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Can Students Learn to Use Textbooks Effectively?

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ABSTRACT

Can a class assignment covering the reading help students do better in an introductory chemistry class for nonmajors? Two sections of the same course have been compared where one section had a reading assignment that "forced" the students to interact with the text while the other class had the typical homework, quiz assignments, and discussion posts. Both groups took 3 exams and the final exam. A t-test compared the means for each exam, the final exam, and the overall class average. The mean was higher for the group that had the reading assignment in each case. The mean for the class was 71.3% versus 66.7% (p value = 0.050). The mean for exam 1 was 73.0% versus 60.5% (p = 0.052). The mean for exam 2 was 73.3% versus 67.5% (p = 0.225). The mean for exam 3 was 76.9% versus 62.4% (p = 0.044). The final exam was 56.6% versus 55.3% (p = 0.445). The implication may be that students do not understand how to study or what is involved in effective studying. When reading the text is incentivized as an assignment, more students seemed to interact with the text, and more were likely to succeed in the class. This paper examines how interacting with the text for a class supports comprehension.

INTRODUCTION

Students have multiple places to get answers to their questions. Previously, the professor, the textbook, or the library were the only options. Today's students have grown up with access to the internet. Students may wonder why they even need a textbook. They can look up all the answers.

Instructors see a different view. The internet is a valuable resource but often feels very scattered. In chemistry, internet content ranges from sites for students taking classes to very advanced technical resources. They certainly do not all agree with each other. Information on the internet can be wrong or disagree with a particular class emphasis. It can be challenging to find one source of information that delivers in the same way that a textbook does.

Many classes that utilize the internet and its various resources still have a textbook. A reading intervention was introduced for each chapter in a nonmajors science class to determine if reading the chapter material helped students do the reading and if reading helped the students be more successful. The hypothesis is that additional scaffolding of the material and creating a reading intervention will cause students to be more successful.

To facilitate increased interaction with reading material, in the Chemistry 100: Chemistry and Its Role in Society (CHEM 100) class, an assignment was made of mandatory reading assignments that would count as homework assignments. As an assignment, students were more motivated to complete readings and answer questions over the task to see if they understood what they had read.

CHEM 100 is a class for students to fulfill the general education requirement for a degree at the Community College of Baltimore County. In the fall of 2020, the class was taught in its usual manner. The course had homework, quizzes, 3 exams, 4 discussion prompts, and a final exam. In the syllabus, the students were advised to read the book and study each chapter. No further instructions were given. There were no assignments to encourage any reading of the textbook.

In the spring of 2021, reading assignments associated with each chapter were assigned for points in the students' homework category. These reading assignments prompted students to answer questions or to read. If the student chose to answer questions, they would need to answer questions correctly to continue. If students could not answer a certain number of questions, they were directed to read a portion of the textbook before answering questions again. These reading assignments were customized to the material the instructor wanted the students to cover, so the students probably did not end up reading the whole chapter. Still, they seemed to read more of the book material than in semesters past.

The hypothesis is that the reading assignments cause the students to do more reading of the textbook. This would result in higher scores on each exam, the final exam, and overall course grades in spring 2021 compared with the fall of 2020. These 2 semesters were chosen because they were similar in the assigned content and the scope of homework, quizzes, and exams.

The course is described in the course catalog as involving basic chemistry. Many students have reported that they feel as though the material is not basic chemistry at all. Many students struggle with the content. The class is offered only online. As the course is a mix of real-life applications with basic chemistry knowledge, it can be challenging to find appropriate resources for the students.

Some resources contain too much information that is not a part of the course due to being aligned with introductory or general chemistry courses. Some resources do not have enough information, as in this class, some topics are not covered in an introductory or general inorganic chemistry class. Some examples are a thorough study of different energy methods, nutrition, environmental chemistry, and how radiation affects living organisms.

Students object to work that they perceive as meaningless. They want to feel as though their assignments are relevant and creating meaning. If reading assignments help students make meaning and promote relevance in the students' chemistry class, that would make the reading assignment a welcome resource and not a source of busywork. Lack of data concerning what types of assignments promote learning in a nonmajor chemistry course is a gap in the literature. Most of the literature in chemistry deals with the general inorganic chemistry sequence at the university level.

Literature Review

Once students have entered higher education, there may be assumptions about ability on the instructor's part. One of these is that students knew how to study. This assumption often turns out to be false. Understanding how to read text is another of these assumptions. Reading and different ways to interact with text is one of the main problems students have. Students do not know how to read their textbook or understand the different types of reading for various reading activities.

Since education exists amid vast amounts of printed information, reading is essential for any student (Bharuthram, 2012). Being able to read the text is only the beginning. Students must put information into context and integrate it with previous material they have learned (Rovers et al., 2018). Researchers have argued that reading is the jumping-off place to critical thinking and problem solving (Howard, 2004).

