



# Are Students Reading? How Formative Practice Impacts Student Reading Behaviors in Etextbooks

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## ABSTRACT

Faculty often suspect that students are not doing the assigned textbook reading—a suspicion supported by research. This can pose a problem for both student learning and outcomes, especially in cases where the textbook is intended to be the primary source of learning content that students are expected to use before class lectures, activities, discussions, etc. In a recent study, researchers gathered a variety of faculty strategies for promoting reading engagement and measured the resulting reading from digital platform data. This study provided a useful benchmark for continued research on this topic of student engagement with their textbooks. In this work-in-progress paper, we replicate the methods of this study to investigate how assigning formative practice in their ebook reader as a strategy impacted student reading behaviors. Initial results from 13 courses at two universities reveal using formative practice as a strategy dramatically increases student reading compared to courses where it was not assigned, and this strategy yielded higher average reading than strategies reported in previous research.

## CCS CONCEPTS

- Applied computing~Education~Interactive learning environments
- Computing methodologies~Artificial intelligence
- General and reference~Cross-computing tools and techniques~Performance

## KEYWORDS

etextbooks, formative practice, reading behaviors, reading strategies, higher education, artificial intelligence, automatic question generation

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## 1 INTRODUCTION

Textbooks are considered to be the gold standard for learning content and are assigned across most higher education disciplines. Yet despite expectations that students read the assigned materials prior to coming to class, many faculty suspect that few students do. Research confirms these suspicions. In a longitudinal study from 1981 to 1997, Burchfield and Sappington [1] sampled students from an introductory and a graduate psychology course and found reading compliance had decreased over this period. Several studies reported finding that students tended to skip readings before class in lieu of reviewing before exams—only 16% read before class rather than before exams [2], only 17% of students completed assigned reading in a macroeconomics course [3], 18% of students reported reading before class in a finance course [4], and only 27% reported reading before class while 70% reported reading before exams [5]. The literature on textbook reading has been active for decades, but not without challenges. In order to understand print textbook reading, researchers have relied on strategies such as surveying students and instructors, journaling, or observations. Phillips and Phillips [6] used qualitative analysis of learning journals to better understand motivational factors and reading strategies for students, hoping to recommend more effective strategies for faculty. These findings are generally mirrored by another qualitative assessment of student reading compliance decisions that also cites personal and external factors such as time management, not valuing the reading, or unclear expectations from instructors [7].

The rise of robust etexts and ereaders have notably changed research into student reading habits. In an early analysis, McKay [8] uses library etext data to investigate student reading patterns. However, this early research did not look at a course-based analysis of how instructors assign readings and how students comply. In a recent study, Russell et al. [9] did just that. In this study, 59 instructors provided their reading assignments, reported instructional strategies to motivate student reading, and if/what grades were assigned for those strategies. The etext log data was then coordinated for each course to determine how students read in each of those courses.

The findings from Russell et al. [9] provide several key benchmarks for better understanding the impact of instructional strategies on student reading. Instructors who reported using instructional strategies used an average of 3.61 out of a possible 10 strategies, which included things like reading quizzes, homework assignments, discussions, clicker questions, etc. (Table

5) [9, p. 616]—nearly all of which were announced and graded. The primary findings were as follows:

On average, among the 59 instructors who provided assigned reading information, 330 pages of reading was assigned during the semester, but students read only 37.4% of these assigned pages. Additionally, only 32.8% of students read more than half of the assigned pages, reading 72.2% of the assigned pages on average. The other 67% of students read less than half of the assigned pages, reading only 19.2% of the assigned readings on average (Table 1) [9, p. 615].

Additionally, of the 59 instructors included in the analysis, 49 reported using instructional strategies and 10 did not. Instructors who did not use instructional strategies had an average of 14.5% of pages read by students as compared to 39.0% by instructors who used strategies.

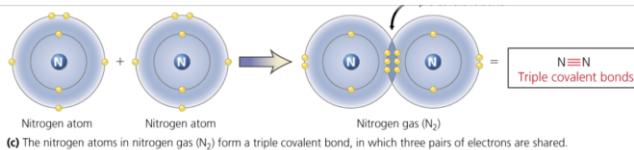
The breakdown of reading strategies and their impact on student textbook reading by Russell et al. [9] was the motivation to begin a comparable analysis. The strategy under investigation in this paper is the assigned completion of formative practice that is provided alongside the textbook content in an ereader platform (Figure 1). The formative practice—in this case generated through artificial intelligence [10], was added to engage the learning science principle called the doer effect. (For details of how the formative practice questions were generated, see [10]; in particular generative AI was not used in generating the questions in this work.) Incorporating learning content with formative practice at frequent intervals as a learning method has proven to

be about six times more effective for learning and to have a causal relationship to outcomes [11][12][13]. While prior research on these AI-generated formative practice questions has focused on their effectiveness and learning benefits [10][14][15][16], the Russell et al. [9] study on reading strategies prompted us to investigate how the formative practice may also be impacting student reading patterns.

