Understanding Student Perceptions and Practices for Pre-Lecture Content Reading in the Genetics Classroom

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Many faculty members assign textbook readings prior to their traditional lectures. In this study, we assessed students’ level of class preparedness and surveyed their textbook reading practices weekly along with entrance and exit surveys concerning their attitudes toward reading the textbook. We report that pre-lecture reading is a significant variable in explaining pre-lecture preparedness as well as exam scores. We also report the reasons participants cited for not reading more of the textbook. We hope this analysis will allow educators to have a better understanding of the level of pre-lecture reading that is occurring in a traditional lecture-style course and the impacts of pre-lecture reading on student success.

INTRODUCTION

Textbook reading is a pervasive instructional tool in most college curricula. The textbook for many college courses is an invaluable resource intended to help guide student learning in conjunction with lecture. It is not uncommon for instructors to request or require reading from a textbook section or chapter prior to lecture. Instructors hope that students will come to class prepared with a foundational understanding of the topic covered and will have questions ready when the lecture arrives at a topic that was difficult to learn from the textbook. In this study, we evaluate the effectiveness of this practice using a longitudinal study of students in a traditional genetics classroom.

Despite frequent assignment of textbook readings by instructors, few students complete the readings before lecture. A study of accounting students found that only 17% of students read the assigned textbook chapters before class (1). A study of finance students discovered that only 18% frequently or always read the textbook prior to class (2). Another study of psychology students found that only 27% of the assigned reading was completed before class (3). Lastly, a study including undergraduates from teaching and nonteaching majors found that only 24% of assigned readings were completed before class (4). These studies suggest that the lack of pre-lecture textbook reading is ubiquitous across universities and it does not appear to be restricted to certain majors.

The aforementioned accounting study also found that the top quartile of students, as measured by course performance, was significantly enriched for students who read before class while the bottom quartile was significantly enriched for students who read after lecture (1). Unsurprisingly, this suggests that pre-lecture reading is correlated with overall course performance. It is possible that strongly performing students might read the textbook as habit but that it does not aid their learning. Therefore, a study that controls for student differences and evaluates differences in performance arising from different reading habits is needed to more rigorously assess this correlation.

Paradoxically, students are spending substantial resources on acquiring evermore-expensive textbooks that they will either not utilize or utilize in a manner that does not maximally increase their course performance. A 2005 Government Accountability Office (GAO) report noted that between 1986 and 2004 there was 186% inflation in textbook prices while the overall inflation increased only 72% over that period (5). A subsequent 2013 GAO report noted that between 2002 and 2012, the price of college textbooks increased by 82%, while overall consumer prices increased by only 28% (6). If instructors continue to require students to purchase these useful, yet expensive, educational materials, then they should be confident that students will be able to use these materials to maximize learning outcomes.

One study queried students about which practices an instructor could employ to encourage increased reading of the textbook. The overwhelming top response (74% of respondents) was to have the professor “Tell me what is important” (2). As a result, we decided that we would...
attempt to tell students what the key points of a given chapter were by providing them a method to guide their reading. At the same time, we were interested in using methods that have been previously demonstrated to improve student outcomes. Therefore, we developed Active Reading Modules (ARMs) to guide students through the reading assignments.

The evidence-based learning methods employed in ARMs varied by week, but they usually consisted of some combination of concept mapping, outlining, drawing pictures, and using external resources. A large meta-analysis of studies evaluating concept maps found them generally effective in improving student outcomes, particularly for courses in biology when compared with other science courses (7). Creating outlines as a way of organizing ideas from textbook reading has been demonstrated to be an effective way of improving student outcomes (8, 9). Additionally, drawing figures has also been argued to increase learning in the biological sciences (10–12). Lastly, interacting with external, web-based resources has been demonstrated to improve student outcomes in a geography course (13).

The objectives of this study were to understand students’ attitudes toward textbook reading, quantify the amount of pre-lecture reading that students engage in, measure the effect of pre-lecture reading on pre-lecture preparedness and exam performance, attempt an intervention to increase reading, and better understand the reasons why students typically fail to read the textbook before lecture. We hypothesized that pre-lecture reading will be a significant contributor to pre-lecture preparedness and exam averages. We also hypothesized that completing our ARM intervention would significantly alter student perceptions and practices with regard to reading the textbook.

