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Textbook Use in the Sciences and Its Relation to Course Performance

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There are limited studies with conflicting results examining textbook use and student performance at the university level. To learn more, we surveyed instructors and over one thousand students in 12 undergraduate introductory science courses. The majority (77%) of the students reported reading the textbook either “often” (>75% of the assigned reading) or “sometimes” (25%–75% of the assigned reading). Those who read “often” had better final marks than those who read “sometimes,” but surprisingly, those who reported “rarely” reading the textbook did as well as those who read “often.” Perceptions of the usefulness of the textbook were generally more favorable in courses in which some marks were based solely on the readings. We conclude that there appears to be different types of learners: some may need to read the textbook “often” to do well, while others do not.

Keywords: assessment, grades, reading, teaching methods, textbook

INTRODUCTION

A textbook or course reading pack is a requirement of most undergraduate introductory science courses. As instructors in these types of courses, we expect and encourage students to complete assigned readings, and guides for student success promote textbook reading as a way for students to improve their academic performance. In addition, many of the study strategies suggested by university academic success centers relate to textbook reading (*e.g.*, University of Guelph 2013).

In spite of the general assumption that textbook reading enhances student learning, student-reported reading compliance in both introductory and advanced courses is low, ranging from about 20% to 70% (Burchfield and Sappington 2000; Cummings, French, and Cooney 2002; Sikorski et al. 2002; Marchant 2002; Clump, Bauer, and Bradley 2004; Podolefsky and Finkelstein 2006; Starcher and Proffitt 2011; Berry et al. 2011; Hoelt 2012). Perhaps even more surprising, there are conflicting results about whether textbook reading in university-level courses is correlated with improvements in student grades in the few instances where

it has been studied. Podolefsky and Finkelstein (2006), for example, found that although 97% of physics students in four introductory courses bought the required text, only 37% reported that they regularly read it. Furthermore, there was no correlation between reading frequency and grades in three of the four courses in the study and only a modest correlation in the other course examined. On the other hand, Sappington and colleagues (2002) found that performance of upper-year psychology students on an initial surprise reading quiz, which largely measured reading compliance rather than comprehension, predicted later exam scores. Those students who passed the quiz averaged 84% on the exam, while those who failed the quiz averaged 68% on the exam. In a study focused mainly on textbook aids, Landrum, Gurung, and Spann (2012) reported a significant positive correlation between “percentage of reading completed” and higher quiz/final grades in a general psychology course.

The conflicting results described above raise the question of the role of the textbook for students pursuing tertiary education. Indeed, if there is truly little or no correlation between textbook use and grades, what’s the point in even assigning one? Alternatively, if instructors believe that textbook reading promotes a deeper understanding of the course material and life-long learning skills, are there strategies that instructors should implement in their courses to promote textbook reading?

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Given the ubiquitous use of textbooks, their expense and the possibility that textbook reading might not improve student performance in some instances, we sought to expand and build on the studies described above that were limited to courses in physics and psychology. Our objective was to examine both student and instructor use of textbooks in science courses and their relationship with student course performance. Specifically, we surveyed students in several large undergraduate introductory science courses across various disciplines about textbook reading compliance and habits, perceptions of textbook usefulness and the resources they used to study for the course. We also surveyed the course instructors about their use of a course textbook including approaches taken, if any, to promote reading compliance. We then determined whether there was a relationship between the student and instructor responses and student performance in the course as measured by final marks.

METHODS

The study participants were students enrolled in 11 undergraduate introductory science courses in a large urban center university and in one science course at a small urban center university. All of the courses were at the introductory level, covering a broad range of topics within a specific discipline (see table 1). The study included biology, psychology, genetics, physics, and physiology courses with a range of assessment components such as term tests, final exams, quizzes and laboratory assignments. Invitations to complete an online survey consisting of ten multiple-choice questions were made about two-thirds of the way through the course via announcements in class and on the course website (see table 2 for the survey questions). Questions 3 and 4 were consistent with an earlier study (Podolefsky and Finkelstein 2006) to allow for a direct comparison with previously published results. Other questions concerning the usefulness of the textbook, textbook cost and how students actually learned the course material were novel, and therefore, increased the scope from the previous studies.