The goal of this investigation is to use data gathered by the e-reader platform for four university courses where these questions were assigned as homework with the reading and replicate the reading strategy analysis by Russell et al. [9] to identify how formative practice impacted reading.

## 2 METHODS

In order to follow the methods provided by [9] we first identified university courses wherein we knew the instructor would be able to identify their assigned reading materials and the assignment for the practice questions. Four faculty volunteered this information for several courses they taught between Spring 2022 and Fall 2023. The disciplines include psychology, sociology, communication, and public relations. In total, information for 13 courses was collected, including 2 courses where the formative practice questions were not available yet—thus giving comparable courses for the ‘no strategies’ category. For the 11 courses that assigned the practice questions as a strategy, all students were notified and the questions were assigned as homework—for completion only—for anywhere from 4–15% of the course grade.



**Figure 2.8**

Covalent bonds form when atoms share electrons. Shown here are examples of single, double, and triple covalent bonds. For each example, the structural formula is given on the far right.

Ions form because of the tendency of atoms to attain a complete outermost shell. Consider, again, the atoms of sodium and chlorine that join to form sodium chloride. As shown in [Figure 2.9](#), an atom of sodium has one electron in its outer shell. An atom of chlorine has seven electrons in its outer shell. Sodium chloride is formed when the sodium atom transfers the single electron in its outer shell to the chlorine atom. The sodium atom now has a full outer shell. This comes about because the sodium atom loses its third shell, making the second shell its outermost shell. The sodium atom, having lost an electron, has one more proton than electrons and therefore now has a positive charge ( $\text{Na}^+$ ). The chlorine atom, having gained an electron to fill its outer shell, has one more electron than protons and now has a negative charge ( $\text{Cl}^-$ ). These oppositely charged ions are attracted to one another, and an ionic bond forms. Because they do not contain shared electrons, ionic bonds are weaker than covalent bonds.

**Figure 1:** The formative practice appears alongside the textbook content so students can refer back to the material if needed. Students have immediate feedback on their answers, can retry or reveal if they get the question incorrect, and can leave feedback on the question. The main goal of these questions is to provide students with an opportunity to actively engage with the learning content at frequent intervals and practice the foundational concepts.

Once the courses were identified and information collected from instructors, the microlevel clickstream data collected by the platform was gathered for each course. Microlevel data is a common type of data collected by digital learning environments which records each user event with a timestamp and can be used to answer questions related to student behaviors and learning [17]. Here, the raw data events are used to identify pages read and questions answered. Consistent with [9], and a common practice in reading analysis in the literature, a page is considered read if a student spends longer than a threshold duration (here 10 seconds) on that page. While a proxy for reading, this measure provides a good approximation for reading behavior. When students answer a question, that data is recorded and coded here as a binary variable: answered or not answered. To be consistent with the original research, readers were confirmed to be any student who had at least one reading session; non-readers never opened the etext for the course and were therefore excluded from analysis.

### 3 RESULTS

The first analysis was to replicate the overall reading results using all 13 course sections. As seen in Table 1, about 10% of students were not readers and excluded from the analysis. The average number of assigned pages was 312.2, very similar to the average of 330.5 reported by Russell et al. [9] Also similar was the average percentage of pages read, in this case 40.7% compared to 37.4%. The percentage of students who read more than 50% of the assigned pages was higher in this instance, and the average pages read by students above and below was a smaller spread comparatively.

**Table 1. Student etext reading for 13 courses.**

Variable	Total
Courses	13
Students	1692
Readers	1534
Avg. # assigned pages (per course)	312.2
Avg. % pages read (among readers)	40.7
% students who read > 50% assigned pages	40.4
Avg. % pages read by students who read > 50%	51.6
Avg. % pages read by students who read < 50%	30.6

A more nuanced understanding of the reading data comes from comparing courses with the strategy applied to those without. In Table 2, the 2 courses without the practice question strategy are compared to the 11 with the strategy. In this case, both courses without the questions are control courses taught with the same etext for the same course as a later semester that did have the questions as a strategy. These results reveal very different insights compared to those in Table 1. One surprising finding is the percentage of non-readers; for the non-strategy courses, 65.1% of students never read any of the textbook, while in the strategy courses only 2.1% of students never read any of the textbook. The average pages read for the non-question strategy courses was only 9.8%, compared to the question strategy courses which was 46.3%. No students read more than 50% for the non-strategy courses. For the question strategy courses, 47.8% of students read more than

half the pages, for a mean of 61.0% pages read. For students who read less than half the pages, the mean was 34.4% pages read.

