

# Immediate Informative Feedback Using a New Homework System

Homeyra Sadaghiani and Lei Bao

Department of Physics, The Ohio State University, 174 W 18<sup>th</sup> Ave. Columbus, OH43210.

Students often complain about the traditional homework system for inefficiency and lack of enough resources for help during the problems solving practices. The Physics Education Research Group at The Ohio State University is exploring a new homework system for introductory physics courses, in which students are given the solutions to their assignments before the due date. Each homework problem is also labeled with A, B or C to show the difficulty level as an additional feedback for students to evaluate their progress. We will report the outcome of this research and the effectiveness of this new system.

## Introduction

Homework is an important tool for students' academic achievement, and can serve various educational needs. First, homework helps students to establish independent study habits. Second, it serves to extend or elaborate the subject discussed in the class. Third, it helps students acquire the skills necessary to solve problems at the end of chapter as well as problems students may need to confront in the work place<sup>1</sup>.

Unfortunately, the traditional way of doing homework is often not very effective in achieving these goals. Students often complain that the traditional homework system is an inefficient use of their time. "... I would like it if homework was less time consuming, and more informative." "...it puts lots of stress on students and leaves little room for flexibility on the part of the students."<sup>2</sup> In addition, students always complain about not getting enough feedback on their homework solutions. "... I had no idea how to do, and when I would get it back from being graded, I would still not have any idea how to do."

Under the traditional system, students have no way of telling if their answers are correct or not while they are doing their homework. Not knowing if they are correct or not weakens the students' motivation. Furthermore, even when students receive the correct solution, they have no time to learn from their mistakes since they must now work on the next homework assignment. As a result, students end up with many of

unsure ideas and piles of incomplete solutions before the exam. Finally, in interviews, students admit that their first concern in doing homework is to have it done before the due date and that they don't really attempt to learn the material.<sup>3</sup>

In education research, many existing studies emphasize the practice of problem-solving rather than the structure of a homework system<sup>4,5,6</sup>. In general, learning is a dynamic adaptive process, which requires an integrated cycle of feedback and practice. Therefore, immediate feedback to both the students and the instructor is very important. In our research, we implemented a new homework system aimed at providing informative feedback to students in order to help them practice newly acquired skills and to evaluate their progress in different stages of learning. In this paper we describe the main features of this homework system and the assessment activities used to evaluate this method; we report on the outcome of this research and the effectiveness of this new system on different groups of students.

## Research Methods

The student population is from a modern physics class in the calculus-based physics for Freshman Engineering Honors at the Ohio State University. Each week 30-35 problems were presented to students, and the level of difficulty for each problem was marked by the letter "A," "B," or "C". This rating was also consistent with the grade the students would expect in the course, if they

could solve all by themselves the problems in the corresponding level of difficulty.

Students were asked to explore the problems and chose ten problems to submit by the end of that week. The solutions to most of the problems were posted on the web page, several days *before* the due date for that homework. Students were encouraged to work on the problems by themselves or in a group and to use the web solutions whenever they needed help, or if they wanted to check their solutions.

In recitations, students practice problems on weekly handouts, which were designed to enhance students' conceptual understanding and problem-solving skills. In addition, students can also get extra help from the TA on the solutions for the homework problems.

**Investigation methods: Data collecting**

We employed multiple methods to access the effects of this system on student attitudes and learning. The methods included:

- 1) Interviews: seven individual student interviews focused on attitudes about the traditional homework system, and about their complaints and expectations concerning the new system.
- 2) Web survey: During the quarter students responded to three sets of survey questions part concerning their attitudes about the new homework system. These surveys occurred in the first, third, and eighth week.
- 3) Self reporting of homework statistics: Each week students were asked to report on the type and specific number of problems they chose to solve, as well as the benefit, if any, they gained from the homework.
- 4) Tests and exams.
- 5) Observations and records of students' homework: We have studied the students' homework submission each week. In addition, we tried to identify students who might be copying web solutions, and rated the quality of their homework from one to

five. This rating was based on following criteria:

- The number of problems they submitted each week.
- The difficulty level of the problems they chose to solve.
- How well in details they worked through solutions.
- If there was any pattern of copying.

We assigned different weights to each problem based on their difficulty, and added total points for problems each student submitted during the quarter. Students who worked in details on solutions and have gone steps further than the web solutions received extra points. On the other hand, students with incomplete and vague solutions assigned partial points. Our numbers for homework quality of each student are normalized result of above calculations. The implications of the rating is shown in Table 1.

*Table 1. Meanings of homework ratings.*

Rating	Implications
1	Submitted only a few problems, with large possibility of copying.
2	Vague and incomplete solutions more than 75%, most C problems, possible copying.
3	Incomplete solutions 50% of the time and usually B and C level problems, some copying.
4	At least 70% of the time worked in detail, and submitted the required number of problems.
5	Submitted more than required number of problems, over 80% of the time worked all in detail, and mostly A and B level problems.

These data were used to analyze the ways students use this homework system.

**Results**

**Student's ideas about the new HW system**

Based on survey data, over 75 percent of the students preferred this homework system compared to the traditional system. It was considered less stressful and more efficient

use of time, “Now I am not doing it to get it done by the instructor, but rather to really learn it”. Students were more relaxed, happier, and more motivated in doing their homework, “With new homework I have more motivation, I used to give up doing homework when I would get stuck in one problem”, “I like the new method I have references when I am struggling”.

