Reading Online Mathematics Textbooks

Mary Shepherd & Carla van de Sande
Arizona State University

Introduction

Many would agree that reading is critical for gaining understanding within a discipline, and that students will not reap the full benefits of their studies if they skim through (or worse yet, ignore) their reading assignments. Even in quantitative disciplines such as mathematics, teachers may assign readings from the textbook with the intent of having students come to class more prepared and giving them exposure to more material than can be taught in the time allotted to class meetings. However, few teachers would be so naïve as to believe that students actually read the text, and often complain about the unpreparedness of the students for instruction. On their part, students complain about how hard it is to read mathematics textbooks, perhaps because they lack appropriate reading strategies that might remedy the situation. Indeed, even first-year undergraduate who are good general readers do not read mathematics textbooks well (Shepherd, Selden & Selden, 2009).

One solution to the problem of getting students to read mathematics texts effectively, despite their deeply instilled poor reading habits, is to harness technology. Online mathematics textbooks are a fairly recent (and increasingly popular) addition to the available set of instructional resources. In contrast to physical textbooks, online texts have affordances for interactive and responsive engagement. In particular, online texts can include activities that foster effective reading through embedded tasks that provide feedback and hints. The purpose of this project is to begin to understand how readers interact with an online mathematics textbook in a quasi-authentic setting, and to study the effects of some scaffolded online activities intended to help students monitor their comprehension of what is read.

Literature & Theoretical Perspective

Reading involves both decoding and comprehension. On the comprehension side of the coin, research has identified several strategies that good readers employ as they engage with a text (Flood & Lapp, 1990; Palincsar & Brown, 1984; Pressley & Afflerbach, 1995). Of course, these strategies depend on the individual reader, the reader's goals, and the material being read. Mathematics textbooks, in particular, are "closed texts" in the sense that they seek to elicit a well-defined, "precise" response that is not open to differing interpretations from readers (Weinberg & Wiesner, in press). Yet, many students have not been taught how to read their mathematics textbooks, and do not read them as intended. For instance, authors of mathematics texts include expository material to help students develop a deeper understanding of the mathematical concepts. Yet, despite the fact that an overwhelming percentage of students claim to read their mathematics textbooks for understanding, few students report attempts at reading the expository sections (Weinberg, in press). Our research addresses how students who *are* making an attempt to read their textbooks engage in this process, and how they might be better supported in their endeavors.

Our theoretical perspective is aligned with the view that reading is an active process of meaning-making in which knowledge of language and the world are used to construct and negotiate interpretations of texts (Flood & Lapp, 1990; Palincsar & Brown, 1984; Rosenblatt, 1994). In helping students navigate mathematics texts, we advocate reading strategies that stem

from the Constructively Responsive Reading framework (CRR) that was developed in reading comprehension research (Pressley & Afflerbach, 1995). These strategies are intended to help students maximize their construction of knowledge from texts. In addition, we place an emphasis on *cautious reading* (Shepherd, Selden & Selden, under review) that helps students minimize inappropriate interpretations of their mathematics texts by detecting and correcting errors, misunderstandings, and confusions. Taken together, CRR-based strategies and cautious reading advocate encouraging students to carefully read expository text and check the correspondence between the inferences they have drawn and the author's intent, and discouraging students from forging ahead without carrying out and evaluating their performance on tasks provided by the authors.

