

Chemistry Student Perspectives on Online Homework using WebAssign

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I teach large sections of general chemistry and organic chemistry for non-majors at North Carolina State University (a Research I institution). My teaching style is not typical of the instructors who teach these large service sections for non-majors. Some of you may not consider my style novel and thus will view this paper as stating the obvious. Others who find themselves in a similar situation with no formal instruction on how to teach and assess students in large enrollment classes may find my ideas valuable. I specifically want to address the issue of homework. The philosophies of homework among instructors in my department range from suggested homework problems with no accountability to daily graded homework problems (daily in this context means every lecture). My philosophy of homework aligns with the daily graded homework end of the spectrum and is derived from personal experience and encouraged by student testimonials. My first objective in this paper is to chronicle the development of my philosophy (Section 1). My second objective is to show how I implemented my homework plan (Section 2). My third objective (from which the title of this paper comes) is probably the most interesting. I will show the students' perception of homework as an effective learning tool as gleaned from post-class surveys and anecdotal evidence (Section 3). Lastly, I will present course grade statistics comparing various aspects to see if there is a correlation between subject mastery and homework (Section 4). I begin with an analogy.

Section 1: Philosophy of Homework

I have been involved in some type of pedagogic endeavor since I was 16 years old. My first experience was teaching children in my rural community how to play the piano. My background in this very performance-based area has influenced my philosophy of homework. In my opinion, learning and applying chemistry concepts is very similar to learning how to play the piano - without "practice" between lessons, student mastery of the subject will not be realized. A student can watch me play a musical score, but until she sits down and tries her hand at the piece, her goal of playing the music proficiently will not be realized. I believe this same phenomenon exists in becoming proficient in chemistry. Because of the nature of large enrollment classes, it is challenging to get students actively involved in the learning process during the lecture and to get students to "practice" between lectures. Continuing with the piano analogy, how can I hear my students practice their pieces before the recital (a.k.a the exam) and, more importantly, how can the students hear themselves practice before the recital?

The traditional teaching style for large enrollment classes (still alive and well today) is the instructor will "play the songs" while the student sits passively and listens. The student is then encouraged to go home and practice the songs (*i.e.*, given suggested homework problems that he should attempt). One assessment method used by the instructor to "hear the student practice" or see if he has practiced is to give a quiz or two in between exams. Because I was internally motivated and grade oriented, I would discipline myself to sit down, do all the suggested homework problems (plus some) without looking at the solutions manual then check my answers against the answer key to assess my mastery of the material. Now after teaching high school for 10 years and college for 3 years, I have perceived that only a small percentage of students are as disciplined as I was. Because a significant percentage of students I teach either do not have the discipline to "practice" between lectures or are subject to the "tyranny of the urgent", I do not believe this method of teaching would be effective in helping them meet the high expectations I have for them. I want to hear my students "practice" during the lecture and between lectures. From my personal experience as a student (and I still consider myself a student), I have found it is more enjoyable and rewarding when there is immediate feedback and accountability for the learning. But how feasible is it to not only make students accountable for their practice both in class and between classes, but also to offer the immediate feedback when I have over 400 students in a semester?

Section 2: Homework Plan in Action

When I began teaching at the university level with over 400 students in the fall semester, I encountered a head-on collision between my belief that students should engage often in activities that develop critical thinking and the logistics of how to make them accountable for their engagement. The first semester I assigned homework problems from the end of the chapter in the textbook after each lecture due at the beginning of the next lecture. Thankfully, the department provided a grader for each lecture section. I would choose 2 questions from the 5 to 10 questions assigned after each lecture for the grader to grade. The grader would grade, alphabetize and record the grades for the 200+ students in each class. At the beginning of each lecture I would post the answers to all of the questions on an overhead transparency and place the graded papers in alphabetized boxes at the back of the lecture hall. Students were encouraged to retrieve their papers and compare their answers to the answers on the transparency to assess their understanding of the concepts. This two-day delay in getting feedback on their work while making them accountable in a tangible way, was the best I could do until I was introduced to WebAssign, a web-based homework delivery and grading system.

