

Student Response to Formats of Teacher-Provided Homework Solutions

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This poster is slightly different than the published abstract: It provides a full treatment of the role of solutions in our new homework system, including students' habits with the solutions, their impression of its usefulness, and the side-issue of hints vs. full solutions. Our companion poster discusses other aspects of the new system.

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Overview

During the Fall 2002 quarter, we implemented a new homework system in the first course in Ohio State University's calculus-based introductory physics sequence. One of this system's major features is the availability of solutions for some of the problems prior to the due date. The problems in each assignment were split evenly into two groups:

- Group I - Solutions for these problems were posted to the course website three or four days before they were due.
- Group II - In some weeks, no assistance was provided for the GII problems, but in alternate weeks, a set of brief hints were posted along with the GI solutions. Complete solutions were put on the website after the problems were turned in.

During the course, students filled out a nearly-weekly survey online. The data presented in this poster comes from those surveys.

Detailed Solutions

Solutions for this course were intended to not merely show the steps needed to arrive at an answer, but to help acclimate students to the world of physics problems. This was especially important for the Group I solutions, which were expected to be read by most students while they worked on their chosen problems. The solutions had to serve as surrogate tutors, answering questions that the students might have as they toiled away.

Thus, our solutions were rather thorough. They often open with a statement of what physical concepts are apparent in the problem, followed by an outline or plan before any mathematics is done or introduced.

Use of Solutions: General

Near the end of the course, students were asked: “Describe the manner in which you use the Group I solutions and Group II hints. For example, do you read them before thinking about the problems? Or refer to them only when you get stuck? Or simply ignore them completely?”

This question had 337 respondents. The common answers are summarized:

- 221 students read the GI solutions only when they are stuck or done with a problem in order to check their work. An example comment: “I refer to them when i get stuck and i think they help me to learn and to get the problem right.”
- 59 students read the solutions either before or while working.
 - 16 of these students specifically stated that they read through once, then set the solution aside and try to recreate it.
- 46 students report that they do not use the GI solutions at all.
- Very few students made specific comments about the Group II hints.

Use of Solutions: General (cont.)

Only 3 students admitted to blatantly copying their GI homework from the solutions, even though copying was not prohibited. Giving future students “permission” to admit this with a prompt in the question may increase this number. Says one of our confessed copiers, an attentive student who earned an “A” in the course: “i pretty much copy the group 1 solutions anymore. the group 2 hints help a little, and i always look at them before i do the problems, but that's just because i am lazy”.

As 2/3 of our class report more or less the same strategy (reading solutions when stuck and/or when done), this statistic encompasses students at many levels of achievement. They will have different ideas of what being “stuck” means, different levels of patience for trying to unstick themselves independently, and different ability to understand the solution when they read it. In other words, there is a lot of variation within those 221 students.

Use of Solutions: Time Spent

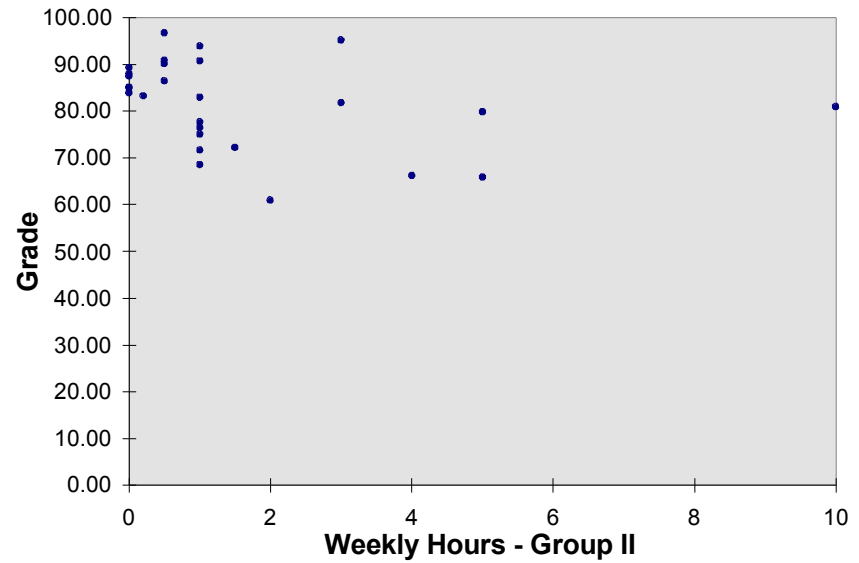
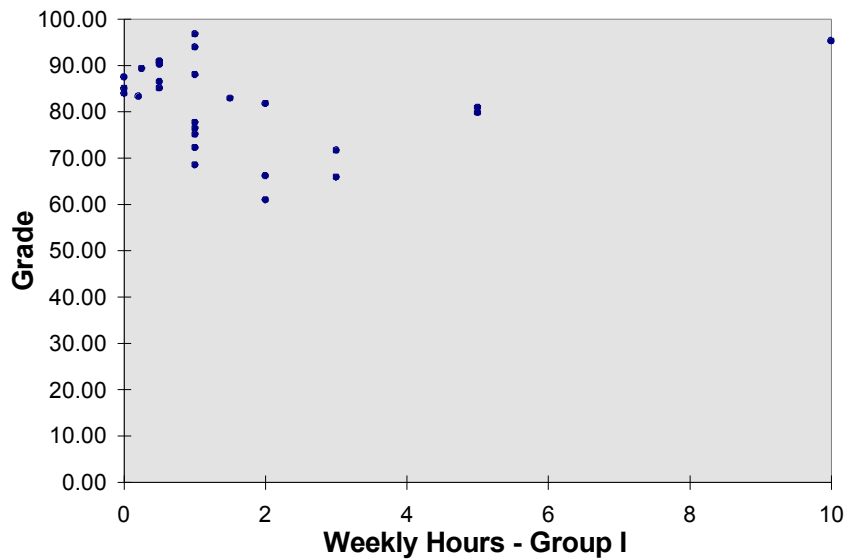
We also asked the students to estimate how many hours per week they spend looking over the solutions from Group I and II:

