ultimately record a score on the problem.

These are several systems in wide spread use. Larry Martin, through North Carolina State University, developed WebAssign[1]. CAPA[2] (Computer Assisted Personalize Assignment) is a Michigan State University project. The Homework System[3] by C. Fred Moore is centered at the University of Texas at Austin. All of these systems are basically computer software packages that focus on homework and exam processing. All of these systems allow the assignment and submission of a wide range of types of problems including essays and numerical problems. None of them can automatically grade an essay. None of them is very good at assessing the method or process by which students arrive at a right or wrong answer to a numerical problem. They do not give partial credit. However, they all allow for numerical problems with randomly assigned values for the variables so that students can be assigned the same problem, but a random number generator ensures that they get different numerical solutions.

I have used such systems in courses. I did so not because I am a lazy educator, or even because of an interest in distance education or international cooperative learning environments. Rather, I used these systems because I was unsatisfied with the process by which homework is typically completed and graded in introductory science courses at research universities.

As an example, consider the course that we taught at Rensselaer Polytechnic Institute two years ago. The homework procedure was typical. We would assign the entire class several problems from the textbook. The students would write out solutions to the problems and graduate student teaching assistants would grade the written responses. I have two significant concerns with this system. First, students all too often submit someone else's work. My second and more significant concern is that students do not get enough meaningful and timely feedback on the homework. Graduate teaching assistants are busy and faculty find it hard to complain when the homework is not graded as promptly as intended and with little more than a cursory check for completeness and correct answers.

Because of these issues, we decided to try using a computer based homework system. Within days of use, there was an outcry from students. Some called us too lazy to grade. Others said that we were technology zealots. Both of these groups of students said that they *hated* using the system. We used the system all semester and the complaints continued.

At the end of the term, we felt we needed to know more accurately the extent of the unhappiness. Hence, we asked a few questions about it on an end of the semester course survey. The students were asked to respond using a five point Leichert scale (strongly agree, agree, neutral,

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disagree, or strongly disagree) to the following statement: "I liked using the computer based homework submission system for homework". I braced myself as I processed responses to this question and was mildly shocked by the outcome. Seventy percent of students either strongly agreed or agreed with the statement, indicating that they *liked* doing homework this way. Another ten percent of the students were neutral. Only twenty percent of the class either disagreed or strongly disagreed with the statement. [4]

However, we don't assign homework for the students' enjoyment. We assign homework in the hope that students will learn by doing it. The majority of students in my classes report on end of the semester surveys that they feel that they learned more doing homework on the computer than they would have using the standard process of homework submission and grading. However, self-reports of learning can be misleading and so it was comforting to find a recently published article on the topic.

An article, written by Kashy, Albertelli and Thoennessen of Michigan State University in conjunction with Yihjia Tsai of Tamkang University in Taiwan, documents in detail the impact of a computer based homework submission system on student learning in the engineering physics courses at Michigan State.[5] They report that, although standards in the course are higher, scores on examinations substantially increased following the implementation of a computer based homework system. Interestingly, female students benefit even more than their male counterparts. Gender differences that are apparent in exam scores for the first semester course (which did NOT use a computer based homework submission system) disappear as student proceed through the second semester course (which did use a computer based homework submission system). The authors attribute this improvement in student performance to prompt feedback and an increase in the amount of time that students spend on homework when using the system.

We continue to use a computer based homework system at my institution. I expect some students still copy work from one another, but at least with a computer based approach they have to understand the material well enough to calculate their own solutions to problems with randomly assigned variables. The students get only a check for completeness and correct answers as feedback. But in reality, they never did get much more. Now they get feed back instantaneously and can attempt to find errors while the problem is fresh in their minds. Some students still complain loudly about the impersonal, bottom-line nature of this approach, but end of the semester surveys continue to show that those unhappy students are outnumbered three to one by students who like the system. After two year of experimenting, we have stopped asking ourselves *if* we should use a computer based homework system and started talking about *how* we best use the system to improve student learning and maximize student comfort with technology.