I was very excited about the capabilities of WebAssign. With WebAssign all of the logistical headaches were eliminated. No more would I have to collect, grade, record and return 400 papers three times a week. Several other positive aspects afforded in WebAssign make this homework system ideal for classes of any size. The question randomization function in WebAssign makes student cheating more of a challenge. The web-based question database allows for dynamic question generation from semester to semester with minimal work on the instructors part after the initial generation of questions. No longer are instructors who are conscious of copying costs and fraternity/sorority answer banks dependent on textbook questions. Other attractive features of this homework system from my perspective as an instructor of large enrollment classes are:

- the freedom it gives me to create my own questions and deploy them in a short turnover time,
- the flexibility of assigning questions to accompany each lecture based on the material covered during each days lecture,
- the ability to view student responses at any time to gain a general idea of student understanding,
- the ability to view student responses while assisting students during virtual office hours or when answering questions via email,
- the ability to easily grant extensions for missed assignments,
- the ability to download summary information for answer analysis.

Attractive features from the student perspective are:

- the immediate feedback on correctness of responses,
- the multiple submissions (as allowed by the instructor),
- the availability and accessibility of the assignments due to their web-based nature.

You can read a more in depth description of WebAssign in action from John C. Dutton's account *in The Technology Source*.¹ You can also experience the WebAssign experience from the WebAssign demonstration website.²

Engaging student participation in organic chemistry homework has its own unique set of challenges. Traditionally, solution manuals giving solutions to all of the textbook problems are made available for student purchase. Once again, WebAssign has opened another venue for student participation and accountability. Creating and assessing assignments which include challenging questions (for which no detailed solutions are readily available) is relatively easy, especially with the JME Molecular Editor applet available in WebAssign,. The JME Molecular editor allows students to draw structures that can be graded for correctness. (See the JME Molecular Editor at the WebAssign demonstration site.)³ Instructors participating in virtual discussions or responding to emails can download student responses and readily view the structures drawn by students. It is much easier for the instructor to give direction when she can see exactly what the student has written. Students who take advantage of the technological contacts (chat

rooms, bulletin boards or email) appreciate the pinpointed guidance they receive from the instructor when the instructor has this ability to view their responses.

Section 3: Student Perceptions of the Homework Plan

Student attitudes toward my teaching/assessing methods are important to me. I do expect my students to spend about an hour outside of class for every hour inside of class applying the concepts presented during lecture to aid them in their mastery of the material. (I use class work questions interspersed throughout the lecture to give brief opportunities for concept application during the lecture for which students are held accountable (*i.e.*, receive a grade) via WebAssign.) Having graded homework assignments exploring the concepts presented in lecture aids students by giving them the motivation and direction they need to spend the time required to master the material. I have had older, highly motivated post-baccalaureate students, who took the first semester organic chemistry class from me, come back and tell me that without the impetus of getting a grade on the homework, they would have not made the time in their busy schedules to "practice" their organic chemistry between lectures as they ought. They told me this after they had taken the second semester organic course where the homework assignments were suggestions. With their busy schedules they found themselves not being motivated to follow through on the suggestion. As a result they did not feel they gained as much from the class even though they made good grades in the class. One student wrote the following on a post-course survey (this student took the first semester organic course during a 5-week summer session):

To be candid, the workload was not easy; it made for many LATE nights and I have never worked so hard in a class. BUT, I also have never learned, and felt a command over, as much material in as short a period of time. I don't think I could say that without the tools you used for the class: classwork, homework, WebCT, and SI. I would imagine that with the time allotted in a full semester, these tools would be an even greater asset. So, thanks for your hard work and late nights.

