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Note Launchers: Promoting Active Reading of Mathematics Textbooks

In the past several decades, the teaching of mathematics has been influenced by the constructivist philosophy in which students are challenged to "learn to think mathematically" (Schoenfeld, 2006, p. 334). Part of the process of learning to think mathematically is being able to read mathematically, "to take the global meaning from the page, not just to be able to read a few sentences" and to recognize that "the reading of a mathematics text is far more complex than simply being able to read the words on the page. It is about comprehending the mathematical idea being put forward" (Noonan, 1990, p. 79). For college students studying mathematics, a source of difficulty is often mathematical language and notation, manifested in students' inability to restate definitions and concepts in their own words (Moore, 1994). Indeed, the densely-packed technical material within mathematics textbooks may be prohibitive for students who are not quantitatively literate. Incoming college students' customary passive reading strategies such as memorizing, reading, and "looking over" (Simpson & Nist, 1990) undercut their abilities to understand the discussions that are to follow in the classroom. Failure to grasp even the first few lessons has serious implications for success throughout the course.

Becoming active readers may help students make their way through this potential mathematical fog. Note launchers, an instructor-designed reading guide, model how to select, decide, and focus upon what textbook material is important to learn. Reading guides are specially-designed study aids that can steer students through difficult parts of assigned

readings (Bean, 1996) while encouraging advance preparation. Part of a broader group of pedagogical content tools (Rasmussen & Marrongelle, 2006) or advanced organizers (Ausubel, 1960), reading guides facilitate students' abilities to make sense of complex material.

The idea of using reading guides as a textbook reading strategy is not new. Five decades ago, Ausubel (1960) noted that advanced organizers can help students comprehend and retain mathematical content better compared to standard pedagogical methods like memorizing formulas and procedures, which merely serve to enforce rote learning. Clements and Wright (1983) later recognized the effectiveness of "guided reading" in their mathematics courses, acknowledging that while textbooks include valuable mathematics information, the ability to learn mathematics from a printed page is quite difficult. Like "partial" notes provided to students during lectures that can increase recall and higher order learning (Armbruster, 2000), reading guides bridge the time between when students read and when they are accountable for that reading during subsequent class meetings.

Study Rationale

The purpose of this classroom research project was to create reading guides to engage students in critical and active reading of mathematics textbooks and to analyze how students used this tool. After observing that students were intimidated by Greek letters, mathematics notations, and equations placed within paragraph structure, the instructor in the present study took a proactive approach to help students change their reading strategies. Named *note launchers* in an effort to engage users, these reading guides introduced students to concepts in the chapter and provided a template of how students could approach new material and make sense of it themselves. This type of active learning prompted students to interact with printed text and selectively identify and record the key elements of what was just read, such as key words, phrases, definitions, and formulas.

Method

During the fall semester of the 2008 academic year, the instructor conducted this project with 50 students enrolled in three sections of Mathematical Modeling and Introduction to Calculus, generally the first mathematics course for students at this four-year postsecondary institution. The note launcher for each lesson required about an hour of the instructor's time to create; over the course of the semester, the instructor created 45 note launchers. The instructor distributed note launchers on each topic at least one class meeting ahead; note launchers

were also available on the course website. Note launchers corresponded to approximately 10 pages of reading material.

While note launchers at the beginning of the course were quite prescriptive and formulaic, later in the semester, note launchers included more open-ended prompts for students to write concepts in their own words, rather than simply render a list of fill-in-the-blank definitions. Early in the semester, Stage 1 of note launchers included fill-in-the-blank quotes from the textbook to help students learn to identify the definitions, rules, and assumptions that support the lesson objectives. For example, a note launcher prompt for the function properties lesson specified to students: *The two parameters for a linear function are: m = ____ or rate of ___ and b = y - ___.* About halfway through the semester, Stage 2 of note launchers evolved into prompts that still helped identify the key concepts, but put more of the note-taking responsibility on the student. In the linear polynomial lesson sequenced halfway through the course, for example, one note launcher prompt asked students: *How does the exponential function differ from the power function? (Hint: Where is the independent variable?)* to guide them to the best answer. For the last month of the semester, Stage 3 of note launchers only included the lesson objectives, placing the entire responsibility on the student to actively read and summarize key concepts based upon those objectives. The instructor intended that this "evolution" of note launcher format would develop the students' note-taking skills and build confidence in their ability to comprehend a mathematics textbook over time. Note launchers comprised a portion of students' participation grade; however, in terms of the overall course grade, note launchers were worth a minimal percentage so that students who chose not to complete them would not be unduly penalized.

