Reading Assignments and Assessments: Are Your Students Reading Math Texts Before Class, After Class, Both, or Neither?

D. Klanderman, M. Maxwell, S. Robbert, B. Boerman-Cornell
Trinity Christian College, Illinois

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Abstract

In his recent book *What the Best College Students Do* [Bain, 2012], Ken Bain defines a number of different types of students including "surface learners," "strategic learners," "routine experts," and finally, "deep learners." In our mathematics courses at Trinity, we have found examples of all of these student types. A major determinant of their preferred approach to learning appears to be the ways and degrees to which mathematical texts and other written materials are read prior to class sessions. Each full-time member of the department both assigns and assesses the reading of mathematical materials prior to class sessions. Assessment methods, as well as the corresponding pedagogical choices, vary significantly. We also discuss the results of a related survey of over 100 Trinity undergraduates enrolled in mathematics courses during fall 2012.

1 Introduction

Do you assign sections of the mathematics text to be read by your students prior to class? If so, do you assess your students' completion and/or understanding of these assigned readings? What percent of your students actually read the material before class? Do any of your students read the material after class, perhaps in the process of doing homework or reviewing for an upcoming exam? At Trinity Christian College, the mathematics faculty members are interested in all of these questions. One of the authors is an expert in literacy and regularly teaches and does research in the area of reading in different disciplines. Since all of the mathematics colleagues regularly assign texts, articles, book chapters, and other readings, and we also hold our students accountable for these reading assignments with related assessments, we decided to delve more deeply into the general topic of reading assignments and assessments in mathematics courses.

2 Insights from Research

Recent studies have confirmed the need for instructors to apprentice students into ways of reading that are particular to different academic disciplines (See e.g., [Hynd, 1999], [Shanahan, 2004], [Stahl et al., 1996], [VanSledright, 1995], and [Wineburg, 1991]). Some specific studies have looked at reading in mathematics. Schwartz and Kenney [Schwartz and Kenney, 1995], Fuson, Kalchman, and Bransford [Fuson et al., 2005], and Martinez and Martinez [Martinez and Martinez, 2001, page 47] delineated specific ways of thinking that are unique to mathematics.

Shanahan and Shanahan [Shanahan and Shanahan, 2008] and with Misischia [Shanahan et al., 2011] compared expert and novice studies to delineate how mathematicians read. Weber and Mejia-Ramos [Weber and Mejia-Ramos, 2013] responded to that study with an investigation of the use of sources in reading for mathematics. Johnson et al. [Johnson et al., 2011] contrasted different literacy practices in language arts and mathematics and determined that the different disciplines required different sorts of literacy practices and strategies. Hersch [Hersch, 1997] argued that students need to be taught how words are used differently in mathematics class. Mathematics may look and sound exactly like everyday English, but words like similar and number have different meanings in everyday English than they do in mathematics.

In our study, though, we were interested in the perceptions of our students. Do college students find a disciplinary literacy approach to teaching mathematics to be helpful? Do they find required disciplinary reading in mathematics to be useful to their understanding? Do regular reading assignments in mathematics courses, accompanied by appropriate assessments, result in students reading the material prior to class? Are these pedagogical approaches viewed as effective by these students?

3 Pedagogical Approaches for Assigning and Assessing Mathematical Readings

Although each of the mathematical colleagues assigns and assesses readings in her or his mathematics courses, there are a variety of methods currently being used. In several introductory level courses (including differential calculus, finite mathematics, and statistics), students are required to read section(s) of the textbook prior to a class session, sometimes with the assistance of key questions to focus the reading. Assessment during the following class takes the form of a short quiz. In one class, students work in (randomly assigned) pairs and may refer to notes that they took from the reading. In another class, the format of the quiz is randomly determined and could be individual, small group, entire class, or possibly omitted. In later semesters of calculus, these reading assessments are continued but sometimes with less guidance prior to the assigned reading.

In "Math Concepts for Teachers I," active reading strategies are modeled and students regularly complete short online quizzes prior to class. In "Mathematics Within a Liberal Arts Tradition," students are assigned to reading groups for a specific chapter from *Mathematics in a Postmodern Age: A Christian Perspective* [Bradley and Howell, 2001]. Students answer assigned questions and share the responsibility of leading the class discussion of this chapter. In the same course, students typically work in pairs to research a famous mathematician and present the resulting "math cameo" during class.