Participation was entirely voluntary and no marks were awarded for completing the survey, except in the physics course where students received a bonus mark of 1%. Once the students were directed to the survey site, they completed a consent form before answering the survey questions. The final course grades were supplied by the course instructors. Individual survey responses were matched to individual student grades by the researchers, thus the course instructors never knew the identity of the students who participated in the study. Course instructors also completed a questionnaire about textbook use in their course via e-mail or telephone (see table 3 for the instructor questionnaire). The instructor responses were used primarily for descriptive purposes and to group the courses into two categories

TABLE 1
Description of Courses Participating in the Study Including the Number of Student Responses

Subject	Year	Test/exam questions based solely on textbook reading?	Number of student responses	Number of course participants
Biology (3 courses)				
Course 1	1	yes	144	1627
Course 2	2	yes	44	1239
Course 3	2	yes	25	1356
Psychology (5 courses)				
Course 1	2	yes	52	56
Course 2	2	yes	9	160
Course 3	2	yes	10	172
Course 4	2	yes	19	170
Course 5	2	yes	11	118
Genetics	2	no	125	1069
Physics	1	no	382	895
Physiology	2	no	58	231
Physiology	3	no	144	712
			Total=1023	

(see Results). The study was approved by the Research Ethics Board at our institution.

The data were analyzed using MegaStat[®] for Microsoft[®] Excel[®]. Chi-squared (χ^2) (1) tests were used to test for differences in reading behaviours between students grouped by whether the courses they took required textbook readings or not. Analyses of variance (ANOVAs) were computed to test for the effects of reading behavior on course grades. A priori linear contrasts, which test each level of a particular factor against a reference category, and Tukey's-B post hoc analyses were used to examine group and experience differences when omnibus tests were significant (*e. g.*, how much of the assigned reading was completed vs. course grades). ANOVAs were also calculated to test for significant interactions amongst variables. Where such interactions occurred, independent sample t-tests were calculated to determine which of the differences in the means of the repeated contrasts were statistically significant.

RESULTS

Instructor Responses

All of the instructors reported that they had adopted a required textbook for their course. Lecture notes were also posted for all courses, and in the majority of cases the instructors stated that the notes could substitute for the textbook readings. In terms of incentives to promote reading, instructors in eight of the twelve courses participating in the study indicated that some of the marks in the course were based solely on the material presented in the readings/textbook (table 1). In addition, the first-year biology course,

TABLE 2
Student Survey Questions and Response Choices

1. Do you have access to the required textbook for this class?
Yes
No
Not Applicable
2. The cost of the textbook was reasonable.
Agree
Neutral
Disagree
Not Applicable
3. I read the assigned textbook chapters / sections / pages
Often (>75%)
Sometimes (25–75%)
Rarely (<25%)
Not Applicable
4. I usually read the assigned textbook chapters / sections / pages
Before class
Both before and after class
After class
Only to study before a test or exam
Never
Not Applicable
5. The textbook is useful for understanding the material covered in class.
Agree
Neutral
Disagree
Not Applicable
6. The textbook is useful for studying for tests and exams.
Agree
Neutral
Disagree
Not Applicable
7. The textbook is useful for solving homework problems or assignments.
Agree
Neutral
Disagree
Not Applicable
8. The textbook is useful for learning just out of personal interest.
Agree
Neutral
Disagree
Not Applicable
9. When reading the assigned chapter/section/pages, I only look at material directly relevant to my assigned work (such as case studies, figures, examples, sample problems, etc.)
Agree
Neutral
Disagree
Not Applicable
10. What is the main way that you learn the material of the course?
Textbook
Assignments
Classes
Labs/Practicals/Tutorials
Discussion with other students
Other sources such as the web

the physics course and one of the psychology courses incorporated reading quizzes.

