

Comparing Grades and Behavior Under a Flexible Homework System

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In fall 2002, our group modified the homework system in the first course of our calculus-based introductory sequence. The two primary features of this system are that students are allowed to pick which problems to submit from a large pool of choices, and that full solutions to some problems are posted before the due date.

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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.

Data for this poster come from web-based surveys which the students were required to fill out weekly.

Homework Flexibility: 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, GII often contained variants on GI problems.

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

Homework was graded for completeness, not correctness.

Homework Flexibility: 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.

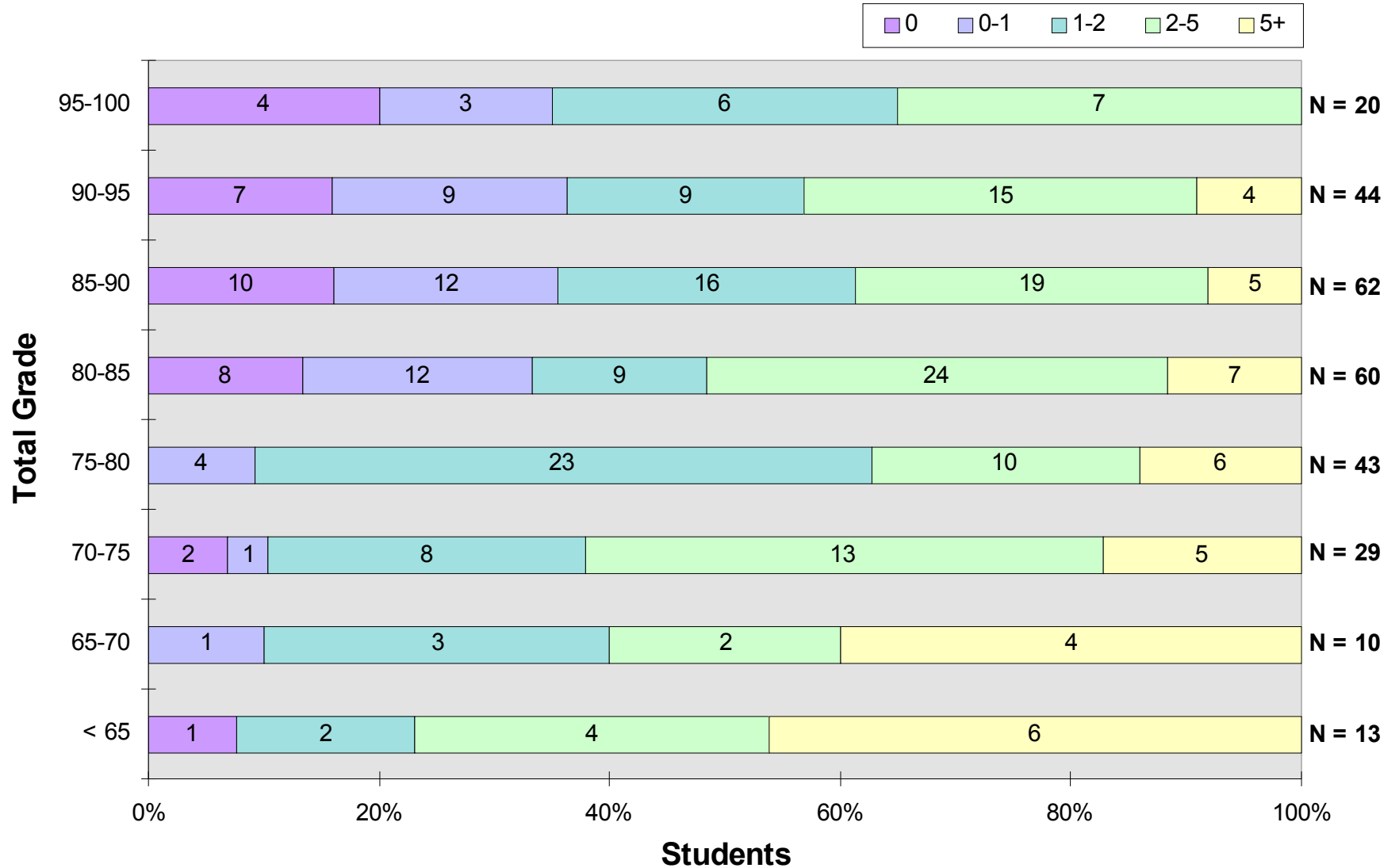
Relationships With Grades

From the outset, two general results seem plausible, and it is not clear which effect will dominate:

- Highly motivated, capable students will take advantage of the flexibility to maximize their gains, while low-motivation students will ignore their options and continue to flounder.
- Highly motivated, capable students will take advantage of the flexibility to minimize their time investment, while low-level students will make larger investments in their attempt to succeed.

In most analyses performed, there appears to be little correlation between a student's final grade in the course and their behaviors or reactions under the Flexible Homework system. However it appears that the first model is closer to the truth: the students with higher grades put less time into the course (at least - as far as homework goes).

Weekly Hours Spent Reading Solutions (GI and GII)



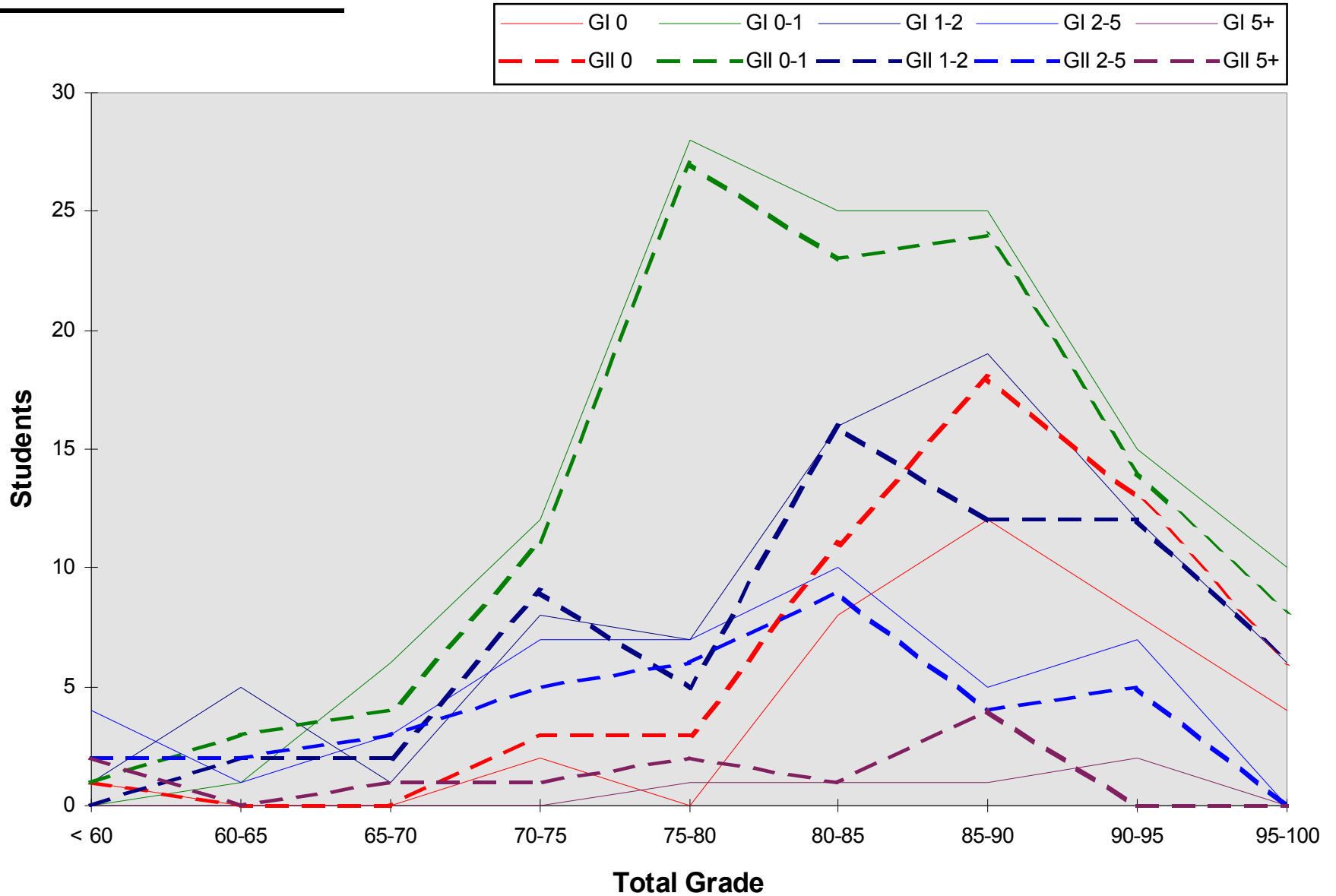
Comments on ‘Hours Spent’ Data

As we move from students with higher to lower grades, the time spent each week reading/studying the posted solutions rises. Presumably, this is because students who “get it” feel no need to spend additional study time on problems that they are not turning in, or have already turned in. Individual analysis of the time spent reading GI and GII solutions corroborates this:

- Distribution of times spent reading GI solutions is roughly the same at all grade levels. GI solutions are used by most students while they are completing their assignment.
- Distribution of times spent reading GII solutions skews towards more time with lower grades. That is, students with lower scores are spending more time reading solutions for already-submitted problems and for “extras”.

Grade distributions can be constructed for different reported reading-times. Although there is a hint of qualitative differences between, say, the ‘0-1 hour’ and ‘1-2 hours’ distributions, these differences do not seem to be statistically significant. (See next page.)

Grade Distributions by Hours Spent With Solutions



Solution-Reading In Other Courses?

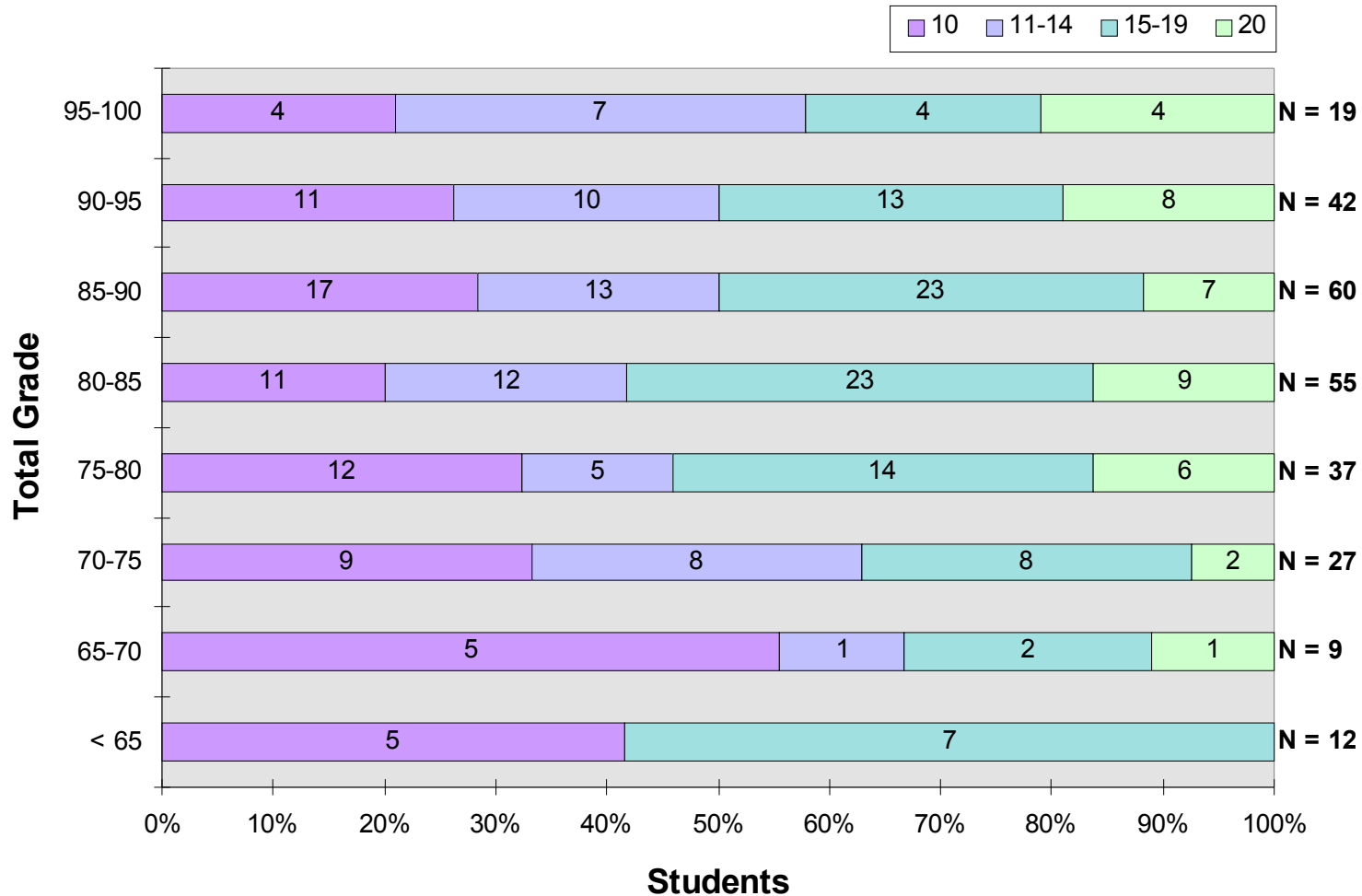
We have begun investigating the solution-reading habits of students in physics courses with traditional homework systems. In spring 2003, at the end of the first course in our algebra-based sequence, we asked students about their use of the posted solutions in that class.