| <i>Hours</i> | <i>Group I</i> | <i>Group II</i> |
|------------------|----------------|-----------------|
| 0 | 42 | 73 |
| 0-1 | 149 | 139 |
| 1-2 | 98 | 76 |
| 2-3 | 27 | 25 |
| 3-4 | 11 | 7 |
| 4-5 | 15 | 14 |
| 5-6 | 1 | 5 |
| 6-7 | 0 | 3 |
| 7-8 | 1 | 1 |
| 8-9 | 0 | 1 |
| 9-10 | 2 | 4 |
| 10+ | 2 | 0 |
| <i>Total</i> | 348 | students |
| <i>Avg. Time</i> | 1.64 | 1.55 |

Although significantly fewer students view the solutions for GII than for GI, the distributions are surprisingly similar. Our students spent almost as much time with solutions to already-due problems as they did with solutions to problems they had not yet turned in. Over a third of the students spent more than a full hour per week looking over solutions to Group II problems.

Grades and Time Spent?

In one recitation section, we have looked for a relationship between the time spent looking at solutions and the final grade in the course:



The Group I data shows a weak trend, with a few outliers, in which stronger students spend less time studying the solutions. These outliers, then, represent unusually devoted pupils. Group II study-time is less systematic, although vestiges of the GI trend are visible.

Use of Solutions: Non-Submitted Problems

We also asked the class: “Do you view the solutions for problems you did not submit? (Select all that apply.)

- Yes, while studying for tests or quizzes.
- Yes, while choosing and working on homework problems.
- Yes, as part of my regular studying for the course.
- I don't read any extra solutions.”

Results can be found in the table at right:

| Situation | % who do |
|------------------|-----------------|
| Test studying | 45.1 |
| While choosing | 32.0 |
| Regular studying | 17.7 |
| Don't read them | 40.1 |

Comparing this information with the data about time spent on the GII solutions, it appears that most of that time is devoted to their submitted GII problems, rather than an exploration of the rest of the problem set.

Preferred Homework Formats

At the end of the course, we asked our students an open-ended survey question about the effectiveness of the different sorts of homework in the course. Respondents were split 262-46 in favor of provided solutions.

- The most common reason cited for preferring solutions was the students' opportunity to check their work. The solutions "help lessen frustration" for them.
- Similarly, the most-maligned aspect of no-solution problems is that students don't know if their answers are right. This, of course, can be alleviated by providing numerical answers without full solutions.
- It's unclear from many comments if the students were answering carefully about homework types' teaching effectiveness or simply their convenience.

Selected student comments from the whole range of opinions follow:

Student Comments (all [sic])

Negatives regarding no-solutions problems:

- “[...]not very effective because there is no help readily available”
- “horrible way to learn...its the most frustrating thing in the world...”

Positives regarding no-solutions problems:

- “makes us actually try for the answer and not just work backwards[...]”
- “challenges a student to really know the material[...]”

Negative regarding solution-provided problems:

- “I think it is pointless and does not help students... It makes students more lazy and they just copy the answer from the web...I think you guys should eliminate it from future courses...”

