Facilitating Learning in a Human Anatomy and Physiology Course through Microtheme Writing Assignments

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Abstract

The process of “writing to learn” has been documented in many disciplines. In this study, a specific type of writing, microthemes, was implemented in a human anatomy and physiology course in order to determine whether this type of writing assignment enhances student exam performance. Student performance on exam questions dealing with topics covered in microtheme assignments was compared to performance on exam questions with no such related assignment. Statistically significant improvements were recorded on two of the four exams.
Introduction

The importance of writing in learning has been investigated and documented in several disciplines including accounting (Garner, 1994), psychology (Stewart, Myers & Culley, 2010), and the biological sciences (Lakrim, 2007; Litchfield, Mata & Gray, 2007). Many educators have become interested in incorporating writing into their classes as a result of Writing Across the Curriculum initiatives (Bean, 1996; Defazio, Jones, Tennant & Hook, 2010; Demski, 2012; Khourey-Bowers, 2011; Knipper & Duggan, 2006; Kurfiss, 1985; Perelman, 2011). Such initiatives may vary from one institution to the next in the types of writing used to improve student learning. Recently much attention has been given to implementing web-based writing (Cooper, 2012; Demski, 2012; Gerdeman, Russell & Worden, 2007). Some writing assignment examples that can be used in any discipline include informal journals, summary write-ups, formal short or long reports and essays, and microtheme assignments (Bean, 1996; Ferrario, 2005; Knipper & Duggan, 2006).

No matter what type of writing is used, there is a consensus among educators that writing contributes positively to student learning at different levels of education and among different disciplines (Bean, 1996; Dixon, 1994; Litchfield et al., 2007; McDermott, 2010; Moore, 1997; Stewart, 2010). A number of studies have demonstrated that writing promotes cognitive development and enables students to process information and learn the material more effectively (Bean, 1996; Dixon, 1994; Ediger, 1999; Haynes, 1993; Moore, 1997). “Writing to learn” is routinely connected to developing critical reading skills (Haynes, 1993). Often, students do not read the textbook before coming to class unless they are asked to complete a written assignment. It is possible that students are poor readers to begin with (Bean, 1996) and thus, might need to be encouraged to read. Wilcox and Murray (2000) reported that when the nature and the amount of material is complex, students are discouraged from reading in anatomy and physiology. Regardless of mechanism, it is evident that the sentiment that students do not read enough, especially in a community college, is supported beyond anecdotal evidence at least for literary reading (Long, 2009).
One way to encourage the development of writing and reading skills, as well as mastering content knowledge, is assigning writing such as microtheme papers. Microtheme assignments allow the students to widely explore a lesson or group of lessons through a single and precise question and empower students to complete the reading assignments for upcoming lectures. Microtheme assignments are concept driven and relatively short compositions. They can vary in length from text that can fit in a 5-8 inch index card (Miles, 1982) to longer assignments between 100-250 words (Ferrario, 2005). The purpose of a microtheme assignment is to have students focus on one particular concept. Through the process of writing, students will gain knowledge, comprehend and potentially apply the material, and use the knowledge to develop analytical and critical thinking skills (McDermott, 2010; Olson, 2010; Quitadamo & Kurtz, 2007). The rationale for this approach is that through the writing of microtheme assignments, which typically focus on a specific concept in the course, students will explore the material, prepare for lectures, and will better comprehend the new and complex concepts presented in lecture. They might do so by reading from the course assigned textbook as well as other resources.

The objective of this study was to determine if microtheme assignments can be used to encourage students to read information about the course content. It is expected that students will perform better on written exam questions on which they completed a microtheme assignment compared to those on which they did not.