In order to assess the effectiveness of note launchers, the instructor evaluated each student's notebook and note launcher completion rate. At each note launcher evolutionary stage, the instructor evaluated course notebooks in an effort to assess the growth of the students' note-taking skills. As the difficulty in completing note launchers increased, the point value doubled. Additionally, to assess their perspectives of note-taking using note launchers, students completed anonymous mid-course and end-of-course surveys.

Results

As note launchers evolved throughout the semester, the instructor assessed the students' note launcher completion rates. Table 1 summarizes the results of note launcher completion statistics for each stage.

Table 1
Note Launcher Completion Rate as a Function of Stage

	Stage 1	Stage 2	Stage 3
Median	72%	83%	63%
Mean	66%	66%	60%
Standard Deviation	23%	33%	29%

The first question on the mid- and end-of-course survey asked students to rate the statement, "Completing note launchers helped me understand the lesson objectives" on a 5-point Likert scale. Figure 1 displays the students' responses, showing that more than 75% of the students ultimately felt that note launchers helped them understand the lesson objectives. There was little change in the students' responses from the mid-course survey to the end-of-course survey. An equal number of students from the neutral category changed their mind to favorable and dissenting opinions.

Students often perceive something as beneficial if it helps them get a better grade, so the next question asked students to rate the statement,

Figure 1. **Student responses to "Completing the Note Launchers helped me understand lesson objectives."**

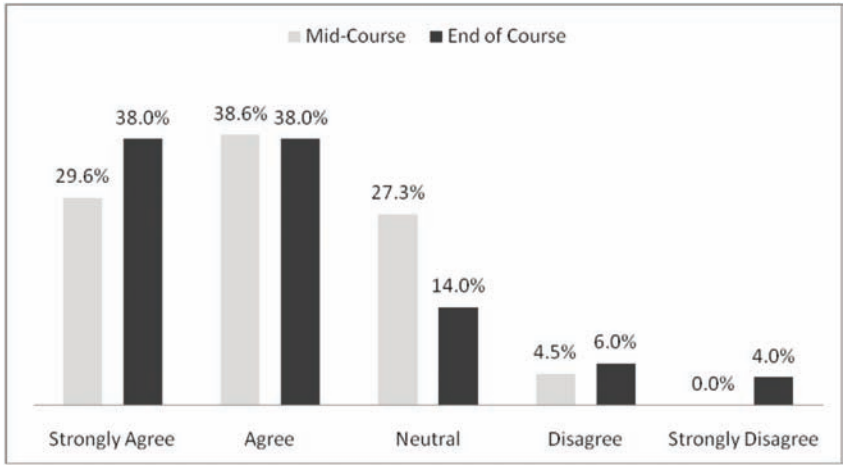
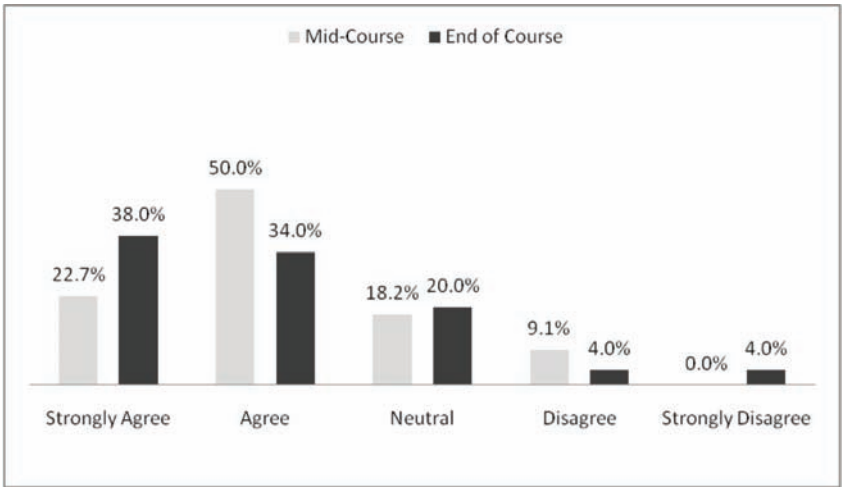


