

Student Textbook Use in Introductory Physics

Karen Cummings, Southern Connecticut State University, New Haven, CT

Timothy French, Yale University, New Haven, CT

Patrick J Cooney, Millersville University, Millersville, PA

Abstract

This article reports on a two part study of extent to which students use a textbook in calculus-based introductory physics courses for scientists and engineers. The first aspect of the study is an investigation of how the placement of worked examples influences student use of the textbook. The second aspect studied is how course assignments can be used to encourage students to read the textbook.

Motivation

Two of the authors of this paper, Cummings and Cooney, are involved in a project with E.F. Redish and P.W. Laws to develop a research-informed introductory physics textbook for use in calculus-based courses. This textbook, called *Understanding Physics* [1] is based on *Fundamentals of Physics* by Halliday, Resnick and Walker[2]. Published by Willey and Sons publishers, the book will be formally released for the fall of 2004. However, a preliminary version of the book is already in use at several test sites including Rensselaer Polytechnic Institute and Millersville University.

The textbook project noted above is central to this study. This is the textbook that the students in the study used. It also motivated the research questions: To what extent do students read their textbook? Are there course specific (contextual) issues that impact the answer to this question? Does the placement of worked examples impact the answer? Do well informed students have a preference in terms of where the worked examples are located?

Background

In order to investigate these questions, we conducted a series of surveys at Rensselaer Polytechnic Institute during the spring of 2002. In addition, an end-of-the-semester survey was given at Millersville University. *Understanding Physics* was the text used in both courses and both were calculus-based introductory physics courses for scientists and engineers. The course at Rensselaer is taught in a "Studio" environment. The course at Millersville has a more standard format with separate lecture and laboratory.

Data for this study was collected at Millersville University in the form of a single, end-of-the semester survey regarding student textbook use. Questions on the survey were identical to questions on surveys given at Rensselaer which are discussed below.

Data was collected at Rensselaer from a series of nine student surveys. On the first day of the semester, one of the authors (Cummings) asked for volunteers to participate in a study of student textbook use. Those students that agreed to participate would be provided with a free Xerox copy of the textbook. This copy would be identical to the textbook for sale in the bookstore, except that the placement of the worked examples changed half way through the semester. The students were informed that volunteers would be expected to respond to weekly surveys and that the results would then be used to determine whether the placement of the worked examples had an impact on student use of the textbook.

The pool of volunteers was asked to answer questions on an initial survey which probed the students' general attitudes toward and behaviors in regard to reading. Based on the results of this initial survey, gender, pre-instruction scores on the Force and Motion Conceptual Exam[3], and the professor teaching their section of the course, the group of volunteers was split into two cohorts with matching group characteristics. The group characteristics were also a good match to the class as a whole (volunteers and non-volunteers).

Students in one cohort, half of the total volunteer group, were given a Xerox copy of the text in which the first eight chapters to be covered in the course had the worked examples located at end of the chapter and the last eight chapter to be covered had worked examples interspersed at appropriate points throughout the chapter. We will call this cohort "Group A". The other cohort, called "Group B" was given a Xerox copy in which the first eight chapters had sample problems interspersed through the chapters and the last eight chapters had sample problems at the end of the chapters. This experimental design is summarized in Table 1.

Table 1: A summary of the experimental design for the Rensselaer Study

Placement of Work Examples	Group A	Group B
For Chapters 1-8	End of Chapter	Dispersed
For Chapter 8-16	Dispersed	End of Chapter

The experimental design discussed above has several advantages in regard to the questions at hand. Giving both groups exposure to the two alternative worked example placements makes them better informed subjects when we ask if they prefer one placement over the other. In addition, we want to know if the placement of the worked examples impacts the amount of reading students do. Having the groups switch at mid-semester helps to separate effects associated with the material being covered or the time of year. For example, it may be that students read more toward the start of the semester. Such issues are confounding factors in this study. Having the groups switch at mid-semester helps to account for such uncontrolled variables.

87 Rensselaer students completed the initial survey. This group was then encouraged to complete weekly surveys on-line. These surveys provided short-term, longitudinal data on the students' use of the textbook. They contained seven to nine questions. Student responses to a subset of the questions given on the weekly surveys will be discussed in this paper.

A total of nine surveys were given including the initial survey. There were four weekly surveys given during the first third of the semester and four weekly surveys given during the last third of the semester. No data was collected during the middle of the semester when we felt that the impact of spring break and the switch in the placement of worked examples would be too immediate and disproportionate. Only students who completed four or more surveys are included in the discussions which follow. There are 67 students in this group.

Results and Implications

Student Preference in Regard to the Placement of Worked Examples

The first question we attempt to answer here is: Do well informed students have a preference in the placement of the worked examples? The "well-informed" aspect is important to us as reform oriented textbook authors. Student preferences often relate to their prior experiences. The question we have is not "what is the status quo?" Rather, we wish to know if the status quo is rooted in a genuine student preference.

