Implementation of Pre and Post Class Readings in Calculus

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Active learning practices highly depend on students’ preparation for class in advance. However, reading Calculus can be a challenging task to students. We address this concern by assigning targeted pre-class readings and reading quizzes in two Calculus II classes. To study the effectiveness of these, we also provided them as post-class readings in two other classes. We report on our implementation and we discuss students’ feedback about the readings and quizzes.

Key words: pre and post class readings, reading quizzes, exit quizzes, Calculus

Introduction

In recent years, Flipped Classroom and Inquiry-Based Learning pedagogies have emerged as methods of active learning. These active learning practices highly depend on students’ preparation for class in advance. To prepare for class, professors often ask their students to read the textbook before they come to class. However, most faculty report that students rarely do this (Felder & Brent, 1996). We believe that this concern is even more evident in mathematics education. Reading mathematics texts before the class can be a challenging task to students especially in introductory classes such as Calculus. In this proposal we attempt to address this issue by implementing active learning practices (Prince, 2004) in four classes of Calculus II.

Our study is divided into two themes: students in two sections had access to short typed targeted notes before class combined with reading quizzes at the beginning of the class period. In two other sections students had access to the same notes after the class and the same reading quizzes were given to them as exit quizzes at the end of the class. After presenting a literature review, we describe the methods of this study. In particular, we describe the structure of these classes, the nature of the readings and quizzes, and the collected data. We report preliminary quantitative and qualitative results on students’ usage of textbooks and these notes. We provide some of their feedback about the pre/post class readings and the respective reading/exit quizzes.

Literature Review

Many science education articles discuss reading assignments and reading quizzes. Hodges, Anderson, Carpenter, Cui, Gierasch, Leupen, and Wagner (2015) discussed different formats of reading quizzes in different STEM areas. We found in (Heiner, Banet, & Wieman, 2014) an implementation of targeted pre-reading assignments with an associated online quiz in two science classes, physics and biology. In an introductory physics course, Henderson and Rosenthal (2006) used reading questions instead of reading quizzes where students posed questions on the assigned readings to the instructor via email before class.

On the other hand, there have been numerous research articles demonstrating the difficulties students have with reading mathematics texts. For example, Shepherd, Selden and Selden (2009) believe that “many, perhaps most, first-year university students do not read large parts of their mathematics textbooks effectively, that is, they cannot work straightforward tasks based on their reading. Whether this is because they cannot read effectively, or choose not to do so, seems not to have been established” (p. 1). Shepherd (2010) also states that “the textbooks for many first-year university courses, such as college algebra, precalculus, and calculus seem to be written with the assumption that they will be read thoroughly and precisely” (p. 3). She also refers to a
brief survey (JMM presentation, Exner & Shepherd, 2008) of Calculus I students where they found that few read the textbook at all. The authors of this presentation (as cited in Shepherd, 2010) provide a typical student comment: “When I think there is a formula I need, I’ll go back and look if there is a formula, otherwise… there is very little chance that I’m going to read any of it.”

In addition, we refer the reader to Weinberg, Wiesner, Benesh, and Boester’s study (2012) in which they surveyed 1156 undergraduate students in introductory mathematics classes about their textbook usage. Students reported that they used the examples instead of the expository text. Weinberg et al. results show that “instructors may play a role in students’ textbook use. When students perceive that they are asked to use their textbook, they report that they are more likely to do so…Although the conclusions that can be drawn from these results are limited, they suggest that instructors may be able to increase students’ use of their textbooks by asking their students to use their textbooks” (p. 23).

The aforementioned student’s comment from (Exner & Shepherd, 2008) and Weinberg et al.’s results (2012) probably describe the attitude of the majority of Calculus students towards their Calculus textbooks. This motivated us to provide students with targeted summarized typed notes that can serve as a tangible resource for students’ learning of Calculus concepts. By going through a literature search, we have found little evidence on the usage of targeted reading assignments in Calculus courses. In this preliminary report, we discuss the implementation of pre and post class targeted readings in Calculus classes. We also report on using quizzes that served as both “reading” (beginning of class) and “exit” (end of class) quizzes. Preliminary results from an end of the semester survey are presented in which we address the questions: How much time do students spend on pre-class readings; how often do they use post class readings? How do they perceive these readings? How do they perceive reading and exit quizzes?

**Study Design**

The study was conducted in four sections (Sections 2, 8 am; 4, 10.50 am; 6, 4.30 pm; 8, 8 am) of Calculus II classes at a comprehensive Northeastern university that has emphasis on sciences and engineering. At this institution, Calculus II covers integral Calculus and Series. The classes had a total of 90 students where a total of 69 students consented to participate in the study (26 females and 43 males). The majority of them were Engineering and Forensic Sciences majors. The classes met in Spring 2016 semester, three times a week for one hour and fifteen minutes.

To answer the questions above, we designed the study to have two sections (4 & 6) with pre-class readings where students took a quiz on new concepts and techniques at the beginning of the class period. Two other sections (2 & 8) had access to the same readings after the material was discussed in class and the same quizzes were taken as exit quizzes at the end of the class.

The readings were targeted in the sense that they were brief and prepared (typed) by the instructors. A typical note is a 1 page (at most 1.5 pages) long that has a short discussion about a concept followed by two or three examples. Fig. 1 is a sample note on Integration by Parts. We omit the second part of this note that included the two examples ∫ xe^x dx and ∫ xlnx dx followed by a brief generalization to any power of x. We designed the quizzes to be very similar to the examples in the readings that included any new formulas and multiple steps to guide the student’s answers. In Fig. 2 we see a sample quiz question on Integration by Parts. It is worth noting that the quizzes constituted only 5% of the final grade and hence did not have a huge impact on students’ final grade.
The collected data for our study include two surveys, the first was given in the second week of classes and the second was given in the last week of classes. Our data also include the reading/exit quizzes, an early quiz on the first day of class and a retention quiz at the end of the semester. The grades for these two quizzes were not counted towards students’ grades but the students were not informed of this till after the quizzes were taken. For this report, we only present data from the two surveys.