Figure 2. **Student responses to "Completing the Note Launchers helped in preparation for graded events."**



"Completing note launchers helped me prepare for graded events" on a 5-point Likert scale. As seen in Figure 2, approximately the same percentage of students were favorable, neutral, or dissenting towards this statement during the mid-course survey as were during the end-of-course survey.

Similarly, the next question asked students to rate the statement, "I appreciate the effort I put into preparing the note launchers" on a 5-point Likert scale. Figure 3 shows evidence that the students appreciated whatever level of effort they put into note launchers.

Ideally, better note-taking skills in one course are transferrable to other courses. As seen in Figure 4, at the end of the semester, after seeing the benefits of how taking notes on reading assignments can assist in learning lesson objectives, more than 75% of the students said that note launchers encouraged note-taking in other classes.

Lastly, students were asked if the instructor should continue offering note launchers as part of course assignments. Figure 5 shows that more than 80% of the students agreed that note launchers should continue being offered.

On the end-of-course survey, students could also answer open-ended questions about note launchers. Students were asked to describe the impact note launchers had on their course experience. Many students appreciated note launchers as a tool to recognize the textbook's signals for key ideas that the instructor planned to emphasize. Students said things such as, "Most importantly, [note launchers] help me pick out what

the most important concepts are for each lesson" and "[Note launchers] provided guidance for what specifics the instructor was looking for us to know for class each day. I knew that if I understood the basic concepts on them that I was going to do all right, and the opposite as well, if I didn't understand I knew exactly what questions to ask."

Figure 3. **Student responses to "I appreciate the effort I put into Note Launchers."**

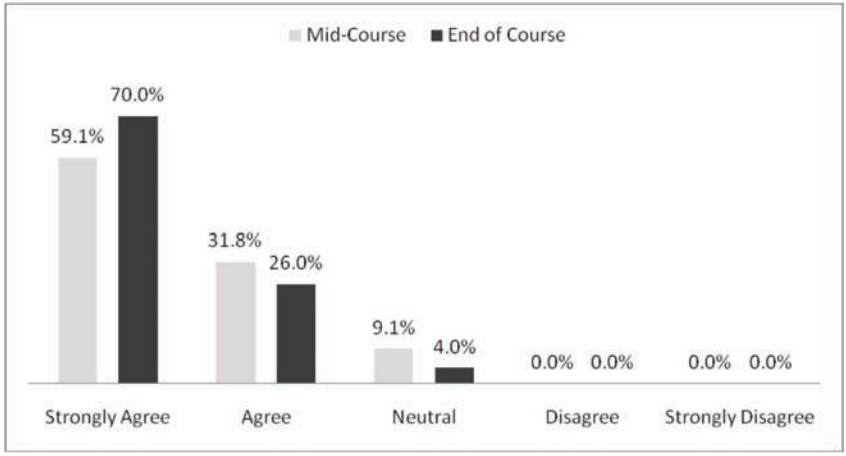
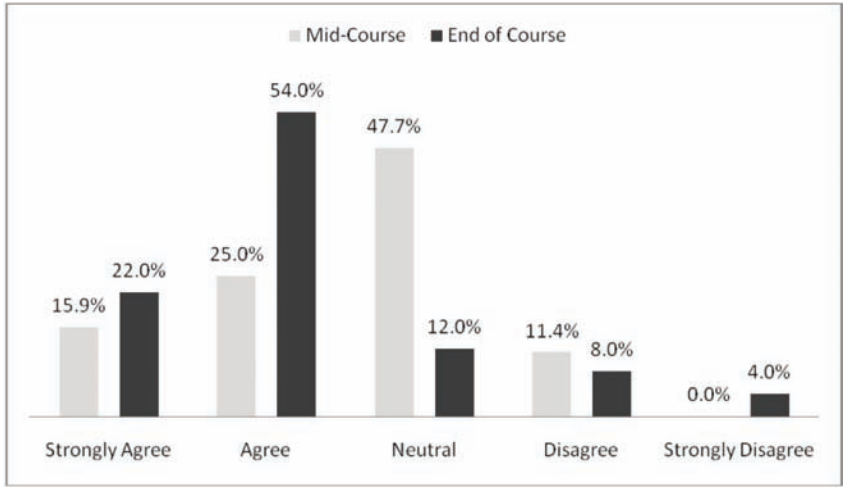