The observation that most, but not all, of the courses had test and exam questions based solely on the textbook raised the question about whether this approach motivates

TABLE 3
Instructor Survey Questions

We are interested in examining the role the textbook for students, how they are used, and if there is a correlation between textbook use and achievement.

1. How many students in the course?
2. Do you use a textbook or a defined readings package?
If yes,
a) What are the characteristics of the text (eg. approx # of pages, fact based, literature based etc)
b) Is the text required reading? If so, what % of the total required readings for the course?
c) Are there lecture notes posted for the course? If so, what % of required reading?
d) Are your posted lecture notes a substitute for the readings? Can the class get by without the required readings, relying just on your lecture notes?
e) Do you have a mechanism for getting the students to read? For example, class quizzes, bellringers etc?
f) Are your tests based on the readings? What %?

students to complete the textbook readings and/or alters their perceptions of textbook usefulness, and whether this is related to course performance. Therefore, in some of our analyses, we divided the courses into two groups: required-text courses and non-required-text courses. In the required-text courses, 10% to 75% of the questions on tests and exams were based solely on textbook readings. As well, in the first- and second-year biology courses, 20% of assignments were based on reading the textbook. The other four courses in the study are called non-required text courses, because even though textbooks were assigned in these courses, there was only a very small proportion or no marks based solely on the textbook readings (table 1). In addition to the analysis of these two groups, we also separately analyzed the courses with reading quizzes (see below).

Overview of Student Responses

A total of 1023 students participated in the survey with course participation rates ranging from approximately 3% to 90%. The average final grade of all of the students who participated in the survey was 75.7%, which was significantly higher than the average final grade (72.1%) of all of the students in the surveyed courses ($p < .0001$). Ninety-six percent of all students reported having access to the required textbook/readings in their courses. Fifty percent disagreed with the statement “The cost of the textbook was reasonable”; only 11% agreed. There was no significant difference in the reported percentage of assigned reading completed between students who thought the textbook was reasonably priced, and those who did not. In addition, the average grade for the students who reported the textbook was reasonably priced was not significantly different from those who did not (77.1% vs. 75.3%, respectively).

The most common method that students selected for their primary means of learning the course material was

“classes” (46%), with the “textbook” being the second most common choice (36%) and well above “assignments” (8%) (see table 4). Other choices, such as “labs/practicals/tutorials,” “discussion with students,” and “other sources such as the web” were selected much less frequently. (Note that all of the courses surveyed had a lab, practical and/or tutorial with the exception of four of the five psychology courses representing a total of 49 survey participants.) In terms of the required-text and non-required-text groups of courses, the “textbook” was the second most common choice for students in both groups, and there was no significant difference in the percentage of students who selected this choice between the two groups (36% vs. 35%, respectively).

Reading Behavior and Course Grades

Overall, the majority of the students (77%) reported that they read the textbook either “often” (>75% of the assigned reading) or “sometimes” (25%–75% of the assigned reading), but statistically significantly more students reported reading the textbook “often” in the required-text courses compared with students in non-required-text courses (table 5).

In terms of course performance, when the responses and grades for all of the survey participants were analyzed together (*i.e.*, participants in both required-text and non-required-text courses), students who reported that they read the textbook “often” had higher final marks than those who reported that they read the textbook “sometimes.” Surprisingly however, students who reported that they “rarely” read the textbook, also did statistically significantly better than those who reported that they read the textbook “sometimes,” and as well as those who reported reading the textbook “often” (see figure 1).