Research Methods

The participants are 30 students enrolled in sections of a redesigned precalculus course at a large southwestern university. The course uses an online text, *Precalculus: Pathways to Calculus,* which was developed at Arizona State University and was designed to foster students' ability to reason conceptually about functions and quantity (Carlson & Oehrtman, 2009). Students were recruited to volunteer for participation in seven Study Hall sessions once weekly of approximately 1.5 hours each. Approximately half of the students received reading instruction prior to their participation in the research project. This reading instruction consisted of reading guides stepping them through how to read each of the first several sections of the online course text, and a 40-minute one-on-one reading session of one section of the text with the researcher/instructor that was carried out about 1/3 of the way through the semester. During the Study Hall sessions, students were asked to complete their current reading assignment on the computers provided. In order to investigate authentic student reading habits as closely as possible, nonintrusive screen capture software was used to measure activities such as scrolling, latency, and browsing. In addition, prior to and following their reading of the text at each Study Hall session, students completed short mathematical assessments based on the relevant text material. Other data sources included brief surveys addressing reading habits, and, for most students, admissions testing scores (SAT/ACT) as a control for mathematical and reading preparedness. Finally, half of the participants from each reading instruction group (received/did not receive) were randomly assigned during the final four Study Hall sessions to a version of the text in which questions with pop-down solutions (e.g., hidden answers) were replaced with scaffolded tasks that provided students with right/wrong feedback and sequences of hints[1] (see Figure 1).

[1] The authoring tools for these activities were developed by the Open Learning Initiative at Carnegie Mellon University.

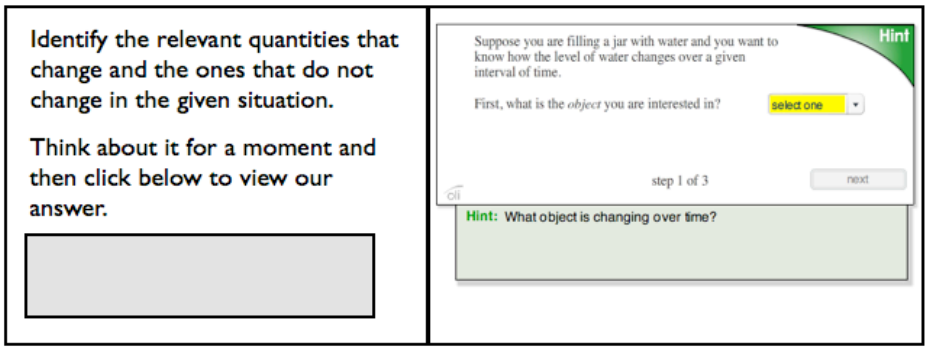

Figure 1. Example of pop-down activity (left) and scaffolded task with hint sequence (right).

Implications for Further Research & Teaching

This research project is a preliminary step for identifying and constructing activities that promote effective reading strategies and that can be embedded in online mathematics textbooks. At this stage, we are restricting our activities to multiple-choice questions. There is a need for research that identifies statistically valid response choices that capture common student errors and ways of thinking so that appropriate sequences of hints can be designed. For instance, certain incorrect answers might be best addressed by posing hints that promote cognitive conflict with that particular way of reasoning.

We would also like to explore how students who rely on embedded scaffolded tasks to read their textbooks effectively can be graduated to the adoption of their own reading strategies that are consistent with reading for understanding. To address this issue, both the timing and manner in which the activities are faded need to be investigated.

Finally, this research has implications for how teachers can connect with the reading aspect of their students' instruction. At present, in order to check whether students have completed a reading assignment, many teachers resort to giving quizzes during (valuable) class time on the relevant material. Online texts can be designed to capture and log student actions, and so provide indicators of whether (and how) students are completing their reading assignments.

Summary

At the heart of our project is the goal of helping students become more effective readers of introductory level mathematics texts. In order to achieve this goal, we are harnessing the affordances of technology, and exploring the ways that activities can be embedded within online textbooks. Although the goal of these activities is to foster reading with understanding, we do not anticipate that they will produce "cautious readers." Instead, our much more modest hope is that we can help students turn over a new page in the way they interact with their textbooks.

Discussion Questions

1. Traditional texts: We chose a text with a large amount of exposition and in which examples function as checks of understanding rather than as analogies, which is the case in traditional precalculus texts. Since online versions of traditional textbooks are also becoming more popular, how might we support students reading these texts?
2. Fading: How might readers be weaned from having to engage in embedded activities in order to read effectively to adopting their own strategies for reading with understanding?

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