**Methods**

This study was conducted at Kingsborough Community College (KCC) of The City University of New York (CUNY), an urban community college located in Brooklyn, New York. All participants (N=97) were students in Human Anatomy and Physiology I, the first semester course of the one-year anatomy and physiology sequence. For some students, it was their first college-level science course. KCC’s Human Anatomy and Physiology course covered, in order, the following major topics: General introduction to the human body, basic chemistry, the cell and tissues, the integumentary system, the skeletal system, the muscular system, the nervous system, and the endocrine system. The study was conducted using five different sections of this course over two consecutive semesters.
Assigning Microtheme Assignments and Analyzing their Effectiveness

The authors designed five microtheme assignments. The microtheme assignments constituted approximately 10% of students’ final grades, while being worth approximately 25-30% of each exam. To complete these assignments, students were required to read related sections in their textbook and then submit their written answer. In order for the students to prepare for the lecture presentation, microthemes were assigned prior to discussing the topic in class and were submitted by the students before the start of the lesson. The answers to the microtheme assignment were then discussed. The first microtheme assignment included material that the students might have been exposed to in other KCC biology classes or in high school while the next four microthemes were on topics that were new to the students. The same assignments were used for all sections of the course. To assess the usefulness of microtheme writings to improve student learning, we administered four exams comprised of multiple-choice questions and written answers. This study reports on the analysis of written answers. The microtheme assignments were designed around relatively complex human anatomy and physiology topics (Table 1).

Table 1: Microtheme topic and the related microtheme assigned to students.

<table>
<thead>
<tr>
<th>Microtheme Topic</th>
<th>Microtheme Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Chemistry</td>
<td>List the 4 major macromolecules. Name their subunits and briefly describe how these subunits are bonded to form these macromolecules. Include in your answer the type of the bonds and name two types of food in which you can find them.</td>
</tr>
<tr>
<td>Cell Biology</td>
<td>Briefly describe the development of the Cell Theory. How does material move in and out of the cell? Name all of the cell organelles. For each, describe its structure and function.</td>
</tr>
<tr>
<td>Skeletal System</td>
<td>Compare and contrast the two types of bone development (Intramembranous Ossification and Endochondral Ossification). In your own words, describe the processes involved in each and highlight the similarities and differences.</td>
</tr>
<tr>
<td>Muscular System</td>
<td>Part I: Label the muscle cell diagram. Part II: Using your own words, but with the correct scientific terms, describe the physiology of muscle contraction, including the sliding filament theory.</td>
</tr>
<tr>
<td>Nervous System</td>
<td>In detail, describe, and then compare and contrast, the steps involved in the local and action potentials.</td>
</tr>
</tbody>
</table>
Data Collection

Each of the four exams had questions centered on the topic of the microtheme assignments (MT) that required a written-answer as well as additional written-answer questions that were on topics not addressed in the microtheme assignments (NMT). The written answers for both MT and NMT questions were graded and standardized based on a percentage scheme. For this study, the written question averages were calculated first, based on pooling all student grades across the five sections of the course, and then for individual exams. This was done for the microtheme and non-microtheme exam questions independently.

Statistical Analyses

Data was compiled using Microsoft® Excel 2010. All parametric and nonparametric analyses were performed using SigmaPlot® version 12 (Systat Software, Inc.). The pooled data for all student grades for microtheme (MT) and non-microtheme (NMT) exam questions were initially compared using a two sample student-t-test. The tests of normality of distribution and homogeneity of variances (homoscedasticity) failed for the pooled data and therefore, a Mann-Whitney Rank Sum test (non-parametric) was used. All test scores were converted to values out of 100.

In a second statistical test, comparing student performance on each exam, a one-way analysis of variance (ANOVA) was used to compare student grades for microtheme and non-microtheme exam questions on each of the four exams and among the different exams. This was followed by a post-hoc test to determine which mean was different from the others.

For each microtheme assignment, there were students who did not complete the work. We used these data as an internal control to assess variability in difficulty between microtheme and non-microtheme exam questions. A one-way ANOVA was used to compare the means for student performance on microtheme and non-microtheme questions for students that did and did not complete the microtheme assignments. The student group that did not complete the microtheme assignment was treated as the control group. A post-hoc test (Tukey) was performed a posteriori to determine which means were statistically different from the others.
Research with Human Subjects

This research study protocol was approved by the KCC Institutional Review Board (IRB approval number 10-07-030-0138) and all students who agreed to participate in the study signed consent forms.

