

A LOOK INTO HOW FIRST YEAR CHEMISTRY STUDENTS AT THE UNIVERSITY OF BOTSWANA USE THEIR PRESCRIBED TEXTBOOK

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ABSTRACT

Studying how students use textbooks is critical in understanding how students learn. This paper reports on a study conducted to get a review of an in-house printed textbook from first years Chemistry students in the University of Botswana and to learn how students use the textbook. Despite an overwhelming majority of students owning the prescribed textbook, only 45% regularly read the textbook. Approximately 48% of the students read both before and after the lecture and an equal number read after the lecture. Only a small fraction of the students surveyed found the textbook challenging in terms its overall scientific level recommended some change to the textbook. [*African Journal of Chemical Education—AJCE* 9(2), July 2019]

INTRODUCTION

Textbooks play a critical role in teaching and learning in most universities around the world [1]. The textbook for a course is often prescribed by the course instructor or the department offering that course. In some instances, university lecturers design course curriculum, develop assignments, and craft exam questions around a particular textbook [2]. Many university lecturers/instructors generally believe that textbook reading facilitates and enhances student learning by promoting a deeper understanding of the course material [3]. In addition, they believe that students who read the textbook or any assigned reading will be more engaged during the lecture and are more likely to participate in stimulating class discussions [4].

The centrality of textbooks in university teaching makes understanding how students read textbooks of critical importance [5]. Textbooks are seen as one of the major components of teaching and learning that need to be studied in order to examine how students learn [6]. Indeed a number of reports on textbook reading have been reported from various disciplines including mass communication [2], psychology [7], accounting [5], and the basic sciences [8-9] covering a range of issues. Early research focused on textbook content [10] and the effectiveness of pedagogical aids used in textbooks [11-12]. Others explored textbook usage by students and study habits [3, 13-14]. While many students believe that textbook reading enhances learning and buy textbooks, few regularly read or complete required readings [3, 15]. A survey of physics students showed that 97% of the students owned the required textbook but only 41% read the book regularly [8]. Hoelt (2017) reported an equally low percentage of students who regularly read. Reasons offered for why student reading of textbooks and other assigned readings is low include a lack of reading comprehension skills, an underestimation of the importance of reading, lack of self-confidence, disinterest in the course material and time constraints [16-17].

Despite the general assumption that textbook reading enhance learning, there are conflicting results on whether textbook reading is correlated with improvement of student grades [14]. In a study of over 1000 students in various introductory science courses, it was observed that there was no difference in the performance of students who read “often” and those who reported “rarely” reading the textbook. A look into how students read textbooks showed differences between academically strong and weak students. Academically strong students’ primary motive was to understand the material, tended to read before the material was covered in class and persisted when the material became difficult while the weak students stopped reading when they could not understand the material [5].

The Department of Chemistry in the Faculty of Science at the University of Botswana decided, in 2012, to adopt an internally authored General Chemistry textbook and offer it to students in both print form and electronic form (for free). The book, now in its third edition, is used for two first year chemistry courses offered over two semesters. The change in textbook seems to have been largely driven by the desire of the department to increase textbook access and not necessarily to offer a textbook better than what had been the prescribed textbook. Durwin and Sherman (2008) argue that course instructors should not only choose a textbook that meets their needs with respect to content coverage, scope and course objectives but should also look for a textbook that students will actually want to read and understand. The *General Chemistry* textbook currently used by the Department of Chemistry at the University of Botswana was authored by faculty members using open educational resources, largely material from a virtual chemistry textbook by Stephen Lower (<http://www.chem1.com/acad/webtext/virtualtextbook.html>) and the authors’ own teaching notes. The textbook is, therefore, largely an open source textbook. While a number of studies have shown no difference in student performance in cases where commercial

textbooks were replaced by open education resources [18], it is not clear what the impact has been in our case since no review of the textbook or how students use and value the textbook has been done. This study, therefore, aims to get a review of the textbook from students and to learn how students use the textbook.