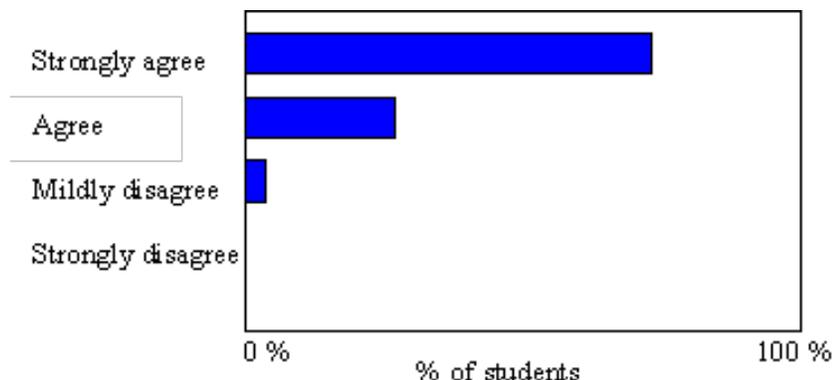
Along with these anecdotes I would like to present the data from the post-course survey. I taught both first semester general chemistry (from a molecular science approach) and first semester organic chemistry in the spring of 2001. I made this survey available during the summer and sent an email out to all of my students asking them to give me their impressions without fear of reprisal - grades had already been turned in and I would download the responses using the anonymous download feature in WebAssign. Of the 178 general chemistry students, 41 (23%) submitted the survey and of the 92 organic chemistry students, 28 (30%) submitted the survey. Following are the questions and the results.

Homework survey:

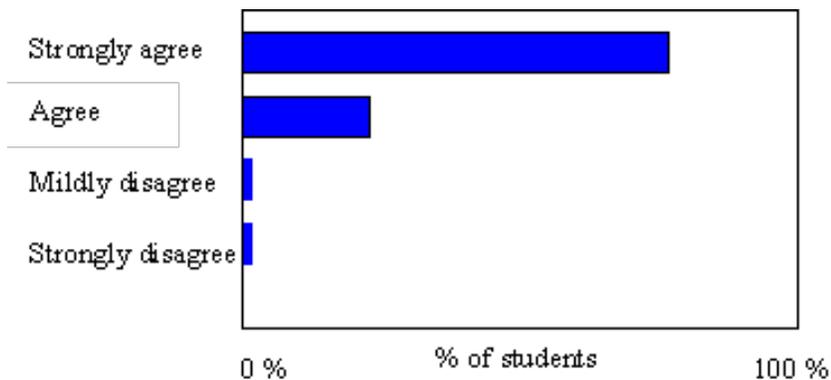
Question 1: Please indicate which expression best describes your feelings or experience in each situation.

The daily homework assignments:

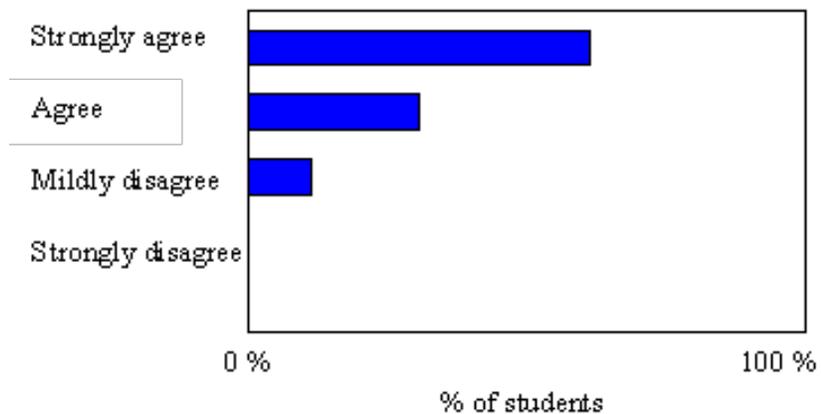
a) were instrumental in keeping me on top of the subject matter,



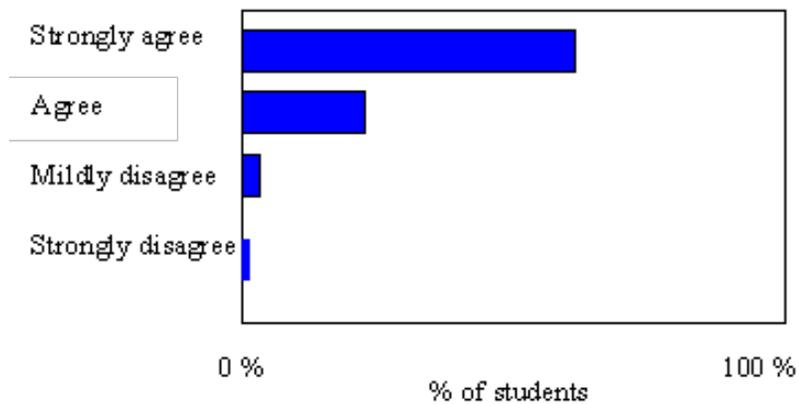
b) gave me an opportunity to assess my understanding of concepts presented in the lecture,