Results

To determine whether microtheme assignments better prepare students, we compared student performance on exam questions dealing with topics covered in the microtheme assignments (referred to as MT questions) to those without a microtheme assigned (referred to as NMT questions). An analysis of the pooled data for the five human anatomy and physiology classes comparing the means for student performance on questions that related to the microtheme assignments (MT) versus those that did not (NMT) indicated failure of tests of normality of distribution and homogeneity of variance (homoscedasticity, Shapiro-Wilk, \( p<0.050 \)). This rendered the two sample student-t-test not appropriate for the comparisons of the means and prompted us to use a Mann-Whitney Rank Sum Test instead. However, it should be noted that if normality of distribution and homoscedasticity are ignored and a two sample student-t-test is performed, the two means are statistically different (\( p<0.001 \)). The mean grade for the MT exam questions (\( \bar{X}_{MT}=67.21\pm31.4, n=351 \)) is larger than that of the NMT questions (\( \bar{X}_{NMT}=50.4\pm33.8, n=351 \)). The more appropriate Mann-Whitney Rank Sum Test yielded the same results (\( \bar{U}=43602.0, \text{Median}_{MT}=75, \text{Median}_{NMT}=50, p<0.001 \)).

A one-way ANOVA was used to compare mean grades for students’ performance on MT and NMT exam questions for each of the four exams administered. The results are provided in Table 2.

Table 2: ANOVA results comparing mean student performance on microtheme (MT) and non-microtheme (NMT) portions of exams I-IV. N=sample size, SD=standard deviation, \( p<0.05 \) depicts statistical significance. A significant difference between the means of microtheme and non-microtheme scores is denoted by *.

<table>
<thead>
<tr>
<th>Exam No.</th>
<th>MT/NMT</th>
<th>N</th>
<th>Mean ±SD</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam I</td>
<td>MT</td>
<td>97</td>
<td>72.7±23.2</td>
<td>0.731</td>
</tr>
<tr>
<td></td>
<td>NMT</td>
<td></td>
<td>65.4±27.6</td>
<td></td>
</tr>
<tr>
<td>Exam II</td>
<td>MT</td>
<td>96</td>
<td>78.2±27.3</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td>NMT</td>
<td></td>
<td>51.5±34.9</td>
<td></td>
</tr>
<tr>
<td>Exam III</td>
<td>MT</td>
<td>83</td>
<td>53.0±33.7</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td>NMT</td>
<td></td>
<td>32.5±29.1</td>
<td></td>
</tr>
<tr>
<td>Exam IV</td>
<td>MT</td>
<td>75</td>
<td>61.8±36.0</td>
<td>0.205</td>
</tr>
<tr>
<td></td>
<td>NMT</td>
<td></td>
<td>49.3±35.2</td>
<td></td>
</tr>
</tbody>
</table>
For all four exams, students had more correct answers for exam questions on which they wrote a microtheme (MT in Table 2) compared to those on which they did not write a microtheme assignment (NMT in Table 2). However, the differences are statistically significant only for exams II and III ($p<0.001$ for both, Table 2) and not for exam I and IV ($p=0.731$ and 0.205, respectively, Table 2).

As a control (Figure 1), for two of the sections, a one-way ANOVA was used to compare student performance on microtheme (MT) versus non-microtheme (NMT) exam questions for students that completed the microtheme assignment with those that did not. It is expected that students that completed the microtheme assignments would do better on microtheme exam questions compared to non-microtheme exam questions. Furthermore, it is expected that students that did not complete the microthemes would have similar performance on microtheme and non-microtheme exam questions. Finally, it is expected that students who did not complete the microtheme assignments would perform the same on non-microtheme exam questions compared to students that did complete the microtheme assignments.