METHODOLOGY

Survey

Data was collected using a paper-based survey which contained twenty-three (23) multiple choice questions. The survey was based on instruments used on previous research [8-9] and consisted of four (4) components: why the students used the textbook, when they read the textbook and how the reading was done. The students were also asked to rate the textbook and indicate how certain features contributed to the learning.

Participants

A total of 385 first year science students in their second semester at the University of Botswana participated in this study. These students were enrolled in the General Chemistry II course, CHE102, and had not determined their majors. The total class enrollment in the course was 903 students. The survey was administered during the tutorial sessions in the last three weeks of the semester. This meant that the participants had interacted with the textbook for close to two semesters. The majority of the students (83%) were aged below 21 years and 52% were female.

Textbook

The textbook used for the General Chemistry II course was *General Chemistry* [19] and was sold for P190 (about US\$19). It contained 16 chapters each with an average body length of 18 pages. The shortest chapter has 6 pages and the longest 36 pages. Each chapter contains a set

of worked examples and concludes with a list of exercises. The chapters are arranged in order of the topics covered in the General Chemistry II course.

RESULTS

Textbook Ownership and Usage

Figure 1 shows that an overwhelming majority of the participants, 93%, indicated that they owned the textbook but only about half of this (45%) read the book “often”. A slight majority of the students reported that they read the book “sometimes”. A small number of students, 2%, read only before the lecture and the rest were equally distributed between reading “before and after the lecture” and “after the lecture” at 49% each. From the students who often read the textbook, 60% read it before and after the lecture.

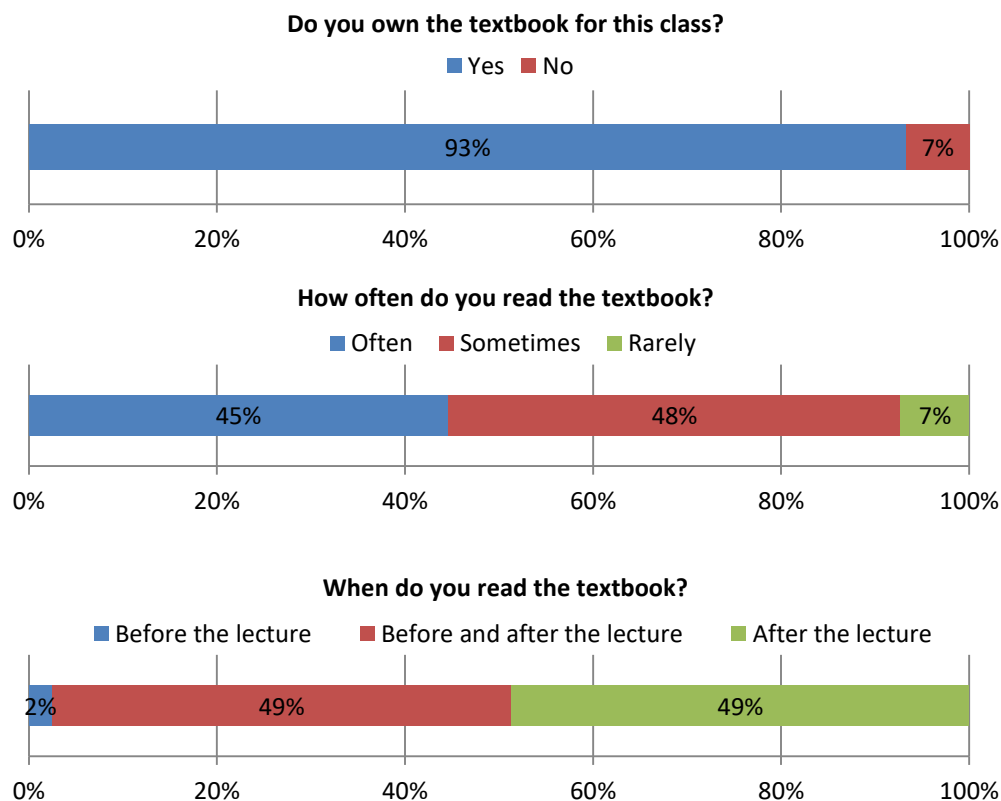


Figure 1: Student textbook ownership, how often they read it and when.