When we performed the same analysis on the two separate groups of courses, we found that in the required-text courses, students who reported reading “often” earned

TABLE 4
The Main Way Students Report Learning the Course Material[†]

What is the main way that you learn the material?	Overall	Required-text	Non-required-text	χ^2 (1)
Textbook	36%	35%	36%	.41
Assignments	8%	1%	10%	5.30*
Classes	46%	59%	40%	5.36*
Labs/Practicals/Tutorials	5%	2%	7%	3.45*
Discussion with other students	3%	2%	4%	1.47
Other sources such as the web	2%	2%	3%	.68

[†]Participants were asked to respond to the question “What is the main way that you learn the course material?” Values represent the percentage of students overall (n=1023); in the required-text courses (n = 314); or in the non-required-text courses (n = 709) who responded with the indicated choice. χ^2 (1) tests revealed significant differences between some of the responses for the two groups of courses (* $p \leq .01$).

TABLE 5
Reading Behaviour of Students[†]

I read the assigned textbook chapters / sections / pages. . .	Required-text	Non-required-text	χ^2 (1)
often (>75%)	59%	50%	2.65*
sometimes (25–75%)	20%	27%	2.15*
rarely (<25%)	19%	22%	.95

[†]Participants were asked to respond to the statement “I read the assigned textbook chapters / sections / pages. . .”. Values represent the percentage of students in the required-text courses (n = 314) or in the non-required-text courses (n = 709) who responded to the indicated answer. χ^2 (1) tests revealed significant differences between the “often” and “sometimes” responses for the two groups of courses (* $p \leq .01$).

higher grades than those who reported reading “sometimes,” but there was no statistically significant difference between the final marks of the students who read “often” and “rarely” or between the students who read “sometimes” and “rarely” (see figure 2). In the non-required-text courses, students who read “often” earned higher grades than those students who read “sometimes,” while students who reported reading the textbook “rarely,” performed as well as those who reported reading “often” and better than those who read “sometimes.”

When asked about more specific reading behaviors, less than 22% of all the survey participants reported reading “before” and/or “after class”, and 30% reported reading the textbook “only to study before a test or exam.” About 7% of students reported that they “never” read the textbook. Chi-squared tests revealed no significant differences between responses related to these specific reading

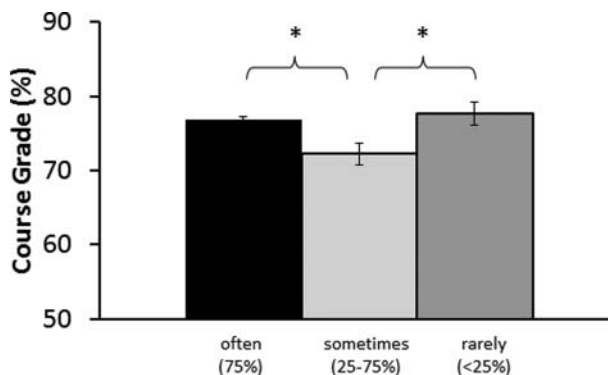


FIGURE 1 Relationship between reported frequency of textbook use and final course grade. The average of the final marks for students who reported reading the textbook often (>75%), sometimes (25-75%) or rarely (<25%) was calculated for all courses. A one factor ANOVA showed significant differences between the responses ($F(2, 995) = 2,232.36, p \leq 0.01$). Since the omnibus test was significant, contrasts and post hoc tests (Tukey’s *B*) were examined and those who read often had significantly higher course grades compared with those who read sometimes (* $p < 0.01$). In addition, those who read rarely had significantly higher grades than those who read sometimes (* $p < 0.01$).