The distribution of times was *much* lower than in our calculus-based class with the FlexHW system. However, there are several complicating factors which make this result only anecdotal at this time, most notably that the courses serve different student populations, and that homework in the algebra course is covered in recitation sections but not collected.

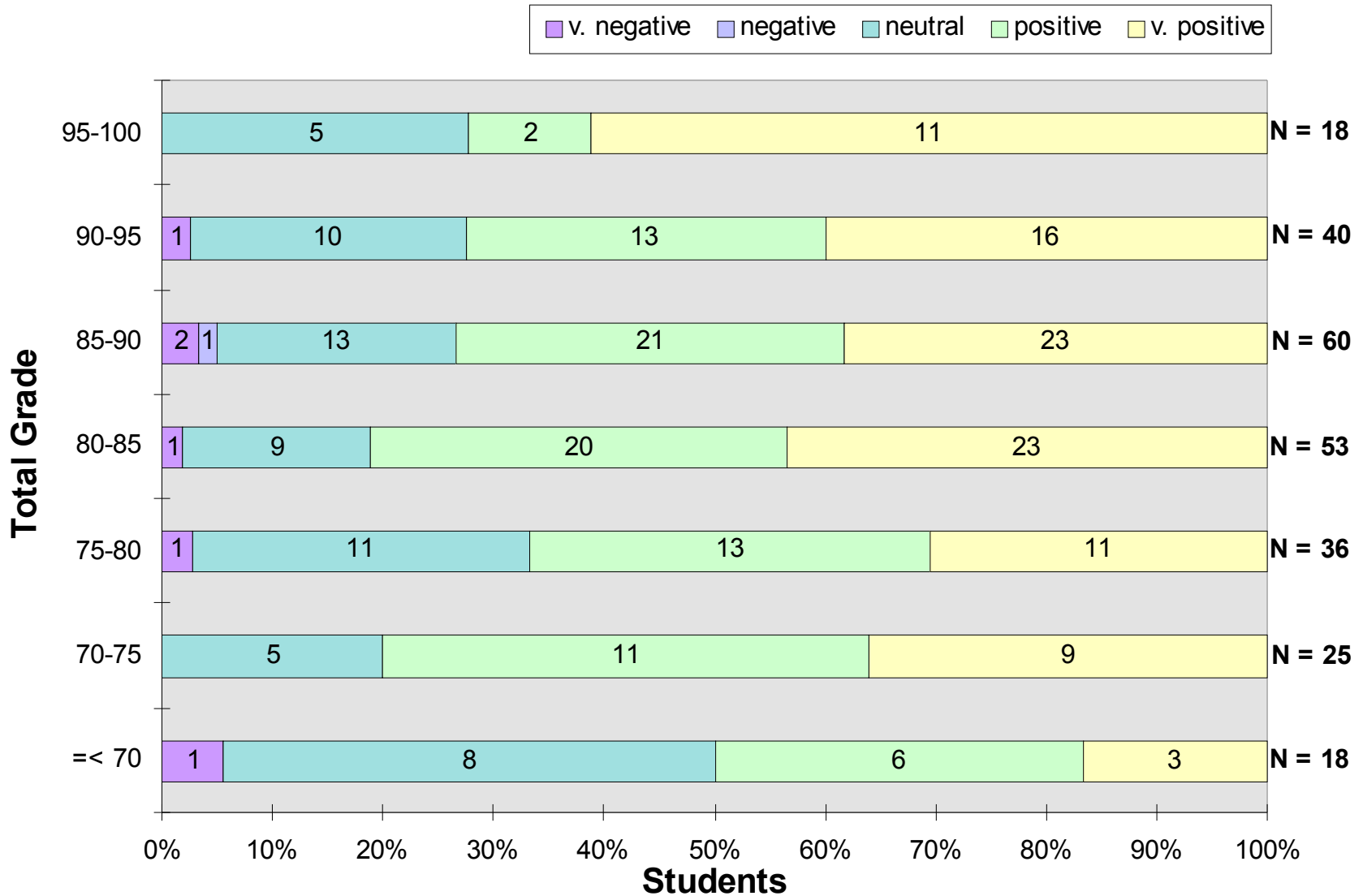
<i>Weekly Hours</i>	<i>% of students in</i>	
	<i>Calc w/ Flex</i>	<i>Algebra</i>
0	11.2	24.3
0-1	16.1	48.5
1-2	25.6	17.3
2-5	33.6	8.4
5+	13.5	1.5

Number of Problems Read

Each week 20 problems were assigned, and students chose 10 to submit. We asked students how many of the assigned problems they read. No clear pattern emerges from the responses, although it appears that low-scoring students may generally sample fewer of them.