Moreover, this method was seen as promoting students’ expert-like problem solving, “The new method allows students to see how hard problems are done and the systematic method in solving them... to apply the same methods to solve hard problems of their own”.

Inevitably, there are possible defects to this homework system; for example, some students can simply copy entire solutions. Although, we detected instances of this occurring, most students (>70%) used the solutions very responsibly, “We all know that we can copy the homework, but it doesn’t do us any good”. Appropriate considerations of these weaknesses will help inform our efforts towards ongoing improvement of this research.

In general, both students and instructors were pleased to see that useful information can be immediately available to students when needed and students recognized the value of using such information. Moreover, this homework system did provided students an environment of integrated learning cycle of practice and feedback.

**Students’ study habit and HW qualities**

We wanted to know which group of students benefited the most from this system. On this issue, we have inspected in detail one section (27 students) of a class (55 total). Through qualitative studies, we first categorize the students into four general groups, based on their confidence, motivation, and learning habits<sup>7</sup>:

A. Students with high motivation and high confidence who study with somewhat constant efforts through out the course.

- B. Students with average motivation and average confidence who spent some efforts during the course and more efforts before the exams.
- C. Students with low motivation who spent little time during the course. Much of their efforts were made right before the exam.
- D. Students with very low motivation and low confidence who either made little effort to learn, or made little progress through learning.

Figure 1 shows the relation between the individual students’ learning habit and the quality of their homework, which is used to infer their ways of using this homework system. The rating of the homework quality was discussed in Table 1.

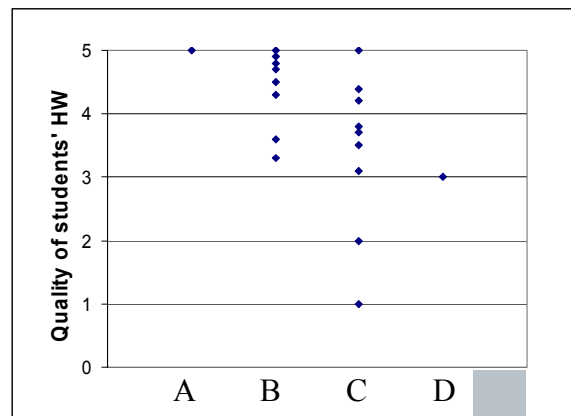


Figure 1. Scatter plot of the relations between individual students’ learning habit (Type A, B, C, D) and homework quality.

In this research our primary concerns was with groups B and C. As we can see, group B students often have good quality of homework, indicating that they are using this homework system in a more constructive manner as expected by the instructor. On the other hand, more students in group C show evidence of “abusing” this system – homework quality with a rating below 3.5 often indicates non-trivial copying behavior. The results show that students with higher motivation and a persistent way of learning would benefit most from this new system. From Figure 1, we see that about half of the students have a quality

rating of their homework above 4.0. This can be used as a rough estimation on the benefits of using this new system (as is now) with a general population. To prevent students from abusing this system, we are currently developing certain controls such as providing incomplete solutions. The goal is to develop a system to benefit the majority of the population.

### **Students' HW qualities and achievement**

Did students who submitted higher quality homework learn more? We found that, students who consistently did their homework with higher quality also achieved better scores on the final grade for the course. Notice the correlation between the students' final grades, (as a measurement of their learning), and their performance in the homework system (see figure 2). Most of the students who have used this homework system constructively achieved better final grades in this course.

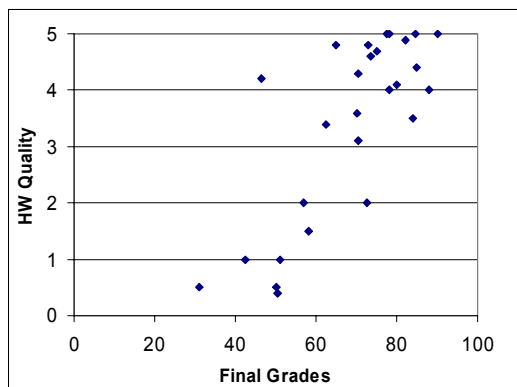


Figure 2. Scatter plot of the relations between individual students' final grades and homework quality.

Clearly, there are students with high quality homework who have low grades on their final and vice versa. This is because homework is not the only factor which affects students' academic achievements.

### **Summary and Implications**

In summary, most students preferred the new homework system compared to traditional system and considered this system a less stressful and more efficient way to practice their newly gained

knowledge independently. Through this system, they also recognize more explicitly their role in learning and become more motivated although certain students may still abuse the system. The immediate availability of expert-like problem solving approaches is another highly valued advantage. We have observed that students with higher motivation and a persistent way of learning would benefit most from this new system. This information can help instructors and researchers to apply or to further develop this system.

This study is in the early stage of an ongoing systematic investigation modifying the format of the homework system in order to enhance student learning. Several issues are considered in further research: research based questions, effective formats of solutions, combination of complete and partial solutions, connections with lecture and recitation, etc.

### **Acknowledgements**

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  - <sup>2</sup> Students' survey at the Ohio State University.
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