**MATERIALS AND METHODS**

**Participants**

This study analyzed a single cohort of students longitudinally across the semester. The study included 198 college students enrolled in a Principles of Genetics course taught by the second author of this manuscript at the University of Maryland. The course follows a traditional lecture-style format in which students are asked to read a chapter of the textbook before arriving to their twice-a-week lecture. They also attended a weekly discussion section to resolve any lingering questions concerning the course material. Thirteen participants did not complete the course, so their responses and scores were excluded from the analysis. The self-identified cohort was composed of 69 males, 107 females, and 9 non-responses to gender. There were 65 sophomores, 93 juniors, and 27 seniors. The course has prerequisites, requiring two prior semesters of both chemistry and biology. Students were recruited by the first author, who described the study on the first day of lecture. Students were given consent forms to complete if they wished to join the study. There were no other incentives provided for joining or participating in the study. While the second author was the instructor for the course, the students were explicitly told that the first author would be the only person who would see their name attached to their responses in order to hopefully elicit truthful responses with regard to their reading level. The University of Maryland IRB approved the protocols used within the study (IRBNet ID: 942543-2).

**Surveys and assessments**

Study participants were asked to complete an entrance survey (Appendix 1) and exit survey (Appendix 2) upon entering and completing the study, respectively. These surveys were used to assess students’ attitudes toward content reading, along with demographic information. Study participants were also evaluated weekly at the beginning of class, with five-question multiple-choice assessments along with a question about how much of the required textbook reading they had completed before arriving to lecture. The question regarding how much of the textbook had been read before class allowed for students to respond with “None,” “Some,” or “All.” One assessment question from Week 8 was flawed and the question was excluded from the analysis. On weeks that Active Reading Modules (ARMs) were provided to students, study participants were also asked how much of the Active Reading Module they had completed. The question regarding how much of the ARM had been completed before class allowed for students to respond with “None,” “Some,” or “All.” Students who did not read could not have completed the ARM, because the goal of the ARM was to actively engage students with the textbook while they read it. Thus, if a student was not reading the textbook, then they could not be actively engaged with it. Survey and assessment responses were kept confidential. Assessments and survey completion were not factored in participants’ course grades.

**Active reading modules**

All students in the course were provided reading guides, called Active Reading Modules, that asked students to use active reading strategies, such as outlining, drawing figures, concept mapping, and interacting with outside resources while reading. The ARMs were provided for every other assessed reading assignment. An example ARM is provided as Appendix 3. Completion of ARMs was not factored into participants’ course grade.

**Analyses**

Surveys and assessments were evaluated and recorded for each student at the end of the semester along with their exam grades from the course. The policy of the course excludes the lowest exam grade from the exam average used in calculating a student’s final course grade. Therefore, we also excluded the lowest exam grade in our exam average
in order to mimic this policy. This mimicry is important because students sometimes will not take an exam for various reasons or decide to not prioritize studying one of their exams because they are aware of this policy, and this effect would introduce considerable noise into our analysis. Statistical significance was assessed using a p value equal to 0.05, and all analyses were run in R version 3.3.1 (14).

There has been a recent effort to use linear models within education research in order to help control for student characteristics (15). Therefore, in order to assess the effect of reading (“None,” “Some,” or “All”), week (1 – 12), and student (1 – 185) on class preparedness as measured by the weekly assessment scores, we constructed a linear model and evaluated the model with ANOVA. The inclusion of week into the model attempts to account for differences in the material from week to week and differences in the difficulty of the material from week to week. The student variable was simply a categorical variable to track students longitudinally and help control for inherent student differences. We did not include ARM completion in this analysis because it was not completely independent of our reading level variable and collinearity of explanatory variables could have arisen.

We also evaluated how students ranked textbook reading compared with other course-related activities, such as essay writing, exams, discussion, and homework, in the entrance and exit surveys. To be included in this part of the analysis, students had to rank the various course-related activities on both the entrance and exit survey. One hundred five of the study participants met these criteria. We used a paired t test to see whether their perceptions of textbook reading changed throughout the semester. Furthermore, we evaluated whether average pre-lecture reading or average level of ARM completion explained any change in how students ranked textbook reading using linear models evaluated with ANOVA. The average reading level and average ARM completion level were both obtained by converting the reported levels to numeric variables (“None,” “Some,” or “All,” corresponding to 1, 2, and 3, respectively) and taking their mean for each student.

