

Effects of Increased Freedom in Homework Assignments

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This poster is slightly different than the published abstract: It provides an overview of our new homework system and then focuses on the problem-choice component. Our companion poster discusses the solutions component.

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Overview

In Fall 2002, the OSU PER group had the opportunity to run several experiments in the first course of our department's calculus-based introductory physics sequence. Roughly 340 students were enrolled between two lectures taught by Dr. Lei Bao. The homework in this course consisted of both web-based interactive problems, and a new system for assigning written, or 'paper-based', problems from the textbook.

There are two major differences between our system and the traditional homework system, designed to provide students with the freedom to decide what is best for themselves:

- Solutions for many of the problems are provided before they are due.
- Students may choose which problems from a long list to turn in.

Homework Freedom: Choice of Problems

In a typical week, instructors selected 20 problems from the textbook to suggest for the students. Problems were labeled according to:

- Difficulty - Ratings from A (hard) to C (easy), roughly corresponding to letter grades. That is, a student who can reliably solve “A” problems can rely on getting an “A” in the course.
- Solution type - Solutions for problems in Group I were posted before their due date. Group II solutions were posted after the due date, although in some weeks, hints or outlines were provided.

Groups I and II were organized to have a similar cross-section of difficulties and topics. Additionally, Group II often contained variants on Group I problems.

Students were required to complete ten problems each week, at least five being from Group II. No restrictions were placed on difficulty.

Homework Freedom: 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.

Further detail about the solutions can be found on our companion poster.