Figure 4. **Student responses to "Note Launchers encouraged note-taking in other classes."**



Responding to the question, "What modifications to your note-taking skills did you make as a result of the note launchers used in this course?", students alluded to efficiency as a skill inherent in this method. For example, one student said, "I learned to sort through what was most relevant and important rather than take down everything and remember nothing." Similarly, another said, "The note launchers helped me focus on the important details of the material being covered. Otherwise I would proably *[sic]* be prone to take pages and pages of notes."

Discussion

The intent of the study was to encourage students who were intimidated by mathematical textbooks to engage actively with the material. As seen in Table 1, the mean note launcher completion rate was always lower than the median completion rate; moreover, there was little difference in the mean completion rate among the three stages. The authors posit that the median completion rate was a more representative descriptive statistic because it mitigated outliers, whereas the mean completion rate was negatively skewed by students who never completed note launchers and therefore was less reflective of students who did not complete some of the early note launchers, but elected to utilize the study aid as the semester continued. It follows that the median completion rate increased during Stage 2, perhaps due in part to students who recognized the benefit of note launchers as a study aid for the first exam and chose to complete note launchers prior to the second exam.

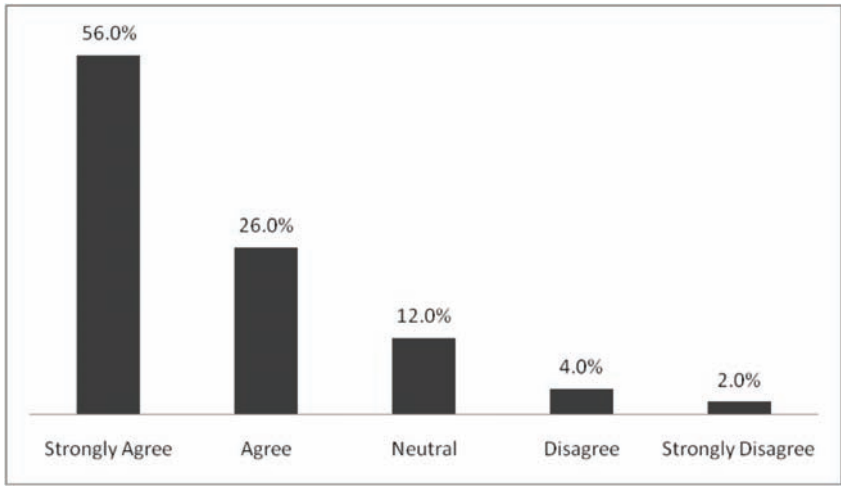
As note launchers became less structured, the completion rates became more varied, as evidenced in the higher standard deviations for Stages 2 and 3. Of course, this structural change should have encouraged higher levels of cognitive processing as the course progressed, but students resisted, making such statements on the end-of-course survey as, "I understand why they did it, but I wish the note launchers kept the questions for us to answer the whole year instead of becoming entirely on our own disection *[sic]* of the information we deemed relevant." Moreover, these results show that the completion rate dropped off drastically when note launchers only included lesson objectives in Stage 3, although the results for Stage 3 might not be very accurate, as the instructor only evaluated note launcher completion and did not review other papers in the notebooks. Because note launchers did not include much information in Stage 3, students may have preferred to take notes on other papers or in the textbook. Nevertheless, as first- and second-year students are generally not independent, self-regulatory learners (Cukras, 2006), it is not surprising that they prefer more structure, and likely benefit more from Stage 1 and Stage 2 type note launchers. As such, the instructor has

since developed note launchers for all lessons that include fill-in-the-blank type questions as well as open-ended prompts, to meet students at their learning levels.