At the advanced level, students are encouraged to use active reading strategies to solve simple practice problems in discrete mathematics. In linear algebra, true/false questions related to the assigned readings enable students to self-assess their understanding and address common misconceptions. Generally, pairs of students are responsible for sharing their answers to these questions with the entire class. If their classmates disagree with any of their answers, or if any of their answers are incorrect, then those questions are explored more fully in class. In geometry, students read chapters and complete related response sheets from *Journey Through Genius* [Dunham, 1990] and *Mathematics in a Postmodern Age: A Christian Perspective* [Bradley and Howell, 2001] and lead discussions during subsequent classes, either individually or as part of a larger group. In history of mathematics, students read assigned material, work on related exercises, and submit a 1-2 page

synthesis accompanied by several questions for class discussion. These questions are submitted prior to class sessions and result in a flipped classroom model for instruction. Finally, students in the senior capstone course read *A Certain Ambiguity: A Mathematical Novel* [Suri and Bal, 2007] and *Mathematics Through the Eyes of Faith* [Bradley and Howell, 2011] in preparation for class discussions and a later midterm paper that requires students to articulate a Christian worldview and its implications for their chosen major and vocation. (See [Klanderman and Robbert, 2012] for additional details on how the latter is accomplished.)

In summary, the types of readings assigned, as well as the nature of the corresponding reading assessments, vary from course to course. However, the common goal is to encourage students to read mathematics texts, books, and articles for understanding and to complete these readings prior to subsequent class sessions. In turn, our pedagogical approaches seek to build on the students' already developing understanding of the concepts rather than to simply repeat the major concepts from the assigned sections in a routine lecture.

4 Results from a fall 2012 Survey of Trinity Students

A total of 114 undergraduate students enrolled in a mathematics course at Trinity Christian College completed a short survey at the end of the semester in fall 2012. Student participation was voluntary and no data from the survey were analyzed before course grades were submitted. Although this convenience sample is not random, it is nonetheless representative in several important ways. Approximately 65% of the respondents were female, essentially matching the college enrollment as a whole. (See Figure 1.) The proportions of respondents from various academic majors are reason-

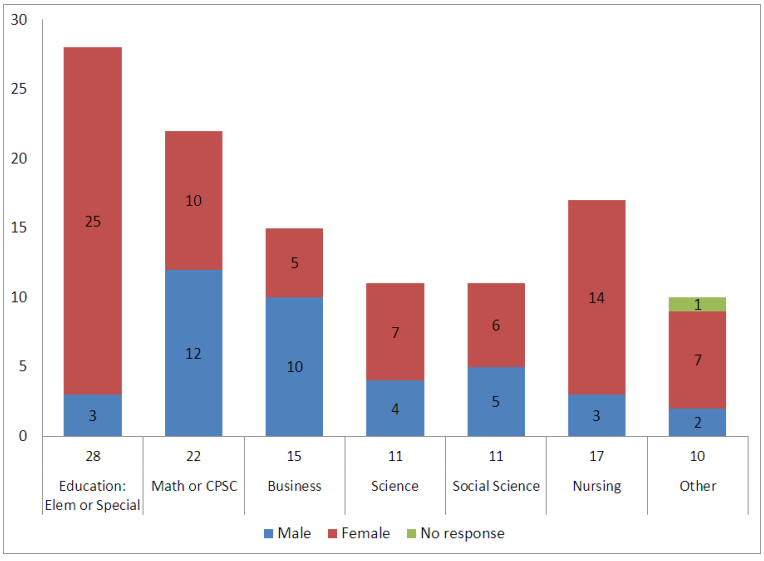

Figure 1: Gender Distribution by Major Cluster

able approximations of the entire student body with two notable exceptions. (See Figure 2.) Due to the mathematics courses included in the sample (introductory statistics, differential calculus, Math Concepts for Teachers I, and advanced level courses in geometry, history of mathematics, and a senior capstone seminar for math majors), very few students with majors in the humanities or fine arts completed the survey. Also, not surprisingly, the sample has a much higher proportion

of mathematics majors (16% of the sample vs. 2.1% for the entire student body). In fact, the mathematics majors in this sample represent 72% of all mathematics majors at Trinity.