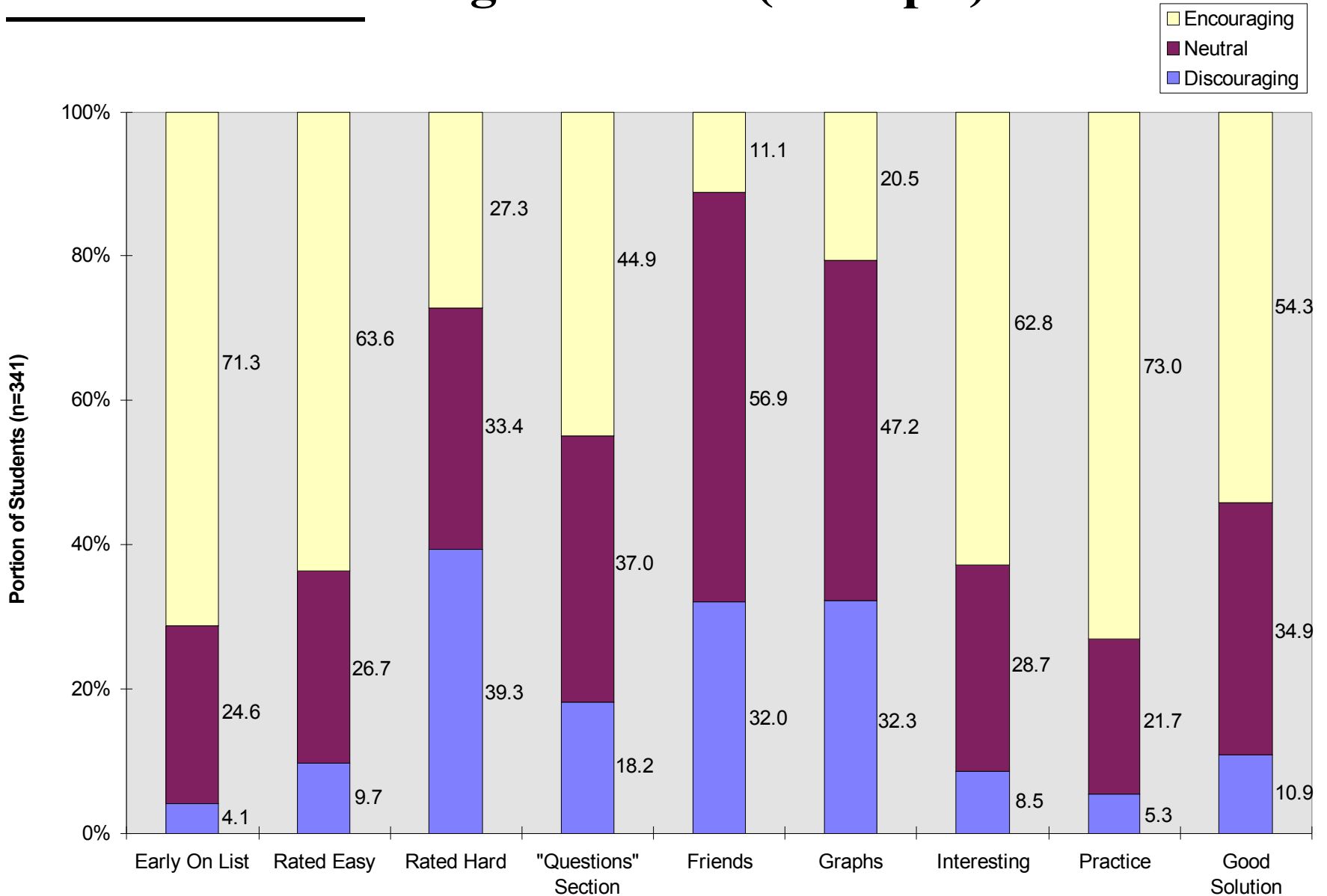
Students' Choices

In a survey near the end of the term, we polled students about their methods of choosing problems to submit. Students were asked if the following characteristics encouraged or discouraged them from trying a problem:

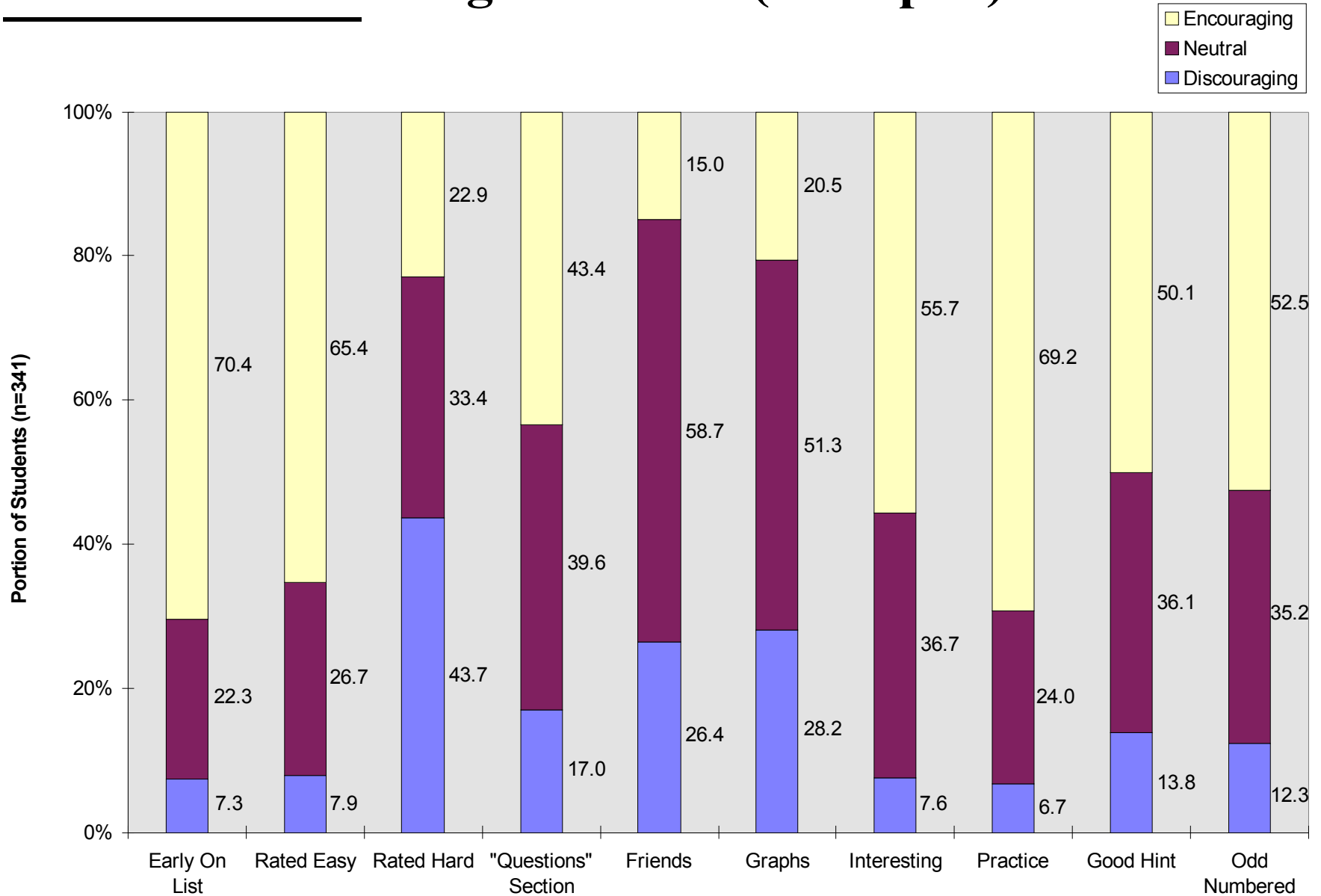
- It came early on the list. (i.e.. You do the first few listed.)
- It was rated as being easier.
- It was rated as being harder.
- It was a "question" instead of an "exercise" or "problem".
- My friends chose the problem already.
- The problem used or asked for a graph.
- It sounded interesting.
- I need to practice problems of its type.
- The posted solution of that problem was clear to me. [Group I]
- The posted hint for that problem was clear to me. [Group II]
- The problem's numerical answer is in the back of the book. [Group II]