We investigated whether students’ average reading level, grade-point average, or major explained exam averages by constructing a linear model and evaluating the model using ANOVA. Lastly, in our exit survey, we asked students why they did not read the textbook more in the course. Students were able to select as many of the provided reasons for why they did not read the textbook as they deemed appropriate.

RESULTS

We first evaluated levels of pre-lecture reading throughout the semester. Figure 1 demonstrates that students who self-reported reading “All” each week were in the minority to students who self-reported reading “Some” or “None.” The week with the highest level of pre-lecture reading was Week 7, when 24.5% of students reported reading “All” of the assigned textbook pages. The week with the lowest level of pre-lecture reading was Week 9, when only 1.6% reported reading “All” of the assigned pages. Averaging across the weekly means for pre-lecture reading reveals that, on average, only 12.3% of students report reading “All,” while 33.3% report “Some,” and 54.4% report “None.”

Next, we analyzed how pre-lecture reading, week, and student influenced pre-lecture preparedness as measured by the weekly pre-lecture assessments. The adjusted $r^2$ for the linear model was 0.397. The ANOVA of our linear model reveals that pre-lecture reading ($p < 0.001$, $df = 2$, $F = 160.6744$), week ($p < 0.001$, $df = 11$, $F = 19.3897$), and student ($p < 0.001$, $df = 164$, $F = 2.0314$) were all significant factors in explaining pre-lecture preparedness. Furthermore, in each of the twelve weeks, students who self-reported as having read “All” of the pre-lecture reading performed on average better than students who reported as having read “Some,” who in turn performed on average better than students who reported as having read “None” (Fig. 2).

Our analysis of how students rank textbook reading with other course activities can be seen in Table 1. Textbook reading was on average ranked in the entrance and exit surveys as the third most-favored course activity, behind homework and discussion, but ahead of essay writing and exams. Paired t tests did not reveal a significant difference in how students ranked textbook reading in the entrance and exit surveys. Furthermore, we evaluated whether any change in textbook ranking could be explained by either average reading level or average ARM completion. Any deviation in how students ranked textbook reading could not be explained by their average reading level ($p > 0.05$, $df = 1$, $F = 0.857$) or by their average ARM completion ($p > 0.05$, $df = 1$, $F = 0.6199$) throughout the course.

We next analyzed whether pre-lecture textbook reading was a significant factor of test average. In order to account for higher-performing students, we included grade-point
average and major along with average pre-lecture reading level as explanatory variables in our linear model to explain test averages. The adjusted \( r^2 \) for the linear model was 0.413. We found that pre-lecture reading average (\( p < 0.001, df = 1, F = 14.7403 \)), major (\( p < 0.05, df = 24, F = 1.8476 \)), and grade-point average (\( p < 0.001, df = 1, F = 34.2396 \)) were each significant explanatory variables for explaining test averages.

We also surveyed students at the end of the semester in order to gain insights into why they did not read the textbook. Of the students who reported in the exit survey that they did not read the entire textbook, 80.6% of respondents cited a lack of time due to coursework from other classes, 27.4% cited a lack of time due to extra-curricular activities and 21.0% cited the exams not covering textbook material as reasons for not reading the textbook (Table 2). Over one-fourth (28.8%) of respondents reported reading the entire textbook and were excluded from the tabulation of reasons why students did not read. It is important to note that this includes all reading and not just pre-lecture reading.

Lastly, we wished to judge whether we could influence students to read more by providing our ARMs. Unfortunately, it was difficult to measure whether these influenced students to read more due to a low participation rate. One hundred forty of the 185 participants reported never attempting or completing one of the ARMs before lecture, and an additional 32 only tried or completed one of the ARMs.

**DISCUSSION**

These results as a whole demonstrate the importance of pre-lecture reading for preparing students for lecture. Pre-lecture reading was encouraged but not required in the course. Our results indicate that students are not taking advantage of pre-lecture reading (Fig. 1). In seven of the twelve weeks of the study, more students reported reading “None” than “All” and “Some” combined. Furthermore, students reporting that they read “All” were consistently the smallest group each week, while “None” was the largest group for nine out of the twelve weeks. These results seem to be generally consistent with previous studies (1–4).