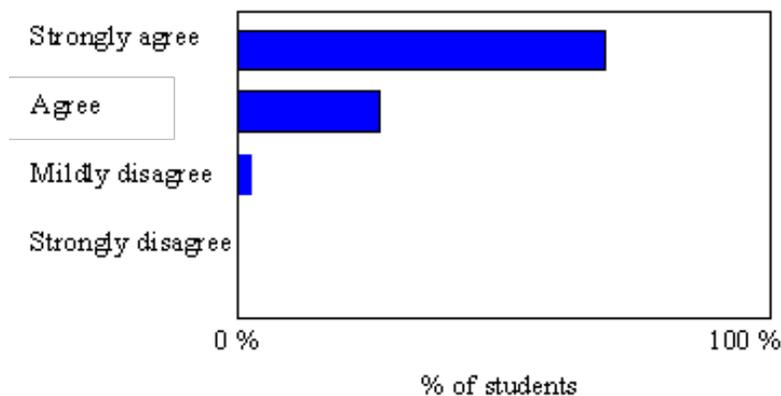
c) encouraged me to discuss concepts with my fellow classmates,



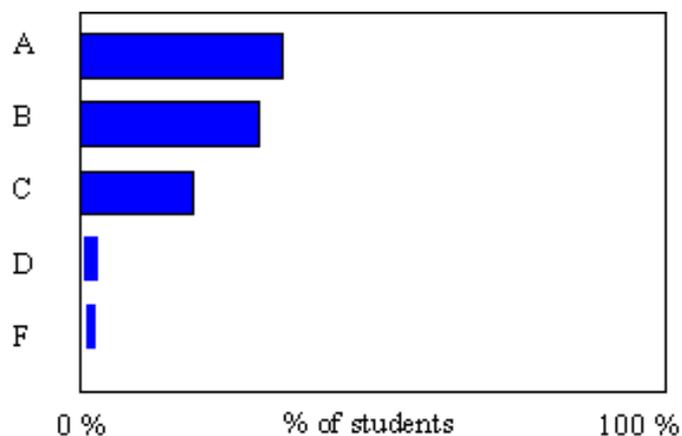
d) were instrumental in preparing me for exams,



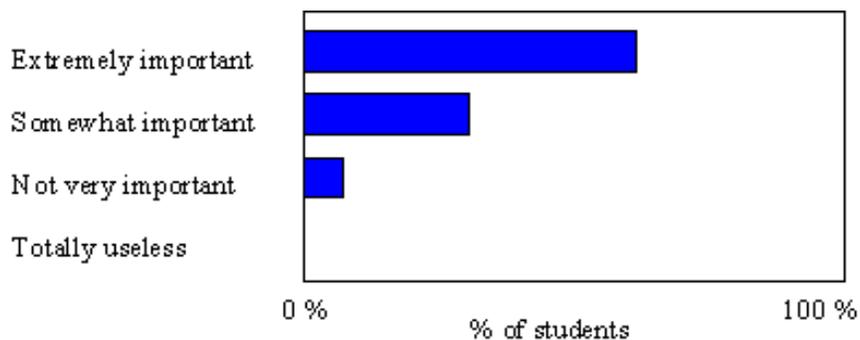
e) is a valuable method for enhancing student learning.