When asked what they felt the textbook was useful for, 57% of the students agreed that it was useful for studying for exams and 51% of the students agreed that it was useful for preparing for the lectures. An almost equal percentage of the students agreed that the textbook was useful for understanding the lectures. The results are summarized in Table 1. While students in general perceived the textbook as equally useful for preparing for lectures and understanding the lecture material, the perceived usefulness differed according to when the reading was done. About 65% of the students who read the textbook before and after the lecture agreed that the textbook was useful for preparing for lectures while 53% agreed that it was useful for understanding lecture material.

Table 1: Students perceived usefulness of the textbook

| I feel the textbook is useful for | Agree | Neutral | Disagree |
|--|--------------|----------------|-----------------|
| Understanding the lecture material | 49% | 44% | 7% |
| Studying for the exam | 57% | 34% | 9% |
| Solving tutorial questions | 39% | 48% | 14% |
| Learning chemistry just out of personal interest | 36% | 44% | 20% |
| Preparing for lectures | 51% | 39% | 10% |

On how students used the textbook, 29% of the students agreed that they read the text word for word, 39% studied end of chapter problems while a significantly higher percentage (77%) looked up constants and equations. The results are summarized in Table 2. The various ways in which students used the textbook didn't seem to differ significantly depending on how often students read. For instance, only 35% of the students who often read the textbook agreed that they read it word for word.

Table 2: Students' use of the textbook

| When I read the textbook I | Yes | Sometimes | No |
|-----------------------------------|-----|-----------|-----|
| I read the textbook word for word | 29% | 44% | 26% |
| I study end of chapter problems | 39% | 52% | 9% |
| I look up constants and equations | 77% | 22% | 1% |

Textbook Features and Ratings

To probe the perceived utility of the textbook, the students were asked to rate textbook features which helped in their learning. It can be seen from Table 3 that students indicated that in-chapter examples and end-of-chapter exercises were very helpful towards their learning. These were placed far above written text and images.

Table 3: Student ratings of textbook features

| Textbook Feature | Very helpful | Moderately helpful | Not helpful |
|--------------------------|--------------|--------------------|-------------|
| Written text | 42% | 54% | 4% |
| Images or photographs | 22% | 51% | 27% |
| In-chapter examples | 62% | 35% | 4% |
| End of chapter exercises | 63% | 34% | 3% |

When asked to rate the degree of challenge of the textbook only 17% of the participants indicated that the overall scientific level of the textbook was very challenging. About 73% found it moderately challenging. Likewise, 26% of the students found the end-of-chapter- exercises very challenging while 66% found them moderately challenging. This is shown in Figure 2. It is perhaps for this reason why 98% of the students recommended some improvement for clarity of explanations in the textbook; 44% indicated that major improvements were needed, 54% recommended minor improvements while only 2% felt no improvement was needed.

Likewise, the majority of students felt the connection of the textbook to topics covered in class needs to be improved. About 37% felt major improvement was needed while 55% indicated that only minor improvements were needed.

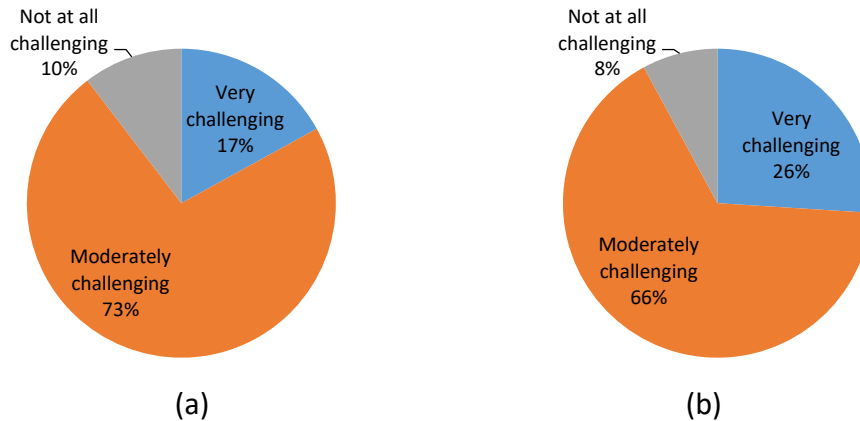


Figure 2: Students' perceived level of challenge of (a) overall scientific level of textbook and (b) end-of-chapter exercises