Past research in applied linguistics and reading research shows a strong correlation between reading proficiency and academic success at all ages (Grabe, 2004). Instructors do not assign textbook assignments as busywork but as a means of assimilating classroom material. Despite this, only 20-30% of undergraduate students complete required readings (Kerr & Frese, 2018). Ignoring class readings represents a tremendous underutilization of the textbook on the part of the students.

Literacy is not a new field of research. Students entering higher education lack the skills to comprehend written materials. In 2006, the American Institutes for Research surveyed 1,827 graduating students from 80 randomly selected 2-year and 4-year public and private colleges and universities across

the United States. They determined that 75% of students at 2-year colleges and more than 50% of students at 4-year colleges do not score proficient in literacy (American Institutes for Research, 2006).

These findings have practical application as it means that these students lack the skills to perform complex literacy tasks, such as comparing credit card offers with different interest rates or summarizing the arguments of newspaper editorials. Research has also shown that students who read more than their peers did achieve higher grades in assessments (Sappington, 2009).

There are several reasons that students list for not doing the reading in a course. These include confusion about what a professor expects of students, whether students perceive a benefit in doing the readings, course structure, lack of time, practicalities, and confidence to determine what is essential (St. Clair, 2017; Ritchey, 2021). In addition, the cost of textbooks is rapidly rising, leading many students to feel that cutting out the textbook is an appropriate measure (Stein & Hart, 2017).

In the sciences, particularly in chemistry, it may seem appropriate to ignore the literacy needs of students. Still, it is a fact that many technical workers in science devote a large amount of their work to reading and writing (Wollscheid, 2020). Even for nonmajors, it is crucial to have a certain level of scientific literacy, to understand current science issues, and to discuss them intelligently.

What might be the best strategy to encourage more students to do the readings for a class? There are several methods that researchers have investigated. These include the use of quizzes or surprise quizzes (Sappington et al., 2009). This study found a correlation between using pop quizzes and exam scores and recommended that instructors use them to encourage reading the textbook.

A research study used regular, announced quizzes, and found that they encouraged students to read (Marcell, 2008). If class time is at a premium, online quizzes taken 1-24 hours before the class have also motivated students to complete reading assignments (Howard, 2004). Howard reported that 98% of his students claimed to read all or most of the time when the instructor employed this strategy.

Reading compliance can also be increased by writing assignments. These can be very formal assignments or more informal journaling assignments. The formal type may require students to focus on the reading and require them to complete a task that includes an introductory statement, an objective for the assignment, some background information, and finally, the writing assignment itself (Yamane, 2006). Informal journaling has been associated with helping students make real-world connections with course concepts (Walker, 2006).

Another method to encourage students to complete readings is to call on students randomly (McDougall & Cordeiro, 1993). Students who were told that they would be randomly called upon to answer questions about the reading material were more likely to read and received higher quiz scores than did students told that oral questions would be voluntary.

There could be a focus on what instructors do with reading materials during class time or whether reading guides or study questions are provided (Hobson, 2004). Generally, students are more likely to read when the assigned materials are shorter (Bradley, 2007), not too difficult to comprehend (Hobson, 2004), and not from textbooks (Howard, 2004).

A study evaluated 7 different possibilities, including announced reading quizzes, unannounced reading quizzes, required short writing assignments, required journal entries, mandatory reading guides, optional reading guides, and being called on randomly in class as methods of encouraging reading material. This study found that students prefer announced and mandatory methods to options like surprise quizzes or random methods (Hatteberg & Steffy, 2013).

If being called on or quizzed is random, students may gamble with the odds rather than doing the readings. If they know a quiz will happen at the beginning of class every time, they know it will happen and may plan accordingly by doing the readings. Students prefer mandatory methods of ascertaining reading compliance.

To facilitate increased interaction with reading material, in the CHEM 100 class, an assignment would be made of mandatory reading assignments that would count as homework assignments. As an assignment, students would be more motivated to complete readings and answer questions over the task to see if they understood what they had read.

METHODS

The participants were students enrolled in CHEM 100 in the fall of 2020 (n = 18) and the spring of 2021 (n = 39). There were 2 sections of the course in the spring of 2021 and a section from fall 2020. The section in the fall of 2020 did not use the reading assignments, while both the spring 2021 sections did use the reading interventions.

The students oriented to their sections using a common Getting Started document. A syllabus was provided with class policies and due dates. Purchase of the online e-book is required since an access code is necessary to access the homework and quiz assignments. The students in the fall semester of 2020 did homework, quizzes, 4 discussion prompts, 3 exams, and a final exam. The spring 2021 classes did all these assignments and, in addition, were required to do an additional assignment for each chapter that referred them to the reading if they were unable to answer a certain number of questions.