Following are figures which compile this data.

Factors In Choosing Problems (Group I)



Factors In Choosing Problems (Group II)



Observations of Figures

Little effort is put into these decisions

- A common tactic is to simply do the first five from each group, sometimes skipping over an “A” problem to do the first five B/C’s.
- It is probably best not to list problems for a group in the order in which they appear in the book, lest students end up working problems from only the first few sections of each chapter.

Students are more choosy in Group II

- They are less likely to pick GII problems on the basis of interest or need for practice.
- “Risky” choices are saved for GI, where full solutions are available, while safer choices are preferred for Group II.

Strange features are present

- Roughly 8% of students claim that if a problem “sounded interesting” this discouraged them from trying it.
- Fairly large groups reported that they avoid doing problems their friends have already chosen.
- Few likely explanations for such results are apparent. In the future, interviews should shed light on such peculiarities.

Students' Choices: Other Details

Students were asked: “If you use any other criteria to choose problems (coin-flipping, similarity to examples [...], etc.), please describe them.”

Possibly in large part due to prompting in the question itself, the most common write-in answer (roughly a tenth of the class) was a similarity to other problems the student had seen. A summary of volunteered criteria:

- 32 students: problem is similar to examples
- 11 students: problem is short / has few lettered sub-questions
- 10 students: try to choose a variety in difficulty / topic
- 8 students: do most or all of the problems anyway
- 2 students: problem “seems important”
- 2 students: choose problems without solutions, to resist laziness

Students were also asked how many of the 20 weekly problems they normally read while choosing. Roughly 25% report that they read only as many as they need to turn in: 10. The most popular numbers are from 11-15, with over half the class in that range.

Relationship Between Choices and Grade?