Textbook Reading and Performance

We attempted to see how reading affects course performance. Students were asked to indicate their anticipated grade for the course. Figure 3 indicates that a majority of the students anticipated a grade of B or better. An average anticipated grade point average (GPA) of 4.1 (out of 5) was calculated based by assigning the lowest score for each letter grade as per the University of Botswana undergraduate academic calendar of 2017/2018, that is A = 4.7, B = 3.5, C = 2.0, D = 0.5, E = 0. The actual average GPA for the course after the end-of-semester examinations was 2.5. While this was far higher than the actual performance of the students, the results somewhat show that the students felt they could still get a good grade without necessarily reading the textbook. For instance, about 39% of students who rarely read the textbook anticipated a grade of A for the course as shown in Figure 4. Students who rarely read the textbook were, nonetheless,

somewhat more cautious when stating their anticipated course grade. All the students who expected a grade of E were those who reported that they rarely read the textbook. Figure 5 show that the timing of reading (before the lecture, after the lecture etc.) had no effect on the expected grade.

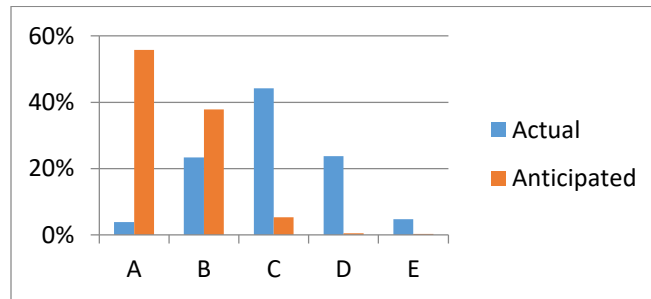


Figure 3: Students anticipated course grade versus actual grade obtained.

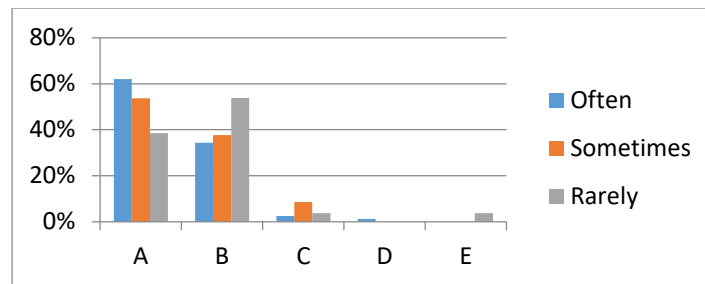


Figure 4: Relationship between reported frequency of textbook use and anticipated course grade.

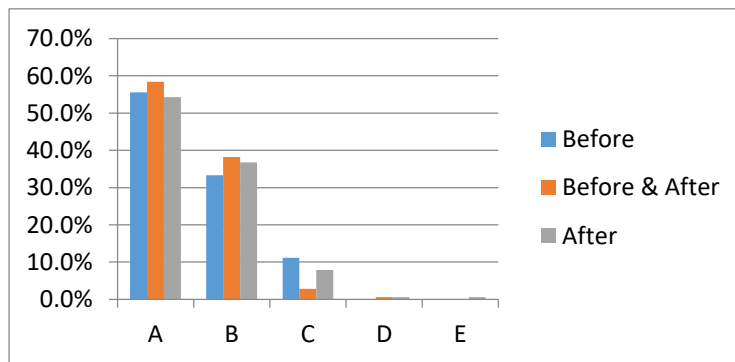


Figure 5: Relationship between when textbook was read and anticipated course grade

Discussion

Textbook Usage

This study surveyed students in a first year chemistry students to review an open general chemistry textbook in terms of its quality and helpfulness. In addition, the study sought to assess how they used the textbook. The question of whether students in introductory courses have the necessary experience in evaluating textbooks has been posed before [6]. It has been argued that students may base their judgements on aspects of the text that have little impact on their learning. However, Durwin and Sherman (2008) have argued that university students are accurate judges of the quality of text from the learner's perspective.