Appendix 4: Karen Cummings Presentation on Computer-Based Homework Systems in Large Enrollment Courses

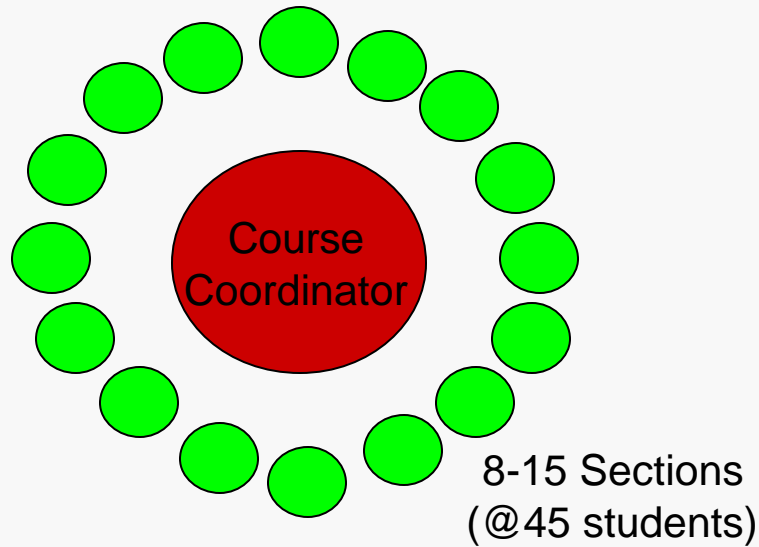# Use of Computer-Based Homework Systems in Large Enrollment Courses

Karen Cummings
Department of Physics
Rensselaer Polytechnic Institute

Use of WebAssign at RPI

- Spring 2000 was the 4th semester of use in Introductory Physics I and II
- Was also adopted for use in another physics course-Physical Principles of Design

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The Introductory Physics Course
(350-550 students)

Course
Coordinator
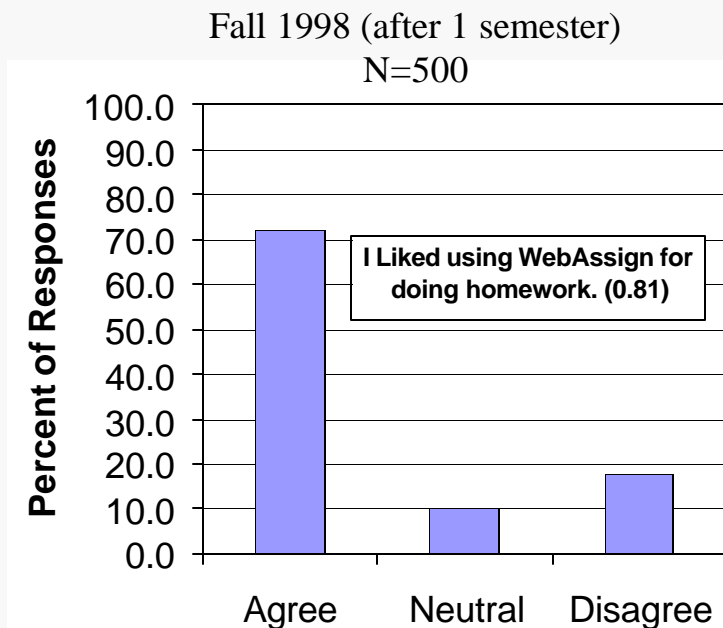
8-15 Sections
(@45 students)