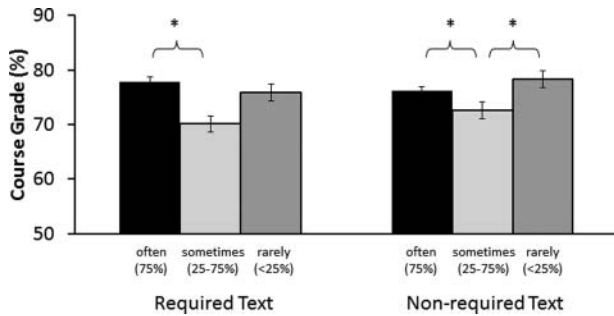


FIGURE 2 Relationship between reported frequency of textbook use and final course grades within the required-text and non-required-text courses. The average of the final marks for students who reported reading the textbook often (>75%), sometimes (25-75%) or rarely (<25%) is shown. A one-factor ANOVA showed significant differences between the reading behaviours in the required text group ($F, 3, 300, 937.94, p \leq 0.01$). Since the omnibus test was significant, contrasts and post hoc tests (Tukey's *B*) were examined and those who read often had significantly higher course grades compared with those who read sometimes ($*p \leq 0.01$). A one factor ANOVA showed significant differences between the reading behaviours within the non-required-text group ($F, 3, 663, 954.848, p \leq .01$). Since the omnibus test was significant, contrasts and post hoc tests (Tukey's *B*) were examined and those who read often had significantly higher course grades compared to those who read sometimes ($*p \leq 0.01$). In addition, those who read rarely had significantly higher grades than those who read sometimes ($*p \leq 0.01$).

behaviours in the required-text and non-required-text groups of courses (data not shown). The timing of textbook reading (e.g., "before," "before and after," "after class," or "only to study before a test or exam") had no statistically significant effect on the average final marks of students in either of the required-text and non-required-text courses. Interestingly, however, students in both types of courses who reported that they "never" read the textbook had on average statistically significantly higher course grades than those who reported that they read the textbook at some time during the course (see figure 3).

The first-year biology course, the physics course and one of the psychology courses were the only courses in our study that incorporated reading quizzes. For the biology course, the reading quizzes were worth a total of 2% of the final mark, and tested material not previously presented in lecture. In addition, a substantial proportion (20%) of the test and exam questions was based on the textbook. Of the 143 students in this course who participated in this study, 68% reported that they read the textbook "often," 18% said that they read it "sometimes," and 14% said that they read it "rarely." We found that the students in this course who reported that they read the textbook "often" did statistically significantly better (average final grade of 80%) than those who read "sometimes" or "rarely" (average final grades of 73% for both groups).

On the other hand, in the physics course, 1% of the final mark was assigned to reading quizzes, but none of the test/exam questions or assignments were based on textbook reading alone. In this course, 58% of the students reported that they read the textbook "often," 31% read it "sometimes," and 11% read it "rarely." Students in this course who reported that they read the textbook "often" did statistically significantly better (average final grade of 75%) than those who read "sometimes" (average final grade of 71%), but not statistically significantly better than those who reported that they read it "rarely" (average final grade of 73%). (The number of students in the psychology course was too low to conduct this type of statistical analysis.)

Student Perceptions of Textbook Usefulness

Student perceptions of textbook usefulness differed between the required-text and non-required-text courses (see table 6). For instance, significantly more students in the required-text courses ($p \leq .01$) agreed that the textbook was "useful for understanding the material covered in