While an overwhelming majority of the students reported that they owned the textbook only half indicated that they often read the textbook. The results are consistent with the study done by Podolefsky and Finkelstein (2006) who also observed that while over 97% of their physics students bought the required textbook, less than 41% regularly read. Low reading compliance have been observed across various academic disciplines [4, 14-15] and a number of reasons have been advanced [16-17]. One such reason is lack of motivation where students will not read unless the value of doing so is clear [13, 17]. The more students believed that their effort has the potential to yield a payoff, the more inclined they seem to try [20]. It has been suggested that students need to be incentivized through quizzes or assignments based on the text to read the textbook. Likewise research suggests that students will read more if they believe that reading the textbook will lead to better grades [21]. It has also been shown that students in courses that have test/exam questions based on the prescribed textbook tend to have a high perceived utility for the textbook [14]. Podolefsky and Finkelstein (2006) observed in their study that students tended to optimize their study time by drawing on resources that they find most productive for success in a course. Indeed

if students can do well on tests without reading the textbook, the use to the textbook goes down [3, 13]. The general chemistry course, in which the survey participants were registered, was made of three lectures, one tutorial and one laboratory (2 hours) session a week. The tutorial questions were not necessarily based on the textbook. This could possibly explain in part why over 93% of our students bought the prescribed textbook but only half of them read it regularly. Only half the students surveyed agreed that the textbook was useful in preparing for the lectures and understanding lecture materials.

The cost of the textbook has also been shown to enhance perceived value. Textbooks sold at a high price are perceived as more valuable than cheaper books [22]. It has also been suggested that students may not read a textbook if they find it too difficult, too easy or poor in quality. As already indicated the textbook surveyed in this study was sold by the Department of Chemistry for P190 (~US\$19) and an electronic copy made available to students for free via Blackboard. The textbook fit the description for a “core textbook” offered by Griggs, Jackson and Marek (2002): brief, low cost text with limited use of graphics. Only 17% of the students indicated that they found the overall scientific level of the textbook very challenging. It may be concluded from this that the majority of the student did not find the textbook too difficult. That more than 90% of the students surveyed recommended some improvement in both clarity of the text and its connection to lectures could suggest that students found the quality of the book poor and this may have contributed to less than half of the students reading the book often. A more focused study using the Textbook Assessment and Usage Scale ¹³ or similar would perhaps provide a clearer picture.

Poor reading skills and comprehension have been shown to act as a barrier to reading textbooks [16]. Poor readers give up reading when they encounter challenging concepts and vocabulary [21]. Phillips and Phillips (2007) observed in their study some reading differences

between strong and weak students. The key difference was that strong students persisted when the reading material became difficult whereas weak students stopped reading when comprehension became difficult. A study on reading competency of first year undergraduate students at the University of Botswana observed that a significant number of students entering the university for their first year of study were not adequately prepared for university reading [23]. While this study was limited to students in the Faculty of Humanities, it may apply to students in the Faculty of Science because of similarities in the entry requirements for English.

Our study showed that most students indicated that in-chapter examples and end-of-chapter exercises were very helpful towards their learning. Similarly, Smith and Jacob (2003) observed in their study that both general chemistry and organic chemistry students perceived in-chapter problems and end-of-chapter exercises as textbook features that contribute most to their learning. They reasoned that students valued those features that they believed would directly help them solve chemistry problems. Other studies of students' perceived value of pedagogical aids in textbook have consistently placed practice questions among the top three [12, 24]. This observation is consistent with the reasoning made earlier about students' tendency to optimize their time on things they perceive to contribute directly to better grades. This may also suggest that the students surveyed underestimate the importance of textbook reading.