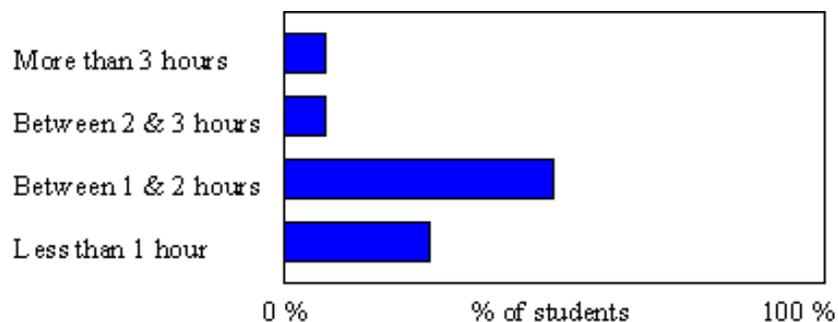
Question 2: a) What was your final grade for this course?



b) How important was the daily homework for you obtaining the grade you did?



c) How much time on average did you spend on an assignment?



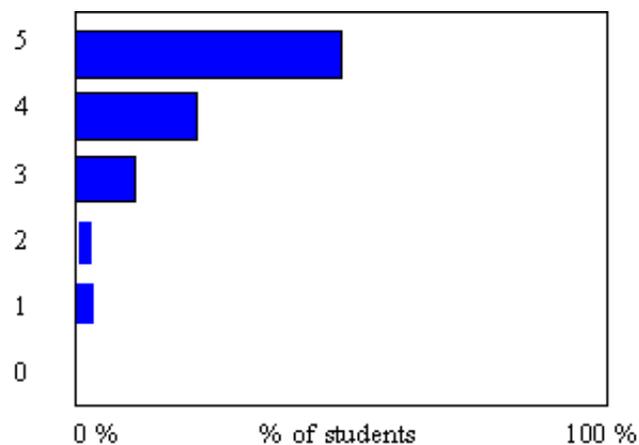
From the responses to Questions 1 and 2, I do not believe students view the given homework as busy

work, but rather see it as an important component to their understanding and learning.

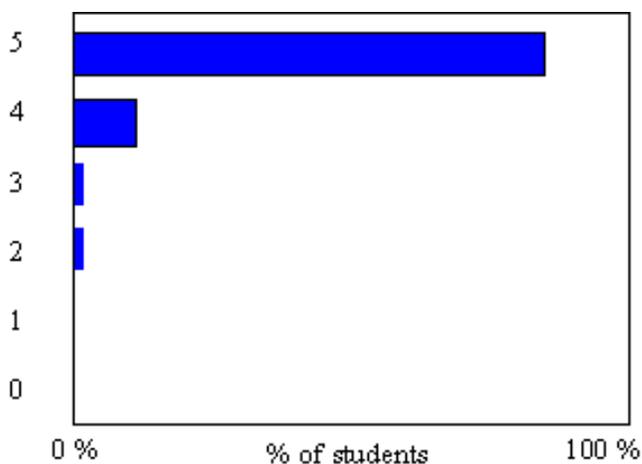
Question 3: Rank the importance of each of the following using the following scale:

5 = very important, 0 = totally useless.

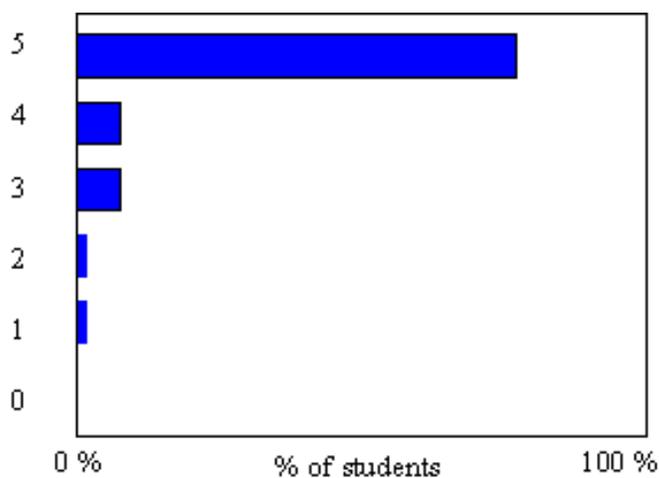
a) receiving a grade for the assignment,