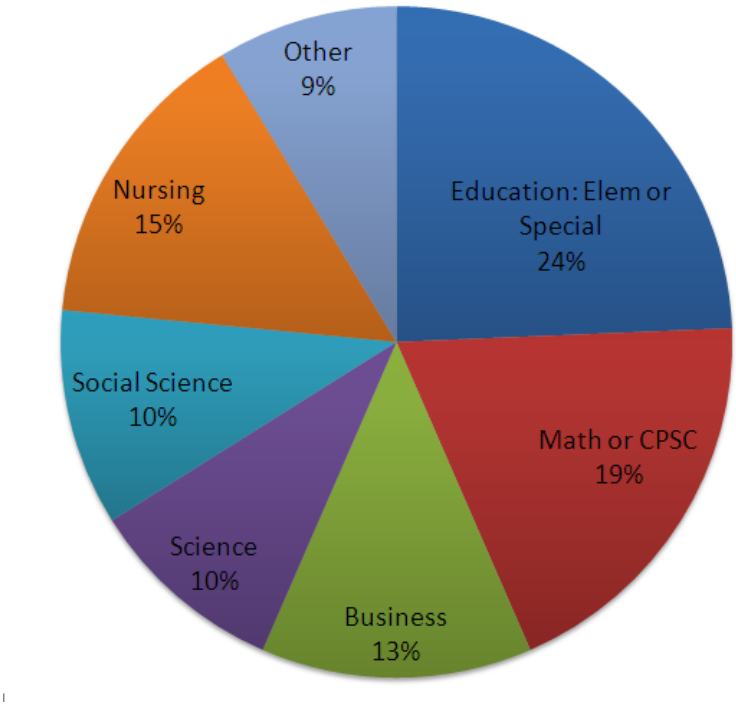

Figure 2: Distribution of Respondents among Major Clusters

In addition to demographic questions discussed above, these anonymous surveys asked students to give a Likert-scale rating (strongly agree, agree, disagree, or strongly disagree) to the following two statements:

Statement 1: *The reading assessments encouraged me to read the assigned material prior to class.*

Statement 2: *The reading assessments were an effective learning tool in the course.*

Students were also asked to identify positive and negative aspects of the reading assessments and to discuss any changes in their approaches to reading that occurred during the semester. Finally, students with a major in mathematics were also asked if their self-perception as a mathematics major had changed as a result of the course.

As we analyzed the data from the surveys, we decided to group the Likert-scale responses into two categories, combining "strongly agree" with "agree" and combining "disagree" with "strongly disagree." For Statement 1, a total of 75% of the 114 students agreed that the reading assessments encouraged them to read the assigned material prior to class. The results were not uniform across major clusters, with 96% of mathematics/mathematics education/computer science majors and 100% of biology/chemistry/exercise science majors responding in agreement. By contrast, only 46% of elementary education majors agreed with Statement 1. Given the gender imbalance among elementary education majors, it follows that the level of agreement for Statement 1 was lower among females (72%) than males (80%). (See Table 1.)

Major Cluster	All		Male		Female		No Response	
Education: Elem or Special	13	(46.4%)	2	(66.7%)	11	(44.0%)	0	
Math or CPSC	21	(95.5%)	11	(91.7%)	10	(100%)	0	
Business	12	(80.0%)	8	(80.0%)	4	(80.0%)	0	
Science	11	(100%)	4	(100%)	7	(100%)	0	
Social Science	7	(63.6%)	2	(40.0%)	5	(83.3%)	0	
Nursing	15	(88.2%)	3	(100%)	12	(85.7%)	0	
Other	7	(70.0%)	2	(100%)	4	(57.1%)	1	(100%)
All	86	(75.4%)	32	(80.0%)	53	(71.6%)	1	(100%)

Table 1: Strongly Agree or Agree for Statement 1

For Statement 2, a total of 68% agreed that the reading assessments were an effective learning tool in the course. Among the major clusters, the agreement level was highest among math/math ed./computer science majors (91%). Interestingly, for students who had completed multiple math courses at Trinity and were now enrolled in advanced level courses, there was 100% agreement with Statement 2. Other majors had lower levels of agreement, the lowest being 53% for the business/accounting majors. Once again, the relative gender imbalance among these latter majors resulted in lower agreement levels for males (55%) than females (74%). (See Table 2.)

Shifting to the qualitative data, there were many positive aspects related to reading assessments that were noted by the students. A total of 40 (35%) of students mentioned that reading in preparation for class enabled them to better understand the professor's explanation or their exploration of the content in class. Of the respondents, 23 (20%) noted that the reading assessments forced them to actually read the material, which perhaps indicates that students need to be held accountable for these readings. A smaller proportion (18 students or 16%) cited the earning of points as a positive aspect, even though none of us count the reading assessments for more than 4% of their total semester grade. A few students mentioned that the readings allowed them to learn concepts in greater depth and to consider different ideas or methods for solving problems. Finally, one student remarked that it also proved valuable to return to the assigned readings after class and as a review prior to the unit exam.

