

## Immediate, Informative Feedback Using a New Homework System

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Students often complain about the traditional homework system's inefficiency and the lack of resources during problem solving sessions. 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 preliminary outcomes and 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 establish independent study habits. Second, it serves to extend or elaborate the subject discussed in 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. [1]

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>1</sup> In addition, students often 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." [3]

Under the traditional system, students have little feedback, if at all, on their problem solving practices while they are doing the homework. This often weakens the students' motivations to work on homework. Furthermore, even when students receive the correct solution, they have no time to learn from their mistakes since they must move on to the next homework assignment. As a result, students end up with many unsure ideas and

piles of incomplete solutions before the exam. In our discussion with students during 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 really understand the material. [2]

In education research, many existing studies emphasize problem-solving strategies rather than the structure of a homework system. [3, 4, 5] 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 toward providing informative feedback to students to help them practice newly acquired skills and to evaluate their progress at different stages of learning. In this paper we describe the main features of this homework system and the assessment 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 85, from a modern physics class in 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".

Students were asked to explore the problems and chose ten to submit by the end of that week.

The solutions to most of the problems were posted on the web page of the course, 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. Students could also get extra help from the TA on certain details of the solutions for the homework problems.

**Investigation methods: Data collection**

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 their complaints and expectations concerning the new system.
- 2) Web survey: During the quarter students responded to three sets of survey questions 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: In addition to regular midterm and final student had two short tests.
- 5) Observations and records of students' homework: We have studied the students' homework submission each week.

Based on the submitted homework, we tried to identify students who might be copying web solutions, by rating the quality of their homework in a scale of 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.

- The level of details of their solution.
- The possibility of copying: e.g., whether a student's answer looks exactly like the solution provided without any additional or intermediate stage information to show the student's independent work.

The implications of the rating are shown in Table 1, which are used to analyze the ways that students behave under this homework system.

Table 1. 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.

We used these ratings to analyze the ways students use this homework system.

**Results**

**Students' 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 a more efficient use of time, "*Now I am not doing it to get it done by due the date, but rather to really learn it.*"

Students reported that they 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 by students as a way for them to solve problems like an expert.

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*“The new method allows students to see how difficult problems are done and the systematic method in solving them... to apply the same methods to solve difficult problems of their own”.*

Inevitably, there are possible limitations to this homework system. For example, some students can simply copy the entire solutions. Although, we detected instances of this occurring, most students (>70%) used the solutions very responsively, *“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 method.

Both students and instructors were pleased to see that useful information can be made immediately available to students when needed, and students recognized the value of using such information. Further, this homework system provides an environment with an integrated learning cycle of practice and feedback.

**Students’ study habits and HW qualities**

We wanted to know which group of students benefited the most from this system. On this issue, we inspected in detail 19 students. Through qualitative studies, we first categorized the students into four general groups based on their confidence, motivation, and learning habits: [7]

- A. Students with high motivation and high confidence who study with persistent 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.

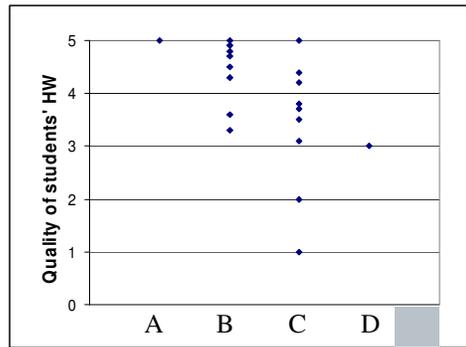


Figure 1. Scatter plot of the relations between individual students’ learning habit (Type A, B, C, D) and homework quality.

Since we only have limited number of students in group A and D, which are also less of a focus of research, students in the medium level groups (B and C) are more emphasized in this study. 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. 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 very rough estimate 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 relation between the students' final grades, (as a measurement of their learning achievement), 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.

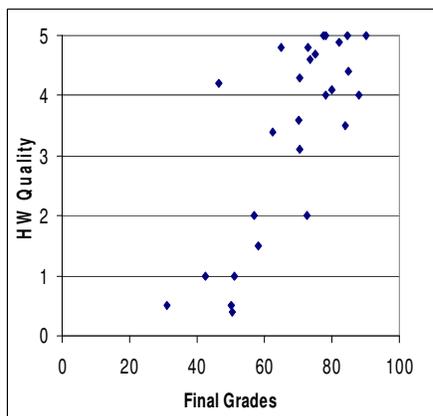


Figure 2. Scatter plot of the relations between individual students' final grades and homework quality.

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 that affects students' academic achievements.

### Summary and Implications

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. Through this system, students recognize more explicitly their role in learning although certain students may still abuse the system. The immediate availability of expert-like problem-solving approaches is another advantage. The information obtained from this research 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 for modifying the format of the homework system in order to enhance student learning. Several issues will be considered in further research such as developing research-based homework questions, identifying effective formats of solutions, using combination of complete and partial solutions, and connecting homework more closely with lectures and recitations.

### Acknowledgements

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