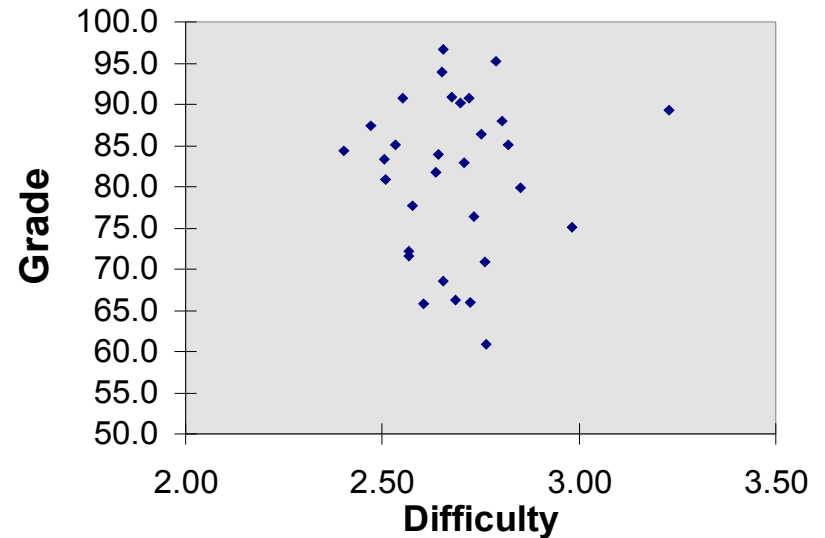
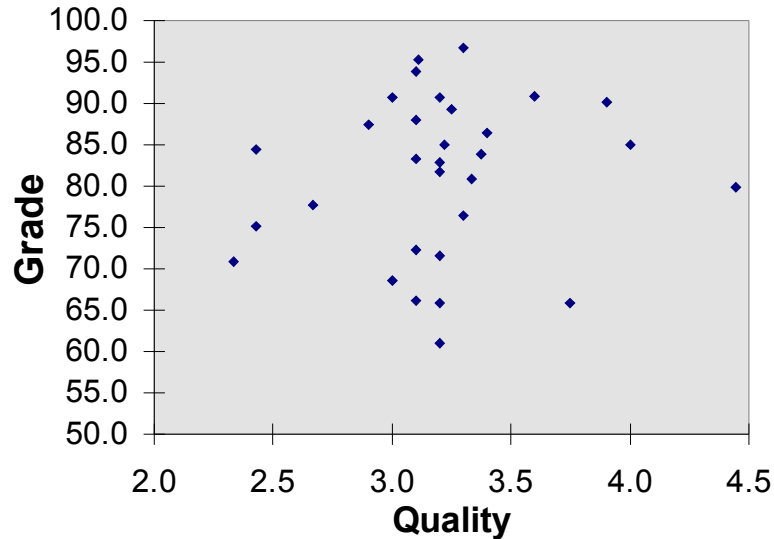
One recitation section (27 students) has been examined in greater detail. In particular, we have looked for relationships between students' final grades and their behavior under this new homework system.

Each assignment turned in by students in this section was given a “quality” score, independent of the grade given. This was assessed on a five point scale, based loosely on such attributes as:

- level of physical reasoning
- detail and consistency of mathematics
- degree of individualization, as opposed to copying of the solutions

Additionally, a list of problems submitted through the term by each student was compiled. A-B-C difficulty ratings were transformed into a number scale for analysis -- 4 for A, 3 for B, 2 for C, in keeping with the “letter grade” idea. (This is more or less arbitrary; different numbers would merely scale/offset the result.)

Choices and Grades?



Little to no correlation is apparent in these data. Both show a clustering of most students -- independent of grade -- around a mediocre level of achievement. The preceding study*, on a 3rd-quarter honors class, showed a weak relationship between homework quality and final grades. This difference may be an effect of the different student populations (honors vs. “normal”), and we hope to gather additional data in the coming months.

* Sadaghiani & Bao, “Effect of a New Homework System on Student Motivation and Learning₁ Behavior”, 125th AAPT National Meeting, (2002)

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.

It appears that the availability of Group I solutions encourages students to examine more challenging problems than they would otherwise choose, but that there is no relationship between the choices made and the students’ level of achievement.

Implementing this homework system can reduce the workload of the teaching staff, especially if homework was being graded in detail. Most of our students felt that having their TA write comments on returned work was not important because of the completeness of provided solutions.

Thus, this system can make things easier for the instructors and the students, while simultaneously “tricking” students into carefully studying several problem solutions each week.

Future Research

In the near future, we plan to expand our analysis of student grade to encompass the full class of ~ 340 . Additionally, the system was used in the Fall Quarter in our honors calculus-based intro class, providing data from a different population.

Also, we hope to implement this system in a more traditional physics course in order to look for an isolated impact on diagnostic test scores. More rigorous schema for assigning difficulty and quality ratings will be developed, and interviews with students will fill in gaps in the survey data.

Aspects of this homework system are currently being adopted in more courses at OSU in both the physics and engineering departments. The solutions being provided in these courses are less thorough than in the course reported on here. The degree to which student reactions and habits are affected by this change also begs investigation.