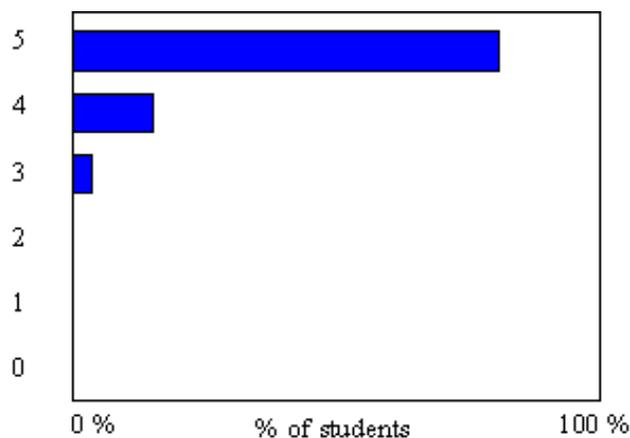
b) having multiple submissions,



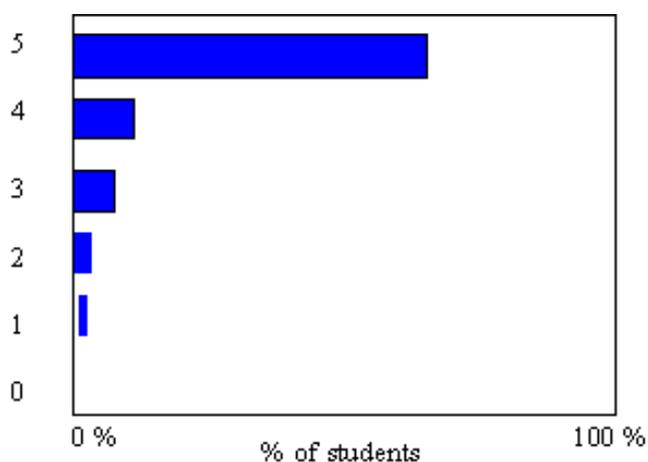
c) receiving immediate feedback,



d) attending the lecture before attempting the assignment,



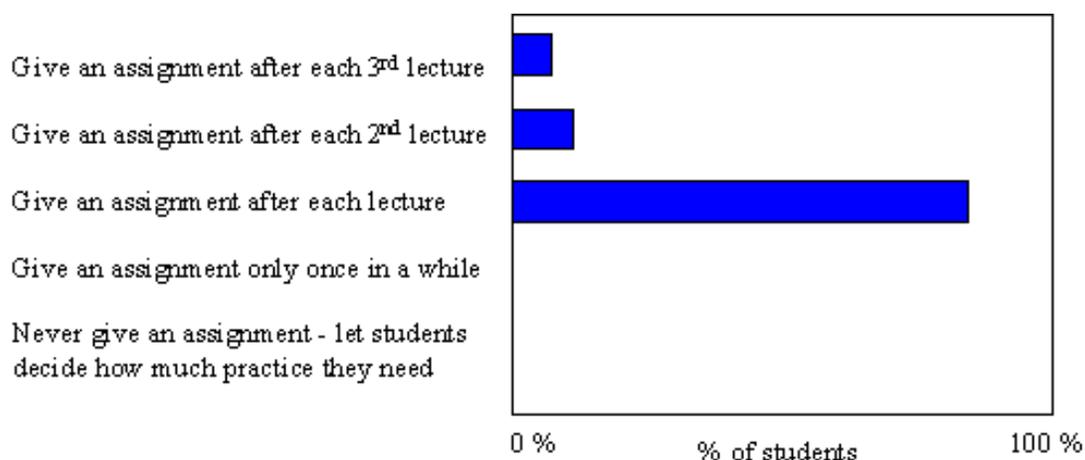
e) having access to the powerpoint lecture notes,