**Table 2. Comparison of courses with practice question strategy versus without.**

Variable	Without Strategy	With Strategy
Courses	2	11
Students	195	1497
Readers	68	1466
Avg. # assigned pages (per course)	300.5	314.3
Avg. % pages read (among readers)	9.8	46.3
% students who read > 50% assigned pages	0	47.8
Avg. % pages read by students who read > 50%	0	61.0
Avg. % pages read by students who read < 50%	9.8	34.4

The question strategy does raise an unusual issue when computing how many pages students read. In order to answer questions, the textbook page must be open. It could be possible that students navigate to the question activities and answer without reading the corresponding page. From the strategy list in [9], we do not believe any other strategy could cause this same concern. In order to provide a conservative estimate, we also calculated the percentage of pages read when removing any pages where a question activity was placed, shown in Table 3. While it is unlikely that students entirely skipped reading the pages where questions occurred, this analysis shows the reading percentages independent of activity pages and also provides a likely upper and lower bound for pages read. The percentage of students who read more than 50% of pages changed with a difference of 13.4%, the average pages read above and below the 50% threshold changed very little—as did overall average pages read. One additional technical consideration that could impact the upper bound in this analysis is related to how the ereader tracks pages. If page 9 is at the top of the screen but page 10 is also within view, the student could read both pages yet only page 9 is marked as read by the ereader. This is a verified issue, yet the extent to which this could impact the upper bound of pages read is not known and therefore not included here.

**Table 3. Courses with question strategy including and excluding pages with questions.**

Variable	Excluding Pages	Including Pages
Avg. # assigned pages (per course)	259.3	314.3
Avg. % pages read (among readers)	41.1	46.3
% students who read > 50% assigned pages	34.4	47.8
Avg. % pages read by students who read > 50%	60.3	61.0
Avg. % pages read by students who read < 50%	31.8	34.4

## 4 DISCUSSION

While a key line of research on the doer effect has proven that doing practice while reading is more effective for learning [11][12][13], the availability of formative practice in etexts provided the opportunity to investigate how using that practice as an engagement strategy impacted reading itself. Russell et al. [9] provided the most comprehensive analysis known to date on the impact of reading strategies on student reading using data from ebooks. By replicating those methods, we were able to identify the impact of assigning formative practice as a reading strategy on student reading in 13 university course sections. Aggregated course data revealed higher—but still comparable—average reading to those reported by [9].

However, when comparing the courses where the formative practice was assigned as a strategy compared to courses where it was not, the results change substantially. In the two courses that did not have the practice as a strategy, the average pages read was 9.8% and zero students read more than 50%. In the 11 courses that included the practice as a reading strategy (including later sections of the no strategy courses), the average pages read jumped to 46.3%, with nearly half of students reading more than 50% (61.0%) and students who read less than 50% still read an average of 34.4%. In Russell et al. [9], the non-strategy courses had an average of 14% pages read and the strategy courses had an average of 39% pages read. While this analysis presents fewer courses than Russell et al., the results for using formative practice as a strategy for reading accountability are very positive.

This replication of this reading strategies study gives a valuable window into the benefits of assigning practice as a strategy for engaging students in reading their etext. However, this investigation also sparked many additional avenues for future research. It would be beneficial to add time spent on pages in addition to percentage of pages read. This is especially important for the formative practice reading strategy as the practice itself takes time to complete which counts toward time on the page. Understanding more nuances on how long students spend on pages with and without practice may give new insights into reading strategies in general and when combined with formative practice in particular. Another good extension of this work would be to investigate reading patterns more in-depth. With syllabi data, assignment and assessment dates, and the reading and practice data from the ereader platform, it is possible that different reading and studying patterns could emerge. McKay [8] identified several patterns in aggregate etextbook data, but using courses with known expectations as the primary focus could be useful for better understanding student reading behaviors.

Prior research on student reading habits repeatedly found that reading completion was much lower than expected and the results of this investigation confirm that. In the two non-strategy courses wherein the instructors assigned and expected the textbook to be read, only 34.9% of students used the etext, with average pages read at 9.8%. Additional courses should be investigated to identify this trend more concretely; however, what is promising is the dramatic change when the formative questions are introduced as a strategy. Introducing the question strategy into otherwise equivalent sections of the same courses taught by the same faculty

reduced non-readers to just 2.8% and increased average pages read to 45.8%. Of all the instructor strategies studied thus far, assigning formative practice in the etext has produced the largest increase in student reading.

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