In the fall 2020 semester course, students did homework, quizzes, exams, discussion questions, and the final exam. In the spring of 2021, the sections completed a reading assignment and an exam review reading assignment that allowed for a review of content in the pertinent modules just before the final exam.

Once the data was assembled, a *t* test was run to see if there was a statistical difference between the fall section in 2020 and the spring 2021 sections. Means for an overall grade, final exam grade, and each class exam were analyzed.

RESULTS

The purpose of the experiment was to determine if a reading assignment intervention helped raise the grades of general education students taking a nonmajors chemistry class. This class is often self-reported by students to be a challenging course for them to pass. The spring 2021 class included reading assignments to help students learn the textbook material and not simply look up individual questions in the text as the students completed homework and quizzes. The hypothesis is that these reading assignments will benefit the students enrolled in the spring 2021 classes versus those in the fall 2020 class. This benefit results from increased interaction with course material through the textbook.

Table 1 contains a summary of the data. For the courses with the reading intervention, the overall class average was 76.5% versus 66.7% (*p* value = 0.050) for the non-intervention course. Exam 1 had an average of 74.0% for the courses with the reading intervention versus an exam 1 average for the non-intervention group of 60.5% (*p* = 0.052). Exam 2 has an intervention exam score of 73.3% versus a non-intervention score of 67.5% (*p* = 0.225). Exam 3 had the biggest gains between the intervention and non-intervention groups. For exam 3, the average was 76.9% for the intervention group versus 62.4% for the non-intervention group (*p* = 0.044). The final exam had the closest difference between the means, with an average of 56.3% for the intervention group and 55.1% for the non-intervention group (*p* = 0.445).

Table 1.
Summary of Means and *p* Values

	Spring 2021 (%) Mean	Fall 2020 (%) Mean	*p* Value
Final Grade	76.5	65.6	0.050
Exam 1	74.0	60.5	0.052
Exam 2	73.3	67.5	0.225
Exam 3	76.9	62.4	0.044
Final Exam	56.3	55.2	0.445

Classroom activities are relevant when they successfully scaffold material for students (Kibble, 2017). As a formative assessment, these reading interventions help students interact with class material to be more successful in the class. The goal of a formative assessment is to prepare a student for the more critical summative assessment. These reading assignments are helping students become prepared for their exams because the assignments give them a chance to rehearse the material they are trying to learn.

DISCUSSION AND CONCLUSION

In every case, the mean was higher in the intervention group versus the non-intervention group. This class is taught online, so it may be that many, or most of the students, were trying to study for the exams by looking up the answers to homework and quizzes taken online. When the reading assignments were introduced, the students had to make their way through the text and do the homework and quizzes. As students have more exposure to the broader and more in-depth aspects of the chapters, it may be possible to do better on the exams and ultimately in the class.

Several of the assessments were even close to being statistically significant. For exam three, the *p* value was 0.044. This statistical result was fascinating. It may be that the reading assignment helps the students the most, just at the time of the semester when the academic schedule is the busiest.

One of the most puzzling aspects of this research was my student evaluations for the spring semester. Several of the students commented that the reading assignments were too long and should be cut from the class. One of the research questions includes how students perceive assignments and whether they understand what actions lead to success. In this case, a student may have gotten a higher grade due to the reading assignments and still resented them for the work they represented, forgetting that one of the requirements in the first place was to read the text. It is a good reminder that often, our students need help learning what works the best.

One last observation is that in the fall of 2020, 3 students stopped doing assignments and 1 additional student earned an F while doing all the assignments. In spring 2021, 2 students stopped doing assignments altogether, but all the students who continued to do assignments passed the class. This result, unfortunately, represents a minimal sample size. Still, the reading interventions may teach students enough about the material so that they do not give up. It might be helpful to develop a survey to determine if students realize that the reading assignments could be helping them to do better in the class. If they can infer that it is a transferable skill to other classes, it would help them be more successful.

In higher education, it is easy to assume that every student entering our institution is ready for the rigors of academic studies, but this is not the case. It is not enough to tell students to read the text. It is essential to help students see why it is helpful to read class material and what could be gained. This study attempted a reading intervention to determine if it is possible to improve students' grades by doing reading assignments for every chapter covered in the book.

This intervention resulted in higher mean scores for the average class grade, all 3 exams, and the final exams. Two of the results are statistically significant. The results are not conclusive but seem promising.

Future avenues of research may include more of an emphasis on why the reading interventions improve grades. Are students thinking about the material more, or are they learning about questions they still do not know how to answer? A survey could ask students questions to clarify whether students understand the importance of reading the material or completing assignments. Would students be likely to carry this importance of reading the textbook material into other classes?

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