Positive regarding solution-provided problems:

- “Paper with the solution is better than without if you use it right and dont just copy the answers. If you get stuck and cant figure it out you can always check the way to do it while it is still fresh in your memory and you learn from that.”

And a nice comparison: “the most affective are the ones that make us do more work i think, but the others help me do those”.

Group II Hints

For Group II problems, we sometimes provided no assistance, and other times provided “hints”. The hints were usually two to three sentences long and either suggested a way to start the problem, explicitly stated which concepts were involved, or provided a detour around a tricky spot.

We asked the students to choose one of the following statements about the hints. The number of votes received by each statement is included:

- They give away too much, almost like a full solution. (1)
- They are just right. (153)
- They are not very helpful. (93)
- I don't use them, so, I don't know. (101)

Considering the large number of students who did not use the GII hints, as compared to only 46 who said they did not use GI solutions, it is probably safe to say that some of those 101 students found the hints unhelpful early in the term, and then stopped downloading them.

Comparing Full Solutions and Hints

We also wanted to get a direct comparison of the hints and solutions from the students' point of view, so we asked: "Ignoring for a moment what makes things easier for you to complete the assignments, which of these methods do you feel is best for your learning of physics?"

- "Having access to completed solutions before the due date." (153)
- "Having access to hints only before the due date." (43)
- "Having access to neither -- it's too tempting to be lazy." (24)
- "A mixture, sort of like what we are doing now." (130)

For the recitation section in which grades have been analyzed, this table shows the distribution of grades in two voting categories. The sample is still rather small, but it will be interesting to see if this difference in the distributions' peaks persists through the whole class.

| <i>Grade</i> | <i>Solutions</i> | <i>Mixture</i> |
|--------------|------------------|----------------|
| 60-65 | 1 | 0 |
| 65-70 | 2 | 1 |
| 70-75 | 1 | 1 |
| 75-80 | 0 | 4 |
| 80-85 | 2 | 1 |
| 85-90 | 5 | 1 |
| 90-95 | 2 | 2 |
| 95-100 | 2 | 0 |

Students' Motivation

When asked what parts of the course had affected their motivation either positively or negatively, most of the homework-related answers did not address the new features of our system as much as they did homework in general. (For example: “the homework being due decreased [my motivation]”. And on the other hand, “I don't think I would have worked thru any of the homeworks unless they were being graded.”)

Regarding the new features in particular, about half a dozen students made comments. One was negative: “The homework system has decreased my motivation. I dont like it at all.” The others said that the new system was beneficial, with comments such as “The independence has increased my motivation,” and “The fact that we have more freedom to do this homework has made me more motivated.”

Perceived Effect On Learning

Early in course, we asked students about the features of the paper-based homework system and to “rate the effect that it has on your learning in this course”. At the end of the course, we asked them to rate, on the same scale, their agreement or disagreement with the statement, “Having some homework solutions and hints posted on the web helps me learn.”

Here negative ratings are for disagreement or deleterious effects, zero is neutral, and positive ratings are “good”.

Results show not only that students consider the system effective, but that the class’ opinion of the system improved over the course of the term.

| <i>Rating</i> | <i>Early</i> | <i>Late</i> |
|---------------|--------------|-------------|
| -2 | 6.2% | 2.3% |
| -1 | 10.5% | 1.3% |
| 0 | 18.9% | 22.9% |
| 1 | 42.3% | 33.2% |
| 2 | 22.1% | 40.3% |

Summary

Student response to this system has been positive. This is not in itself very surprising -- the system is “easier” because of the provided solutions. However, students report that this homework system is more effective in helping them learn than is a traditional one.

Availability of Group I solutions provides students with immediate feedback on their work, while working, at whatever level of detail they need. The students appear to be using the solutions responsibly and to their benefit. Many students read over solutions for problems they did not submit -- it's useful for these to be available. Additionally, nearly as much time is spent looking at Group II solutions as Group I.

The “hints” for Group II problems were not a big hit. Expanding them slightly is probably called for. However, it appears that keeping a mixture of solutions, no-solutions, and hints problems is the best compromise.

Future Research

In the near future, we plan to expand our analysis of student grade to encompass the full class of ~340. There will also be data for different student populations and with variations in the detail of the solutions coming in over the next few months.

Survey data for the next round of classes will be coupled with interviews to better understand the way students use the provided solutions. We also hope to begin looking at diagnostic test scores for an isolated effect of this system.

Lastly, the data about time spent studying the problem solutions has led us to wonder how much time is typical in a traditional physics class. It's possible that "forcing" students to look at the Group I solutions can turn them on to the idea of looking at solutions and example problems in general.