As for the negative aspects of reading assignments, some of the most frequently occurring responses were not viewed as negative by their professors, including "time consuming" (28 responses or 25%) and "no response or none" (21 responses or 18%). A total of 27 students (24%) noted that the readings were often confusing to understand and required further discussion during class. This

Major Cluster	All		Male		Female		No Response	
Education: Elem or Special	15	(53.6%)	1	(33.3%)	14	(56.0%)	0	
Math or CPSC	20	(90.9%)	10	(83.3%)	10	(100%)	0	
Business	8	(53.3%)	4	(40.0%)	4	(80.0%)	0	
Science	6	(54.5%)	1	(25.0%)	5	(71.4%)	0	
Social Science	9	(81.8%)	3	(60.0%)	6	(100%)	0	
Nursing	12	(70.6%)	1	(33.3%)	11	(78.6%)	0	
Other	8	(80.0%)	2	(100%)	5	(71.4%)	1	(100%)
All	78	(68.4%)	22	(55.0%)	55	(74.3%)	1	(100%)

Table 2: Strongly Agree or Agree for Statement 2

response provides us with impetus to examine more fully the complexities of reading mathematics texts even as it confirms the value of input from the professor in the learning process. Other negative reactions that were cited less often but multiple times included "readings were boring," "hard to focus on key ideas," and "not motivated to read the entire section."

With regard to whether the inclusion of reading assessments affected the students' approach to reading, the plurality of students (43 responses or 38%) stated that there was no change. However, a total of 42 students (37%) indicated a positive impact on their approach to reading, including the realization that reading is imperative to understanding, that reading is worth doing and helps in learning math, that previewing is helpful, and that "math books can actually make sense." Only 7 students (6%) indicated that they still hate reading or do not want to read textbooks as a result of the course.

As a way of sorting through all of the aforementioned data, we decided to group the students into one of four categories based upon their perceived attitude to reading assessments and their effectiveness as a learning tool. The categories were based primarily on their qualitative responses. We titled the first of these four categories "Learners." Students in this category emphasized positive aspects of reading assessments and their role in learning the material in the course. A total of 69 students (61%) fit in this category. A total of 83% of this group agreed that the reading assessments encouraged them to read the material and 80% agreed that the reading assessments were a valuable learning tool. Few negative responses were observed in this group, although a few noted that readings could be confusing and a few others commented that in cases where they fully understood the material prior to class, the class sessions were not as beneficial. Overall, we were very encouraged by the large size of this category of students who clearly benefited from the assigned readings and related assessments.

We classified a second group as "Obeyers," a group that included 22 students (19%) of the sample. Students in this group obeyed the professor and read the assigned materials, resulting in 100% agreement that the reading assessments encouraged them to read the texts. However, only 68% of these students agreed that the reading assessments were an effective learning tool. Not surprisingly, the most frequently cited positive aspect was that the reading assessments encouraged them to read the material. Few negative comments were offered and those listed either cited the length of time required to read or the need for the assessments to count for more credit in the course grade. Overall, we were satisfied that students in this category also benefited from the assigned readings, perhaps due to the related assessments.

A third group we named "Point Maximizers." As the name implies, these 17 students (15%) were motivated by the (relatively insignificant) credit awarded for the reading assessments. Positive aspects typically pointed to the ability to increase their course grade through these assessments, while negative comments typically noted that the readings were often confusing. Interestingly, only 41% of these students agreed that the reading assessments encouraged them to read (as opposed to the credit earned by these same assessments) and only 35% of these students agreed that the reading assessments were an effective learning tool. Rather, the reading assessments appeared to be a means to the end of a higher course grade. Overall, we are satisfied with the result of students reading the material, even if the primary motivation was the earning of a small amount of points toward the course grade.

Finally, there is a group that we chose to call the "Unhappy Campers." Fortunately, only 6 students (5%) fell into this response category. None of these students agreed that the reading assessments

encouraged them to read the text, and only 33% of them agreed that the reading assessments were an effective learning tool. For these students, there were no positive aspects, and the common negative aspect was that the readings were confusing. While we were disappointed with these respondents, we were relieved that only 5% of our students were placed into this category.

5 Conclusion

Overall, the survey data confirm what we had hoped. Namely, reading assignments in mathematics courses, when accompanied by appropriate assessments, can promote learning and motivate students to be prepared to learn when they arrive at our mathematics classes. It was interesting to us that different students seem to be motivated by different factors but that 75% of the students self-reported that they completed the assigned readings, even if some may have resorted to skimming the material to answer assigned questions or prepare for a reading quiz rather than reading the entire section. The number of students that remarked that the readings were at least sometimes confusing and difficult to understand highlights the need for further study into the distinctive features of reading mathematics texts and a related need for professors to offer guidance and scaffolding, particularly in the introductory mathematics courses.

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