To probe this issue, we looked at students' responses to the following question on the weekly survey: *To what extent do you agree with the following statement regarding the location of the worked examples in last few week's reading assignments: I liked the location of the worked examples in the chapters. Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree, I haven't used the textbook enough to say*

Individual student responses to this question were quite stable from week to week. Hence, we present the results from two representative surveys done at Rensselaer on February 22 and March 29 in Figures 1 and 2. "Strongly agree" and "agree" answers were grouped together for ease of presentation, as are "strong disagree" and "disagree".

On February 22, Group A was using a text with worked examples at the end of the chapter and Group B was using the same text with sample problems interspersed. Neither group had yet had exposure to the other format. By March 29, the students had switched formats and had two weeks to adjust to the change. The text in use by Group A now had sample problems interspersed and Group B's were located at the end of the chapter. Figures 1 and 2 indicate that before and after the switch, students had a significant preference for the worked examples dispersed throughout the chapter.

Figure 1: Student response to whether they “liked” the placement of worked examples, measured toward the beginning of the semester.

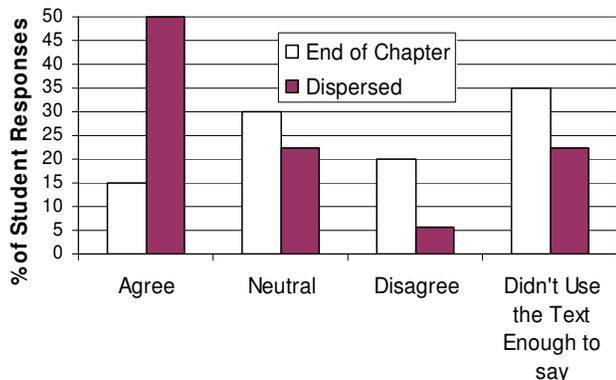
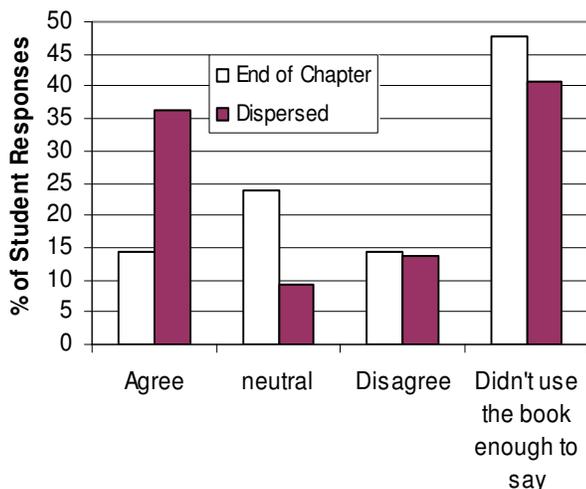


Figure 2: Student response to whether they “like” the placement of worked examples, measured after mid semester and an opportunity to have tried both alternatives.



Results from the end of the semester survey given at Millersville are shown in Figure 3. These students used the commercially available (but preliminary) version of *Understanding Physics*. In this text, all chapters are arranged with the worked examples placed together at the end of the chapter.

Figure 4 shows the Millersville data broken down according to students’ self-reported level of reading. Students who reported doing at least some reading are grouped together as “readers”. Students who reported

that they did not read the text at all (although they may have used it to look up problems or equations) were grouped together as “non-readers”. These graphs indicated that, like Rensselaer students, the Millersville students also preferred the interspersed model for worked example placement. This preference was held by “readers” and “non-readers” alike.

Figure 3: Millersville student response to whether they “liked” the placement of all worked examples at the end of the chapter.

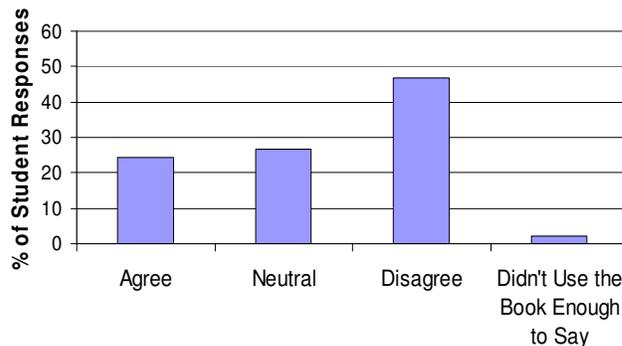
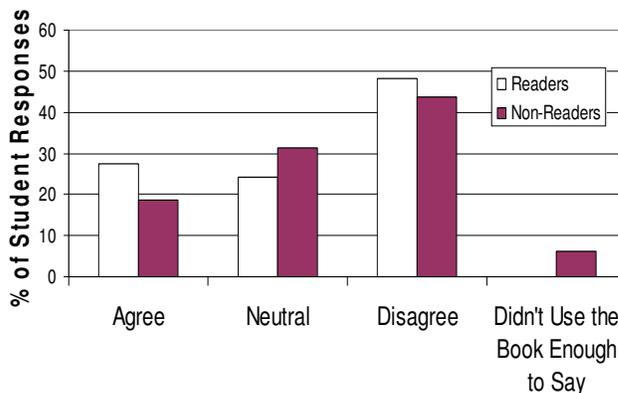


Figure 4: Millersville student responses broken down by self-reported level of reading.