The pre-lecture assessments clearly bear out the consequences for the lack of pre-lecture reading. In each week, students who reported reading “All” had on average higher pre-lecture assessment scores than students who reported reading “Some.” Also, students who reported reading “Some” had on average higher pre-lecture assessment scores than those who reported reading “None.” The effect of pre-lecture reading is further validated in the linear model that utilized pre-lecture reading, week, and student as explanatory variables for class preparedness as measured by the pre-lecture assessment. The significance of each of these explanatory variables is important because it demonstrates the critical role that pre-lecture reading has for increasing pre-lecture preparedness. The significance of the last two explanatory variables is evidence of two points: first, that the material and its corresponding assessment were not equally difficult each week; second, that some students have stronger foundations in certain topics from other courses and that students approach the course with different study habits and amounts of background knowledge.

**FIGURE 2.** The level of pre-lecture preparedness of students for each week of the study as assessed by pre-lecture assessments. Colored lines represent the average pre-lecture assessment score for students according to whether they reported reading “All,” “Some,” or “None” of the assigned reading before lecture. Counts for each group, corresponding to Figure 1, are also provided.

**TABLE 1.** Student rankings for various course activities.

|                     | Entrance Survey | Exit Survey  |
|---------------------|-----------------|--------------|
|                     | Mean Standard Deviation | Mean Standard Deviation |
| Homework            | 2.10 1.01        | 2.20 1.14     |
| Discussion          | 2.13 1.28        | 2.20 1.27     |
| Textbook Reading    | 2.75 1.18        | 2.95 1.33     |
| Essay writing       | 4.10 1.11        | 3.49 1.23     |
| Exams               | 3.92 1.03        | 4.16 1.00     |

Values on a scale of 1 to 5, where 1 = the most favored activity; 5 = the least favored activity.
Unfortunately, we were unable to find any evidence that we significantly altered student perceptions of textbook reading. Not only did textbook rankings from students not significantly change over time, but any change that was witnessed was not attributable to the average level of pre-lecture reading or average level of pre-lecture ARM completion. However, the latter may be the result of low ARM participation. Taken as a whole, it seems that our intervention was ineffective at swaying student perceptions and we failed to identify a method to significantly change those perceptions. While a previous study stated that students wished for instructors to “Tell me what is important,” our cohort did not seem to take advantage of the instructor telling them what was important in the form of ARMs (2).

Our results indicate that pre-lecture reading, major, and grade-point average are all significant indicators of exam average. Not only does it prepare a student for the lecture they are about to receive, but the fruits of this work are also demonstrated in improved exam scores. We were concerned that high-achieving students may inherently perform better and we chose to control for this by including self-reported student grade-point averages into our model. The results confirmed the assumption that grade-point average was a significant explanatory variable in exam average. Furthermore, we were concerned that some majors may be more prepared to be successful in this course than others, and our results also bear out this conclusion.

We were also interested in why the students didn’t read their textbook. Two major results came from this analysis: first, students are not reading for a variety of reasons, although many report that it is the result of time constraints imposed by other courses, and second, some students appear to be reading after lecture. The first observation emphasizes the time constraints that undergraduate students are facing as they attempt to balance course loads and is consistent with other studies (1, 2). The second observation is seen in the higher level of reported reading of the entire textbook in the exit survey when compared with the level of pre-lecture reading collected throughout the semester. This indicates that some students are reading the textbook, but some portion of the reading occurs after rather than before lecture.

While we expect that many geneticists and other science educators may not view many of our results as novel, it does provide a window into understanding undergraduate study habits. It is critical that science educators understand student perceptions and student practices surrounding pre-lecture textbook reading in order to teach more effectively.

### CONCLUSIONS

From this analysis it is evident that undergraduate students do not widely utilize pre-lecture textbook reading. However, adoption of this practice would significantly improve the exam scores and pre-lecture preparedness of students. Furthermore, the majority of undergraduate students fail to complete the assigned reading for a course and the most common reasons cited for this shortcoming are a lack of time due to coursework from other classes and a lack of time due to extra-curricular activities.

### SUPPLEMENTAL MATERIALS

- Appendix 1: The entrance survey to the study
- Appendix 2: The exit survey to the study
- Appendix 3: An example of an active reading module (ARM) that was provided

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