The majority of students in this study read the textbook after the lecture. Students in a study by Phillips and Phillips (2007) stated that reading the text before the lecture made them to not feel "lost" during the lecture. Those who read after the lecture indicated that this made the textbook quicker to read and easier to understand. Indeed, Ryan (2006) observed that when students are given global reading assignments such as "Read Chapter 15" many students reported getting lost in the reading. It was further observed that giving students focused reading assignments with

extensive teacher feedback was a good motivator for reading. Students who participated in our study received detailed course outline and schedule of activities and were expected to read ahead of the lecture without any specific reading assignment. This lack of focused and explicit reading assignments could lead to students feeling overwhelmed and may explain why few students read before the lecture. While it was not done in our study, a number of studies have attempted to assess whether the timing of textbook reading was associated with course performance with conflicting results [5, 8, 14]. Phillips and Phillips (2006) observed that top performing students were more likely to read the textbook chapters before the lecture while weak students were more likely to read after the lecture. French et al. (2015) on the other hand found that the timing of the textbook reading had no effect on the student performance.

Textbook Reading and Performance

The anticipated average GPA was higher than the actual GPA recorded after the end of semester exams. Smith and Jacobs (2003) observed a similar overestimation of grades, though to a lesser extent. Discrepancies between self-reported and school record GPA are a source of concern in research [25-27]. It has been observed that students tend to over-report (or over estimate) their GPA's than under-report. The percentage of student over-reporting is often twice as large as the percentage of under-reporting [25, 28]. Over-reporting of GPAs is more common among students with lower GPA's. One reason advanced for over-reporting self-report data is social desirability. Socially desirable responding is the tendency of an individual to present him/herself in a socially favorable light and is prevalent in research surveys where respondents know that researchers will not verify the information and such information pertains to the respondent's ability [28-29].

The survey for this report was conducted during the last two weeks of the semester when students had taken all their assessment pieces and had a good idea of what their continuous assessment (CA) grade, which accounts for 50% of the final grade, was. Only 8% of the students enrolled in our chemistry course had a CA grade of A- or better. Data from this survey suggest that close to 50% of students believed that they could raise their GPA during the final examination. Official examination results, however, show that only 2% of the students were able to improve their grade while 15% maintained their grade. The GPA for 83% of the students went down: 59% by 1 half grade (e.g. from B to B-), 20% by 2 half grades (e.g. B to C+) and the rest by more than 2 half grades. Perhaps the students were buoyed by their performance in their previous chemistry course (CHE101), a prerequisite to CHE102, in which 25% of the students improved their GPA during the final exam. The difference between the two is however big and it is likely that quite a number of students gave into the social desirability bias and over-reported their expected final grade. While the anticipated grades seem bloated, some inferences can still be made from the data.

For instance, that about 39% of students who rarely read the textbook expected a grade A for the course could suggest that a good number of students believed that they could get a good grade without reading the textbook or simply that the students underestimate the importance of reading the textbook. Indeed one major factor that contributes to the observed low reading among students is underestimation of the importance of reading by students [16].

A number of interventions to encourage student to read more have been discussed in this paper. These include giving quizzes on the assigned reading. It has also been noted that students will generally spend more time on reading resources that contribute directly to their GPA. It would be presumptuous of us to recommend the many solutions identified in literature without first pinpointing the major causes of the observed low reading of the prescribed textbook. It would also

be beneficial to find out if behavior is observed across other departments within the faculty of science, that is, do students who do both biology and chemistry approach their reading in the same way.

CONCLUSIONS

This study does not provide a comprehensive review of the prescribed General Chemistry textbook but provides a useful look into the student's perceived quality and helpfulness. The majority of the students who participated in the study indicated that they owned the prescribed textbook. However more than half of those who owned the textbook did not read as often as they probably should. It appears that many students believe that they could perform well in the test and exams without reading the textbook. A number of questions remain unanswered from this study. For instance, it is not clear why a large number of students buy the prescribed book but use it sparingly. It would also be interesting to find out what other reading materials or sources of information students use for the course.

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