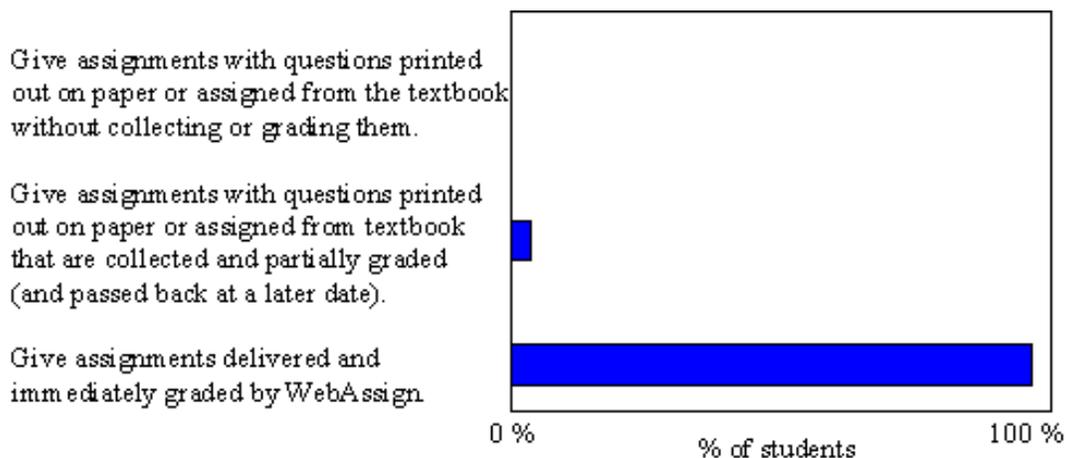
From responses to Question 3 - d and e, I believe students see an intimate connection between the concepts presented in lecture and the problems they are asked to solve in the homework.

Question 4: If my goal is to make the class as profitable for students as possible, which of the following would help me meet that goal the best?

a)



b)



My colleague was surprised by the response to Question 4 - a. Since each course I teach builds on itself, it is important for students to have a working knowledge of the concepts presented during yesterday's lecture for tomorrow's lecture to be meaningful. Most students I have informally polled regarding this appreciate the "force" the daily homework places on them to stay on top of the material. The very first day of class this semester I shared this statistic with my classes when I informed them that every lecture would have an accompanying WebAssign homework assignment. In the free expression essay portion of the survey 76% of the students mentioned explicitly that my homework plan was a good idea (it was the most common response given).

Section 4: Course Grade Statistics

For Tables 1 - 7, I have taken statistics from my course grades *without any adjustments*. (To determine the final grade, I adjust each exam grade according to the 96th percentile resulting, on average, in a 5-point curve and I replace the lowest regular exam grade with the final exam grade if the final exam grade is higher.) The exam average is calculated as follows: exams 1, 2 and 3 count 20% each and the final exam counts 40%.

Table 1 compares the percentage of students who had an A exam average (89.5 - 100) with their homework average.

Table 1	CH101 spr 01	CH221 spr 01
	A exam ave %	A exam ave %
A HW ave	83	100
B HW ave	13	0
C HW ave	4	0
D HW ave	0	0
F HW ave	0	0

Table 2 compares the percentage of students who had an F exam average (0 - 59.5) with their homework average.

Table 2	CH101 spr 01	CH221 spr 01
	F exam ave %	F exam ave %
A HW ave	8	0
B HW ave	21	26
C HW ave	13	48
D HW ave	33	17

F HW ave	25	9
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Table 3 compares the percentage of students who had an A homework average (89.5 - 100) with their exam average.

Table 3	CH101 spr 01	CH221 spr 01
	<i>A HW ave %</i>	<i>A HW ave %</i>
A Exam ave	28	40
B Exam ave	32	37
C Exam ave	23	13
D Exam ave	13	10
F Exam ave	3	0

Table 4 compares the percentage of students who had an F homework average (0 - 59.5) with their exam average.

Table 4	CH101 spr 01	CH221 spr 01
	<i>F HW ave %</i>	<i>F HW ave %</i>
A Exam ave	0	0
B Exam ave	0	0
C Exam ave	8	0
D Exam ave	42	50
F Exam ave	50	50

Table 5 gives the grade distribution based only on exam averages.

Table 5		
Exam based	CH101 spr01	CH221 spr 01
A ave	13%	13%
B ave	20%	23%
C ave	29%	15%
D ave	25%	24%
F ave	13%	25%
Average	74%	71%
Median	73%	71%

Table 6 gives the grade distribution based only on homework averages.