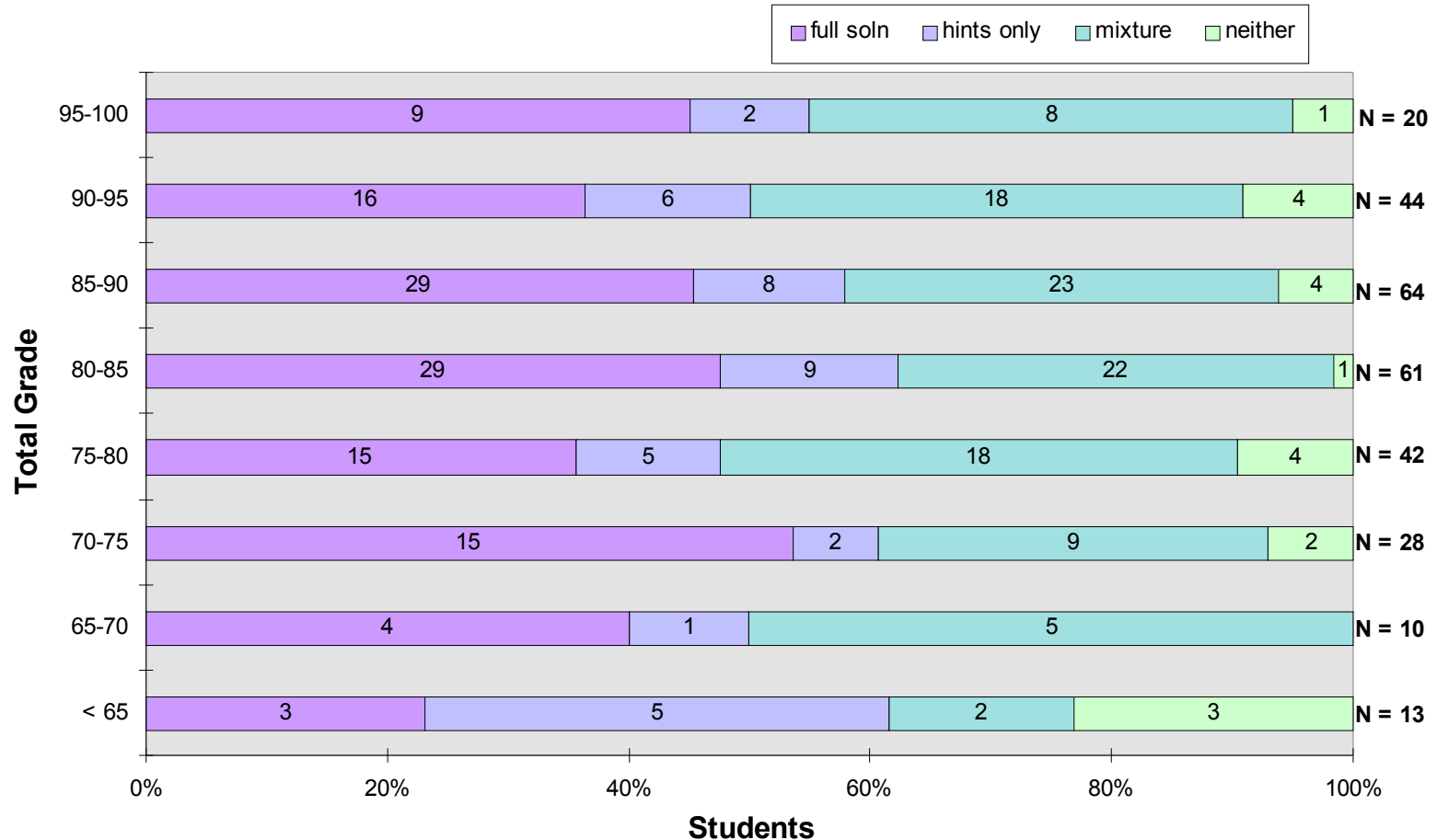


Self-Reported Impact of FlexHW on Learning



Preferred Solution Formats

We asked students what sort of early ‘help’ was best for their learning: receiving full solutions to the problems, receiving hints or outlines only, receiving a mixture as in our class, or no help at all.



Comments on Self-Reported Data

The strong majority of students at all grade levels claim that receiving teacher-provided hints or solutions before their homework is due is beneficial to their learning process. Furthermore, most of them prefer complete solutions to partial solutions. Our question specifically asked students to disregard issues of laziness/easiness and answer solely on what is best for their learning process, but it is still possible that laziness is creeping in here. Or, perhaps they are legitimately better served by homework when they have a model solution to refer to.

Also of note is that students with higher grades gave more strongly favorable reviews of the Flexible Homework system. It is unlikely that FlexHW had a large enough impact to essentially self-select the students it “fits” with and boost them into the highest grade positions. What specific features of FlexHW, then, appeal to those students “at the top”?

Summary

As reported at the Winter meeting, student response to the Flexible Homework 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.

Based on our first -- and so far, only -- large-enrollment case study, it appears that the FlexHW system is especially popular among high-scoring students, but is liked almost universally and does not seem to prompt significantly different behavior between different groups of students.

Also, it appears as if the system has been successful in “tricking” students into carefully reading several problem solutions each week.

Future Research

The Flexible Homework system is expanding into more and more courses at Ohio State University. As it is used and more data becomes available, we will be able to answer the primary research question:

- Does the FlexHW system improve students' learning of physics?

Also, is the FlexHW system better suited to certain types of students than others (based on level of motivation, previous physics courses, mathematical ability, etc.)?

The problem-choice aspect of this system also provides a unique opportunity to determine what students are looking for in a homework problem. By continuing to analyze which problems are chosen and which are passed up, we may be able to learn how to write problems that students will “like”.