

# Experience with teacher-provided homework solutions in an algebra-based physics course\*

Gordon J. Aubrecht, II, Department of Physics, Ohio State University, Marion, OH 43302-5695 and Columbus, OH 43210-1106 Address: 1465 Mt. Vernon Ave., Marion, OH 43302-5695 Phone: 740-389-6786, ext 6250 Fax: 614-292-5817 Email: [aubrecht@mps.ohio-state.edu](mailto:aubrecht@mps.ohio-state.edu)

and

Steve Stonebraker, Department of Physics, Ohio State University

and

Lei Bao, Department of Physics, Ohio State University

The OSU PER group has reported on the effects of a flexible homework system in calculus-based physics courses in which students were given solutions to some assigned problems before the due date.[1-3] Here we report on the results of using this system for the algebra-based physics course.

[1] H. Sadaghiani and L. Bao, "Immediate, informative feedback using a new homework system," in S. Franklin, K. Cummings, and J. Marx, eds., *Proceedings of the 2002 Physics Education Research Conference* (New York: PERC Publishing, 2002), p. 109.

[2] S. Stonebraker and H. Sadaghiani, "Effects of increased freedom in homework assignments," *AAPT Announcer* **32**(4), 110 (2003).

[3] S. Stonebraker, H. Sadaghiani, and L. Bao, "Student response to completeness of teacher-provided homework solutions," *AAPT Announcer* **32**(4), 110 (2003).

\*Supported in part by NSF grants REC-0087788 & REC-0126070

There are **two major differences** between the **flexible homework system** and the traditional homework system. The **flexible homework system** was designed to provide students with the freedom to decide what is best for themselves:

- **Group I:** Solutions for this half of the problems were posted to the course website three or four days before they were due.
- **Group II:** Complete solutions were put on the website after the problems were turned in (at least half the problems turned in were from the group having no solution listed).

Solutions for this course were intended not merely to show steps needed to arrive at an answer, but were meant to help acclimate students to 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 served as surrogate tutors, answering questions that the students might have had as they solved the Group II problems. Thus, problems were paired by the instructor for their underlying physics.

Prior research had focused on the calculus-based course. While there was no clear signal of gain for students, **most students liked it and it did not appear to cause them any harm in performance.**

Aubrecht teaches small classes on OSU's Marion Campus, and elected to try the method with his algebra-based course this Spring. Initially the enrollment was 17, but almost half the class dropped out within the first two weeks as a result of their scores (not recorded for a grade) on the mathematics pretests (which showed that many students who had signed up lacked the basic skills needed to take the class), so statistics are very scant.

During the course, students filled out a weekly survey online, as had the calculus-based students. Few algebra-based students participated consistently and so these data were not very useful. The data for this poster came from a survey taken during the ninth week of the quarter. Six of nine remaining algebra-based students filled out the survey.

### *1. What is your method of choosing items to submit?*

	Encouraging	Neutral	Discouraging
The item came early on the list (i.e., you do the first few listed).	2	3	1
The item was rated as being easier.	3	2	1
The item was rated as being harder.	2	1	3
The item was a “question” instead of a “problem.”	3	2	1
My friends chose the item already.	0	4	2
The item used or asked for a graph.	1	5	0
The item sounded interesting.	4	2	0
I need to practice items of its type.	5	1	0
The posted solution for that item was clear to me. [Group-1]	2	3	1
The item’s numerical answer is in the back of the book. [Group-2]	0	5	1

The only clear signal is that algebra-based students like to do interesting problems, and acknowledge that they need practice.

There is some indication here that the students shied away from the harder problems (the ones we had said would show them they were on track for an A if they could solve them consistently).

It is not clear to us how to encourage algebra-based students to choose more of these difficult problems.

Calculus-based students were asked how many of the 20 weekly problems they normally read while choosing. ~25% reported that they read only as many as they need to turn in: 10. Over half the class reported numbers in the range 11-15.

Algebra-based students say they looked at a somewhat greater number than that (on average).

*2. How many of the 20 weekly questions do you normally read while making your choice of items to do for each week's homework?*

	S1	S2	S3	S4	S5	S6
fewer than 10 problems.						
exactly as many as I need to to turn them in (i.e., 10).					X	
between 11 and 15.		X		X		
between 16 and 20.	X		X			X
exactly 20.						

Many students did use the Group I solutions as we intended. A few did not.

*3. Please describe the way you use the Group I problem solutions. 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?*

I attempt to do the problem without looking at the solution and if I think I have figured it out, then I may check to make sure I got the correct solution or if I am confident I may not even look at the solution. On problems that I do not have an idea how to approach then I will look at your solution to see if I can clarify my questions, but often I will ask someone how to approach a problem.

try to solve the problems then check solutions when I'm done or I get stuck

I TRY TO DO THE PROBLEMS FIRST AND THEN IF I GET STUCK I REFER TO THE ANSWERS.

usually ignore them completely

I do the easier problems alone and then check my method and solution with the given solutions. The more difficult problems I do along with the given solutions making sure I understand each step. They were a big help this way.

Typically i don't use the solutions unless i'm really stuck and then i normally don't do solution one cause time constraints. I do problem set two so i know that what i get isn't cause i look but because i did it.

*4. Ignoring for a moment what makes things easier for you to complete the assignments, which of these methods do you feel would be best for your learning of physics?*

	S1	S2	S3	S4	S5	S6
Ordinary homework, not like the homework in this course, that are optional and not graded.						
Ordinary homework, not like the homework in this course, that are graded individually and returned.			X			
Having access to completed Group I solutions before the due date.		X		X	X	i think that questions more oriented towards the concept rather than the math would help me better.
Having access to completed solutions to all problems before the due date.						For me personally I feel that it would be good to have all of the solutions before the due date, but I do not think this is the best solutio for the class because I know if you do this some people will not really “do” any of the problems. I do not mind that the homework is assigned and I think we should get points for homework.
Other (explain):						

Most students expressed satisfaction with the flexible homework system.

## Most students did use the solutions to study.

5. Do you view the solutions for problems you did not submit? Mark all that apply

	S1	S2	S3	S4	S5	S6
Yes, while studying for tests or quizzes.	X				X	
Yes, while choosing and working on homework problems.	X			X		
Yes, as part of my regular studying for the course.	X	X			Some-times	
I don't read any extra solutions.			X			I don't really read <i>many</i> solutions but they are ones that i don't due but are curious as to how they are done.
I don't read any solutions at all.						

Most students spend 2 to 4 hours per week doing homework. This is lower than was reported for calculus-based students.

6. About how much time per week do you spend doing solutions for the homework assignments?

	S1	S2	S3	S4	S5	S6
None (0 hours)						
0-1 hours						
1-2 hours						
2-3 hours		X	X		X	X
3-4 hours					X	
4-5 hours				X		
5-6 hours						
more than 6 hours						

Most often it takes me about 4 hours to do my homework only.



Students do not seem to think that the flexible homework was helpful for the midterm (despite the fact that some assigned homework problems—changed a bit—were used).

*7. What component of the class had the largest positive impact on your performance on this test?*

	S1	S2	S3	S4	S5	S6
Lecture			X			X
Flexible Homework					X	
Problem solving by teacher in class.	By seeing problems worked I understand better how to approach the problems.	X		X		
Problem solving by groups of students in class.	I would have to say a combination of problem solving by teacher and problem solving by groups in class.	X				
Office visit						X
Other (explain):						

At least flexible homework has done no harm in this regard to students. The grade distribution in this and previous years was similar. The students appeared to be more content with the course overall.

**“I’ve been blessed this quarter with professors who encourage me to think, and I am grateful for it.”**