Use of WebAssign at RPI

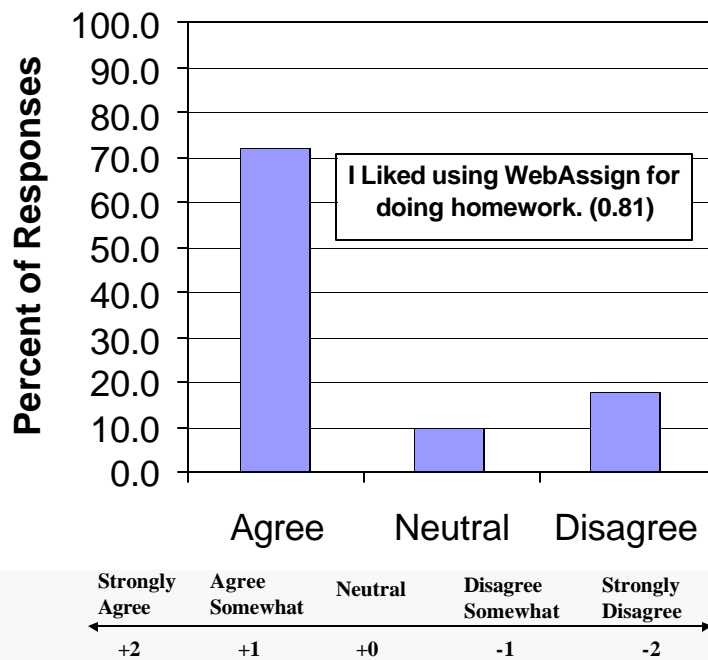- Course coordinator takes responsibility for administration of the system with help from upper level undergraduate students.
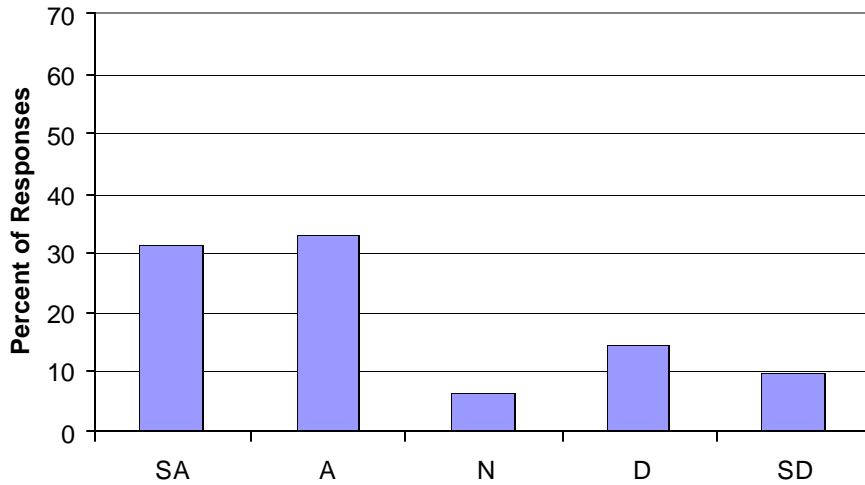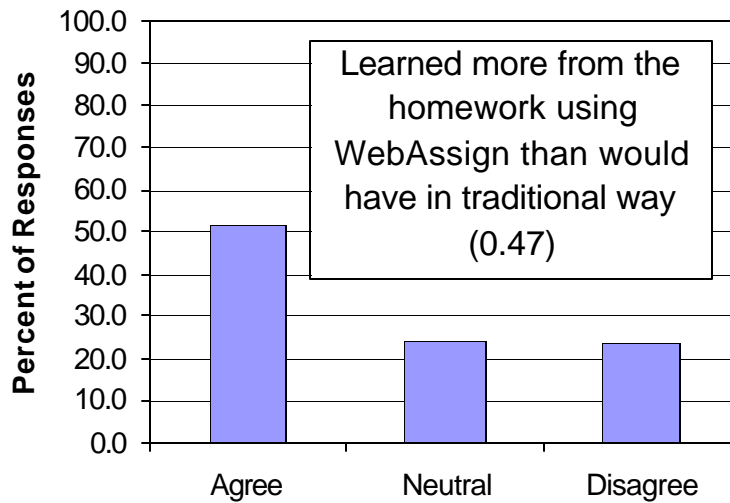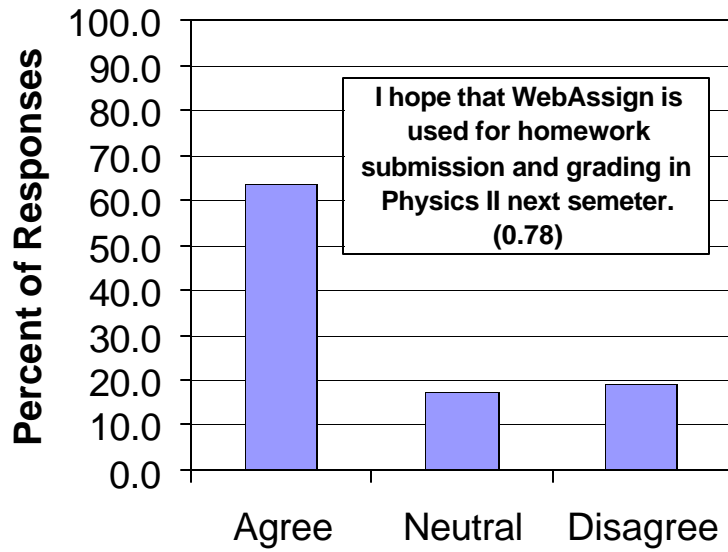
Grumble, Grumble