Table 6		
HW based	CH101 spr01	CH221 spr 01
A ave	39%	33%
B ave	32%	33%
C ave	12%	22%

D ave	11%	9%
F ave	7%	4%
Average	83%	82%
Median	87%	84%

Table 7 gives the grade distribution based on the final grade calculated as follows: HW average counts 17%, each of the 3 regular exams count 17% and the final exam counts 32%.

Table 7		
<i>Final grade based</i>	<i>CH101 spr01</i>	<i>CH221 spr 01</i>
A ave	14%	13%
B ave	22%	24%
C ave	32%	21%
D ave	20%	18%
F ave	10%	23%
Average	75%	73%
Median	75%	73%

Table 8 gives the grade distribution based on the all grades and adjustments (96th percentile curves, final exam grade replacement of lowest regular exam, daily grade including class work and homework).

Table 8		
<i>Final grade based</i>	<i>CH101 spr01</i>	<i>CH221 spr 01</i>
A ave	25%	39%
B ave	30%	24%
C ave	24%	22%
D ave	15%	12%
F ave	5%	3%
Average	80%	83%
Median	81%	83%

(71% of the CH221 spr 01 students had their lowest exam grade replaced by their final exam grade.)

The results shown in Tables 1 and 4 are not surprising. The results shown in Tables 2 and 3 are more interesting. The disparity in Table 2 is troublesome if successful practice should translate into subject matter mastery. The fact that there is not a one-to-one correlation is not surprising since the modes of assessment are different. On an exam the student only gets one submission, no immediate feedback and a time constraint whereas on homework she gets 3 submissions, immediate feedback and a 2-day submission window.

I had a student, "Herman", who took my organic chemistry class. It was clear to me early in the semester that he was in for a struggle (not that I let him know I believed he was fighting a losing battle). He made a D on the first exam and Fs on all of the other exams (including the final) but he had a B+ homework average. Clearly, his success on the homework did not translate into concept mastery, but he worked very hard (it was agonizing to watch how hard he worked) and he sought help at every turn (a key factor in

"his" homework success story). When the final grade was determined he had a D- average (just by the skin of his teeth!) I was so excited! Even though he did not gain a working knowledge of organic chemistry (which he evidently does not need to succeed in his chosen field), he was able to move on. The homework did play an important role in this "accomplishment". (As a side note, I do not get excited when a student who needs a working knowledge of chemistry to advance in his field makes a C in my class.)

The results in Tables 5 - 7 suggest that, on average, a student's final grade will be 10 points lower than her homework grade.

Section 5: Conclusion

In conclusion, students see my homework philosophy in a positive light and think I should continue to follow it. I view my homework plan as a way of providing steps for students to climb to meet my high expectations for their learning. Unfortunately, practice does not always make perfect, but the daily homework does provide other positive benefits. "Hermans" story and the discipline developed by this mild form of college boot camp are just two beneficial by-products of daily homework. I close with remarks made by one of my student supplemental instructors who assisted students throughout the semester during regularly scheduled study sessions:

By having frequent homework assignments students must keep up with not only the concepts discussed in lecture, but also their own understanding of the course material. In addition, out of class assignments can provide appropriate learning frameworks for students with diverse learning styles. For those students who learn best in groups, out of class assignments allow communication with other students unlike what can be achieved in a lecture setting. Homework also offers an appropriate outlet for those students who prefer individual study to group work. Finally, as opposed to "cramming" large amounts of information into short-term memory, homework allows the student's knowledge of a subject to progress smoothly, thus developing the fundamental skills and understanding needed to fully grasp the course material.

Nate Wigner

¹John C. Dutton "WebAssign: A Better Homework Delivery Tool." *The Technology Source*, January/February 2001. Available online at <http://horizon.unc.edu/TS/default.asp?show=article&id=836>.

²WebAssign website: <http://webassign.net>

³Go to the WebAssign website (<http://webassign.net>), click the "WebAssign Expanded Demo" link, click the "Chemistry, section 1, Fall 2006" link, scroll down and click the "Organic Chemistry Using JME Editor" link.