Preliminary Results

In the early survey we asked students about their study habits and, in particular, how often they read the textbook prior to the next class. We found that about 65% of the students who took the survey reported that they never or seldom read the textbook before coming to class, about 22% of them said they read the textbook about half the time, and about 13% said they read it usually or always. This shows that most students did not spend time outside the classroom to reinforce the learning of the concepts that were discussed in class before they come to the next
class period. These results served as a motivation for assigning pre-class readings or providing targeted readings for an after-class reinforcement of concepts.

We now present some preliminary results from the end-of-semester survey. We analyzed two questions from the survey. In sections 4 and 6, we asked the students: How much time (on average) did you spend on each pre-class reading assignment while in sections 2 and 8, we asked the students: Did you use the typed notes when you worked on your homework or studied for tests (did not use them, sometimes, frequently, all the time). In all sections, students were asked to rate the usefulness/effectiveness of the typed notes. In sections 4 and 6, 59% of students spent between 20 and 40 minutes, 16% spent more than 40 minutes, while 25% of students spent less than 20 minutes on the typed notes. The survey analysis showed that 69% of students in these two sections found the notes either effective or very effective. In sections 2 and 8, 76% of students either used them sometimes or frequently when they worked on homework assignments or studied for tests and 68% of students found them either effective or very effective.

In the following, we support these positive students’ perceptions by providing some of their feedback on the notes and the quizzes. Even though the quizzes constituted only 5% of the final grade, they had a relatively high impact on students’ pre-class reading efforts in sections 4 & 6, and on students’ attention span in sections 2 & 8. We will support this claim via students’ qualitative data from the end-of-semester survey.

We start with comments from students in sections 4 and 6 who had pre-class readings. We refer to students from these sections as S-number. Student S1 reported:

The notes and quizzes constantly forced us to actively learn outside of class which I thought was very effective.

Student S2 found that:

The typed notes and the quizzes are great additions to the class is probably why this class has not been as stressful as previous math courses.

Student S3 pinpointed the main purpose of having pre-class readings:

The typed notes and quizzes made us have an understanding of the topic before class but left room for further understanding during class discussions.

Student S4 had a concern about the grades when s/he said:

The notes are helpful but don’t give the same understanding like doing it in class does which effects the grades since we do the quizzes in the beginning.

Student S5 commented:

The typed notes were very helpful because they helped me have some understanding of the material before it was taught to me. There were only a few that were hard to understand but then the lecture was able to help me get a better grasp of the material. The quizzes were also very helpful because they pushed me to actually read the notes.

We also provide some feedback from students who had access to the typed notes after class and we present their feedback on the exit quizzes. We refer to students from these sections as T-number. The main theme of students’ feedback was that the typed notes were helpful in doing the homework and that the quizzes kept the students’ attention at a high level. For instance, student T1 said:

The provided typed notes were a great help in doing the HW. They should of however, been uploaded before class instead of after. The quizzes were good to make sure that you are actually understanding the lesson that day.

Student T2’s feedback was:
The typed notes helped with the typed homework and the quizzes helped reinforce what I learned that day.

Student T3 found that:

The notes, quizzes, & the assigned typed HW helped me comprehend the content even more than what I had expected.

While Student T4 commented:

I liked the typed notes, but for the last few classes of the semester the typed notes did not cover everything we did in class. I like the way the quizzes are (right after the lesson)….I think that quizzes sometimes took away from the lecture when we could have used that time to finish the lecture.

Student T5 gave the following comment:

Typed notes: I find it hard to understand math written out on a piece of paper.
Quizzes: a nice grade booster and opportunity to show what I learned.

Discussion/Future Research

Our preliminary data analysis shows that the majority of the students reported that the typed notes and quizzes were helpful and conducive to learning. Some students went even further and recommended some changes. For example, Student T1, from a post-reading section with a final C+ grade in the course, expressed her/his preference to having access to the typed notes before class rather than after. Her/his feedback basically encapsulates instructors’ hope of increased exposure to concepts outside the classroom. It is indeed our goal to assign these readings before class in every course, but for the purpose of this study, this was not the case in Spring 2016.

As pointed out by some students, there were a few notes that were technical and harder to read. We definitely agree and we will surely modify these notes as we implement these readings in the future. However, we do not plan to increase their size as we want to intentionally keep them short and concise. The purpose of the notes is not to replace the classroom mini-lectures or discussions, and consequently they will not cover everything that is discussed in class.

To address student T4’s concern about the time taken by the quizzes (typically about 5 minutes), we looked into other alternatives such as online quizzes but we believe that in class quizzes give a better hands-on learning experience for students. We also claim that they provide a better assessment method of students’ reading efforts and attention span.

For future research we hope to have a more in depth analysis of our data. In particular, we would like to have:

• A comparative analysis of the grades on quizzes and/or exams of the 4 sections through the lens of the targeted notes’ usage,
• A study of the effect of these notes on students’ content retention using the retention quiz,
• A study of the effect of pre-class readings on the classroom environment as reported by the instructors’ observations, and
• An exploration of the shortcomings of this study such as the different meeting times and lack of instructions on how to read mathematics.

Preliminary Report Questions

1. Do the different meeting times of classes impact students’ learning and performance?
2. What does existing research suggest for instructions to read mathematics?
3. What is the correlation between students’ GPA and their motivation to read mathematics textbooks/notes?
References