- During the first semester of use it was clear that there were very unhappy students.
- Examples of oral comments included: "Faculty is just being lazy, the system is uncooperative, I'm paying a lot of money, I want people to evaluate me, **Everyone** hates this…."
- So, at the end of the semester, I did a survey: Asking students to respond Strongly disagree to Strong Agree to several comments.

Fall 1998 (after 1 semester)
N=500

I Liked using WebAssign for doing homework. (0.81)

I liked using WebAssign for Homework Submissions

Responses showing more detail

I Liked using WebAssign for doing homework. (0.81)

Strongly Agree	Agree Somewhat	Neutral	Disagree Somewhat	Strongly Disagree
+2	+1	+0	-1	-2

I hope that WebAssign is used for homework submission and grading in Physics II next semeter. (0.78)

Learned more from the homework using WebAssign than would have in traditional way (0.47)
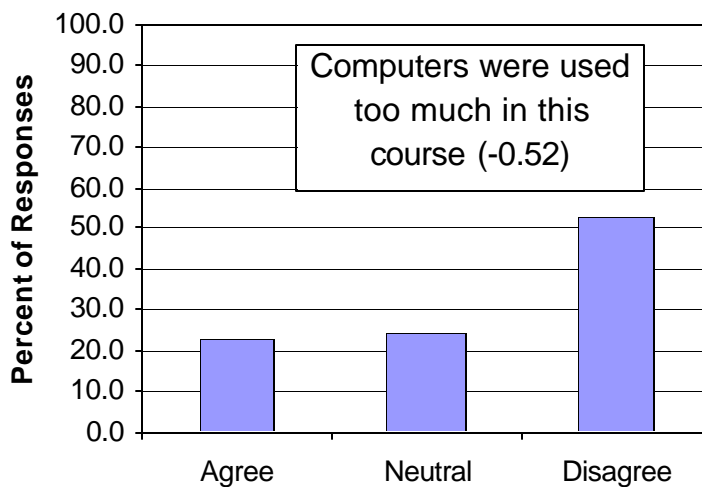
Typical Written Student Comments on WebAssign:

- "I really like Webassign because you immediately know if you're right, therefore you work out the problems again until you're right, learning more. "

- "Webassign gets frustrating, when I'm on my last submission and still get the question wrong. Even though my rationale is correct, my calculation is wrong, and there is no partial credit for my work."

Faculty Response

- Initial Faculty response was very positive.
- "The students hate WebAssign"
- On-going faculty opinion seem highly correlated to how well the system is administrated.

- Administration issues include:
1. Coding error and inappropriate questions.
2. Grade calculations at the end of the semester. (section changes)
3. Extensions and other problems during the semester.

Godsend or Encroaching Evil?

- What can we do to address the short comings of this method of doing homework?

-Students don't get credit for process (Too much emphasis on getting the "right" answer.)

-Students don't get practice in writing out coherent solutions

-Instructors don't monitor student progress. (Lack of human contact).

- What do we do for the 10% that hate using the system?

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