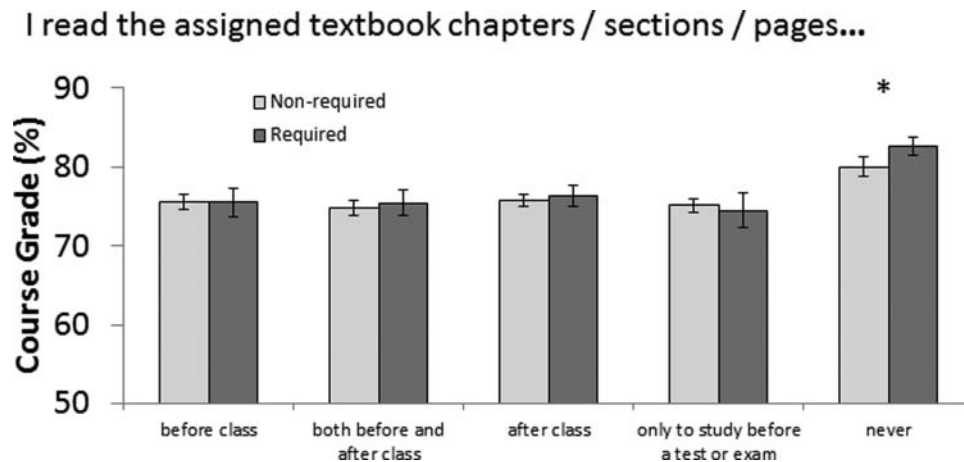


FIGURE 3 Relationship between reported textbook reading behaviour and final course grade categorized for students from required-text and non-required-text courses. A one-factor ANOVAs showed no significant course grade differences between groups (required vs. non). A one-factor ANOVA did reveal differences between the reading behaviours ($F, 4, 960, 546.226, p \leq .01$). Since the omnibus test was significant, contrasts and post hoc tests (Tukey's *B*) were examined and those who claimed to never read, had significantly higher course grades individually compared to all other reading behaviours ($*p \leq 0.05$).

TABLE 6
Student Perception of Textbook Utility[†]

Survey statement	Required-text	Non-required-text	χ^2 (1)
The textbook is useful for understanding the material covered in class.	74%	60%	4.07*
The textbook is useful for studying for tests and exams.	67%	48%	5.56*
The textbook is useful for solving homework problems or assignments.	35%	50%	4.36*
The textbook is useful for learning just out of personal interest.	62%	47%	4.41*
When reading the assigned chapter/section/pages, I only look at material directly relevant to my assigned work (such as case studies, figures, examples, sample problems, etc.)	49%	43%	1.79

[†]Values represent the percentage of students who chose “Agree” to the listed survey statements in required-text ($n = 319$) and non-required-text courses ($n = 709$). The other choices were “Neutral”; “Disagree”; “Not Applicable”. χ^2 (1) tests revealed significant differences between the two groups of courses ($*p \leq .01$).

class”, “studying for tests and exams”, or “just for learning out of personal interest”, but not for “solving homework problems or assignments” nor “only to look at material directly relevant to assigned work”. There were no statistical differences in the final marks of the students who agreed to these statements between the required-text and non-required-text groups.

DISCUSSION

We surveyed students and instructors in several large undergraduate courses to examine textbook use, and its relationship to student grades. We also asked students about the usefulness of the textbook, and the main way they studied for the course. While several studies have asked students about whether they read their textbooks and/or how they use them, few have attempted to correlate textbook use with academic performance in courses at the university level, and those that have are mainly limited to studies of psychology or physics courses. Since we surveyed over one thousand students in university science courses across several disciplines and correlated individual responses with final course grades, our research both broadens and extends our understanding of student textbook use and academic performance.

More than 80% of the students in our study reported using the textbook either “often” or “sometimes” (table 5). This is at the high end of student-reported reading compliance described in previous studies, which ranged from 20% to 70% (Burchfield and Sappington 2000; Cummings, French, and Cooney 2002; Sikorski et al. 2002; Marchant 2002; Clump, Bauer, and Bradley 2004; Podolefsky and Finkelstein 2006; Starcher and Proffitt 2011; Berry et al. 2011; Hoefl 2012). It is important to note that our student surveys were conducted online and outside of class time and that not all of the students in each course participated in our study. Thus it is possible that the students who were more involved in a particular course in general chose to participate in the survey and that this resulted in a greater percentage of students reporting that they used the textbook.

It is likely that actual reading compliance of the participants was lower than what they reported. Sappington,

Kinsey, and Munsayac (2002), for example, discovered that while 93% of students in a psychology class stated that they had read the entire course syllabus, only 22% followed instructions embedded in the course syllabus informing them that they would receive a bonus point in the course if they e-mailed their instructor. Unlike the Sappington, Kinsey, Munsayac study, however, survey participants in our study were informed that the course instructor would never know their identity. Nevertheless, even if reading compliance was actually lower than reported, we believe that the relative amounts of reading are likely to be valid (*i.e.* those that read “often” likely did read more than those who reported that they read “rarely”).