After 16 weeks, students felt more strongly about whether or not note launchers helped them understand lesson objectives and helped in preparation for graded events than they did at the mid-course point. On the end-of-course survey, more students strongly agreed or strongly disagreed that note launchers were useful. The group of students who strongly disagreed may not have given much effort and were satisfied with little effort, perceiving note launchers as not useful. This finding is supported by the evidence in Figure 3, in which a majority of the students in the end-of-course survey appreciated their own efforts put into note launchers; the actual quality and quantity of time is not a variable, only the students' perceptions of their efforts. Still, the students' agreement as to whether or not the instructor should continue offering note launchers (Figure 5) shows a substantial number of students perceived note launchers as useful.

The most impressive student responses were to the statement, "The benefits gained from completing note launchers encourage me to take notes in other courses," rated on a 5-point Likert scale. While the scope of other course notes was not a variable in this study, 76% of the students agreed or strongly agreed that note launchers had indeed encouraged note-taking in other classes. Such skill transfer suggests that

Figure 5. **Student responses to "The instructor should continue offering Note Launchers."**



note launchers were an example of a teachable self-regulatory learning aid, something that students could practice in one discipline and then apply on their own in other academic situations. This finding was well worth the effort and time the instructor devoted to developing note launchers and grading course notebooks.

This research supports the instructor's intent to make mathematics texts more accessible, and as a result, the instructor has continued using note launchers in subsequent courses and has discovered that the time to create or update note launchers lessens with each iteration. Remarkably, students have written, unprompted, on the usefulness of note launchers in the overall course survey; one student commented that the "note launcher is also a very good thing, with…fill in the blanks for notes" and another noted that note launchers "were very valuable in WPRs and Writs" [institution-specific terminology for tests]. Observed another student, "I really liked the course note launchers that my class had because it helped me figure out what was important from the lesson and I learned more from that than I would have from simply taking notes on the readings." One student had the valuable suggestion to make note launchers available online to students in other sections of the course as well.

There were limitations to this study. First, to prevent fear of retribution, the surveys had to be anonymous; therefore, the instructor could not correlate note launchers with survey results, note launchers with final grades, or survey results with final grades. The authors recommend a research study that would allow for such correlations, the findings of which could be used to promote active note-taking habits early in the semester. Second, the instructor could not dedicate enough time to formative assessment, given the other amounts of graded work in the course and institutional requirements. The instructor would have preferred to evaluate note launchers with more detailed individual feedback, but frequently settled for a few brief comments and a general discussion of observations to the class. Third, although the instructor gave minimal grade weight to complete the assignment, he perhaps overestimated students' intrinsic motivation, as the incentive was disproportionate to the effort that students spent to produce substantive note launchers. Last, to supplement note launchers, the instructor encouraged students to annotate the textbook as they read, but never evaluated that note-taking technique. Likely mutually beneficial, these processes would be worth examining in future research.

In future applications of note launchers, the authors suggest instructors have a solid understanding of their students' cognitive stages, so as to provide the appropriate amount of challenge within the assignment.

Note launchers should have just enough structure to engage students in active reading without appearing burdensome to students, or too elementary for learning to begin. Additionally, when introducing the concept, making available an exemplary completed note launcher would demonstrate what right looks like. Finally, to aid the unconvinced, instructors can share written comments from pleased former students about the value of note launchers.

As an example of a reading guide, note launchers can be a useful technique for facilitating mathematics textbook comprehension and getting students to read carefully and critically. In this study, although students sometimes grumbled about the amount of extra effort *at the outset,* many of them eventually recognized that note launchers make them more efficient studiers. At the very minimum, note launchers compel students to stay active during the reading process. Moreover, they provide students a framework for the kind of information—objectives, fundamental concepts, vocabulary, examples—they should seek in their textbooks, a skill that students can transfer to reading assignments in other courses.

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