Impact of Worked Example Placement on Reading Levels

Another question of interest is whether the location of the worked examples impacts the level of student reading. As shown in Figures 5 and 6, the percentage of readers in Group A and the percentage of readers in Group B were not significantly impacted by the mid-semester change in the location of worked examples. “Before Mid-Semester” Group A was using

the “End of Chapter” format and “After Mid-Semester” Group A was using the “Dispersed” format, yet the percentage of readers remains steady.

Figure 5: Self-reported levels of reading before the mid-semester switch in the placement of worked examples. Group A is currently “End of Chapter” and Group B is “Dispersed”.

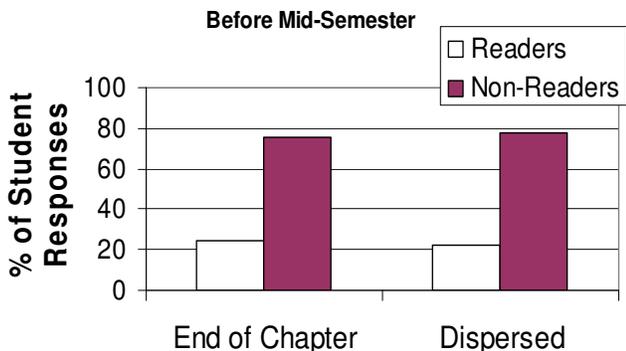
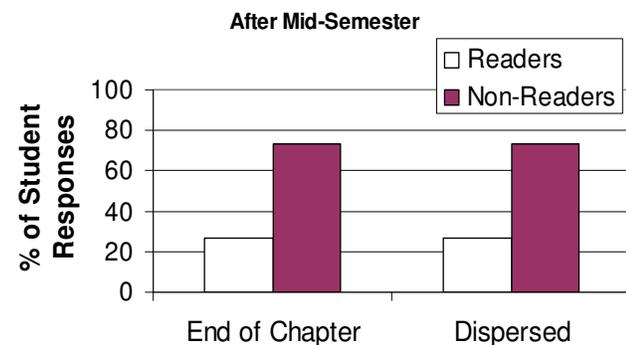


Figure 6: Self-reported levels of reading after the mid-semester switch. Group A is currently “Dispersed” and Group B is “End of Chapter”.



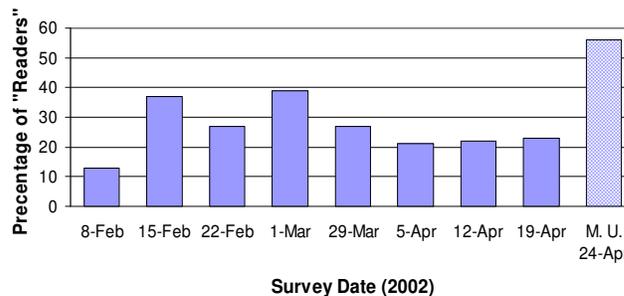
Unlike students’ responses to the question regarding their preference of worked example location, an individual student’s response to questions regarding their level of reading varied significantly from week to week. Hence, the data presented in Figures 5 and 6 represents the summation of all data before mid semester (in figure 5) and the summation of all data after mid semester (in figure 6).

What percentage of our students read the textbook? Are there things that we can do to improve these numbers?

The data presented in Figure 7 combines the two cohorts of Rensselaer students into one larger group. Percentages of Rensselaer students who are self-reported readers on the dates of the eight surveys are shown. Also shown is the percentage of Millersville students who reported being readers on the end of the semester survey.

Figure 7 highlights two important conclusions of this study. First, levels of student reading at Rensselaer are remarkably low on a consistent basis. Second, this is not necessary true at Millersville University. Hence, this data hints that there are contextual issues (i.e. classroom specific issues) that can significantly impact levels of student reading. At Millersville, students were required to submit answers to reading exercises in a “just in time” teaching process. Other adjustments to course structure may work as well or better.

Figure 7: Self-reported levels of reading over time in Rensselaer students as a single group. Levels of reading at Millersville is also shown.



The most significant message is that most of our students have not figured out for themselves that reading is a potentially useful intellectual endeavor. On a more optimistic note, there seem to be things that we can do as teachers that encourage our students to read. Doing so may help them develop habits that will be important in future courses and as self-directed learners later in life.

References:

- ¹ ISBN # 0-471-39383-5
- ² ISBN # 0-471-10559-7
- ³ R. Thornton and D. Sokoloff, "Assessing student learning of Newton's Laws: The Force and Motion Conceptual Evaluation and the Evaluation of Active Learning Laboratory and Lecture Curricula," Am. J. Phys. **66** (4), 338-352 (1998).