The average course grade of study participants was somewhat higher than the average for all of the students in the courses that we surveyed. This difference, while statistically significant, was only 3%, and we believe that it is unlikely to have had a major impact on the study findings.

Our results suggest that some students achieve higher grades by completing more of the textbook readings, while others can still achieve high grades by completing 25% or less of the assigned readings or by not reading the textbook at all. Specifically, students in our study who reported reading the textbook assignments “often” did on average better than those students who report reading the textbook assignments “sometimes” (see figure 1). Our most surprising finding, however, was that students who reported that they “never” read the textbook had on average higher course grades than students who reported reading the textbook at some point during the course (see figure 3). Thus it appears that the courses in our study offer enough other resources to allow this group of students to do well in the course. Indeed, “classes” was the main way that students report learning the material. It is possible that the lecturers in these courses were very effective at conveying information, so that supplemental resources were not required or perceived to be required by the students. In addition, since the courses surveyed were introductory, it is possible that the students who did well without reading had already learned a considerable portion of the course material in high school or in previous studies. We did not examine advanced courses, and therefore, do not know whether the trend we observed would hold for those types of courses as well.

We discovered that there were two different approaches that some of the instructors took to promote reading. One was to have test and exam questions based solely on the textbook readings, while another was to include reading quizzes throughout the course. In the case of courses in which there were some test and exam questions based solely on textbook readings (*i.e.*, required-text courses), students who read “often” did better than those who read “sometimes”, but there was no difference between those who read “often” and those who read “rarely” or between those who read “sometimes” and those who read “rarely.” Thus, it appears that even in the courses in which the instructors report that between 10% to 70% of the text/exam questions come directly from the textbook, some of the students perform well without reading the textbook, while others do not.

In terms of courses with reading quizzes, in the first-year biology course, students who read the textbook “often” did statistically significantly better than those who read “sometimes” and “rarely”; however, we did not observe the same results in the physics course, which also incorporated reading quizzes, but did not otherwise test for material exclusively in the textbook. It should be noted that 10% to 20% of of the test/exam questions in the biology course were based solely on the textbook readings.

The results from the biology course are most similar to results from previous studies. For example, in the courses described by Sappington, Kinsey, and Munsayac (2002), in which textbook reading was associated with improved performance on the exam, surprise reading quizzes were included in the course. In addition, reading quizzes were included in the one physics course in which Podolefsky and Finkelstein (2006) did observe a modest correlation between how often students read the textbook and final grades.

In our study, we also found that the reported timing of textbook reading (*e.g.*, “before,” “before and after,” “after,” or “only before tests and exams”) had no effect on the student performance in the course, even in the required-text group of courses (see figure 3). Perhaps instructors should keep this in mind when counselling students regarding study strategies.

We included a question on student perceptions of textbook cost because it has been known for sometime that textbook cost can enhance perceived value (Piehl 1997). It might be, for example, that a textbook that is perceived to be expensive will be used more often. This did not appear to be the case, however, textbook use did not differ between students who thought the textbook was reasonable and those that did not, and there were no differences in the average course grades of students in these two groups.

Interestingly, students in the required-text courses perceived the text to be more useful for learning course content and even for reading out of interest, suggesting that having test/exam questions based solely on the textbook does

promote an appreciation of textbook utility that goes beyond the immediate learning objectives of the course.

We anticipate that our results will prompt those who teach within the sciences and beyond to examine the ways that they use textbooks in their courses. Questions to consider include: Do I really need to assign a textbook in this course?; If so, should test/exam questions be based solely on textbook readings?; Should I incorporate reading quizzes or other methods to encourage textbook reading?; and Are there ways to identify those students who would benefit the most from completing textbook readings?.

In conclusion, our study suggests that there are different subgroups of learners in our courses. One subgroup may need to read the textbook “often” to do well in the course, while another subgroup appears to rely on other resources such as classes and assignments or perhaps even prior knowledge to do well in the course.

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