When combining all data for the four exams, students that completed the assignments did significantly better on both MT and NMT questions compared to those that did not complete the microtheme assignments (Figure 1). We did not observe a significant difference between students that did not complete the microtheme writings on MT versus NMT exam questions, indicating that the overall level of difficulty between microtheme and non-microtheme exam questions is the same. The mean grade for students that did not write the microthemes on microtheme questions was $\bar{x}^b = 25.0 \pm 21.6$. This was not significantly different from the mean grade of students that did or did not write the microthemes on non-microtheme questions ($\bar{x}^b = 35.7 \pm 30.8$ and $\bar{x}^b = 21.5 \pm 23.7$, respectively). By extension, the mean grade for students that did complete the microtheme writings on microtheme questions ($\bar{x}^b = 79.7 \pm 22.8$) was significantly higher than the performance of students that did not write the microthemes on both MT and NMT questions ($\bar{x}^b = 25 \pm 21.6$ and $\bar{x}^b = 21.5 \pm 23.7$, respectively), and those that wrote the microthemes on non-microtheme questions ($\bar{x}^b = 35.7 \pm 30.8$). Interestingly, student grades for those that wrote the microtheme assignments are higher, albeit not statistically significant, than those that did not write the microthemes.
Figure 1: Bar graph illustrating average (mean) grades for students that did not write the microtheme assignments (DNW, n=11) and those that did write the microtheme assignments (W, n=119) on exam questions that were microtheme related (MT) and those that did not relate to the microthemes (NMT). Students did significantly better when they wrote microtheme assignments on exam questions that are microtheme related (a). This mean was statistically higher than the means for students that did not write any microthemes (regardless of MT or NMT nature of question) and on the non-microtheme exam question even if they wrote the microtheme (b).

Discussion

Student preparation for lectures has important implications for their learning as well as their success. Generally, it is recommended that for every hour of class, students spend additional two hours on course work; however, this is rarely accomplished (McCormick, 2011). One way to promote studying is through writing. The concept of using the process of writing to foster student learning has been explored in a number of disciplines including those at community colleges. For instance, at Kingsborough Community College, a “writing to learn” approach was used in an anatomy and physiology class by Polizzotto and Ortiz (2008) through a “design project” assignment. Selove (1992) showed that writing helped develop critical thinking skills in an anatomy and physiology course at Lord Fairfax Community College. Furthermore, Wilcox and Murray (2000) examined the effectiveness of writing in an anatomy and physiology class. They reported students were less anxious due to their participation in the writing
process. The use of a specific type of writing, such as microthemes, has been discussed in a number of courses (Bean, 1996; Ferrario, 2005; Miles, 1982; Stanley, 1991a, 1991b). However, in our literature review, the use of microthemes in a community college human anatomy and physiology class has not been explored.

Our results indicate that the students who participated in this study performed better when they completed microtheme assignments. This enhanced performance is reflected in the pooled data for the four exams for all five sections of the course. It is also reflected for two of the four exams individually (Table 2). Student performance was significantly better on microtheme questions that had a writing component for exams II and III. For exams I and IV, there was a benefit for students that completed microtheme assignments, however, it was not statistically significant. There may be a few different reasons for the lack of significance. For exam I, a great deal of the work was material considered in earlier college or high school science or biology courses. This is supported by two lines of evidence. First, the mean performances for the students in microtheme and non-microtheme exam questions are relatively close to each other. Second, student performance on non-microtheme exam questions on exam I (review material) is higher than student performance on non-microtheme questions on exams II-IV (Table 2). For exam IV, the likely reason is that the variation in student performance was so high so as to render the results between microtheme and non-microtheme questions not significantly different. To investigate this variation further, it is possible to assess student knowledge before the administration of the corresponding microtheme and exam IV.

It appears that we have also found evidence to support our hypothesis that student preparation through completing microtheme assignments motivates the students to spend greater “time on task” with the course content. Students possibly read above and beyond the microtheme material as they were completing these assignments. This is evident through better performance on non-microtheme exam questions for students that completed the microthemes compared to those that did not (Figure 1), albeit that for exams I and IV the difference in performance on exams was not statistically significant (Table 2). For example, a question relating to physiology of muscle contraction (Table 1, assignment 1) will inherently prompt students to read about muscle structure (macroscopic and microscopic such as organ,
fascicles, and fiber), as well as material on the neuromuscular junction. These topics are not explicitly specified in the microtheme assignment. Therefore, before being able to complete the microtheme assignments, students must first explore all of the above mentioned topics. Furthermore, it is possible that the assigned microthemes for materials for exams II and III provided an opportunity to identify and review pertinent information.

In order for this microtheme approach to work, the students must complete the assignments before the lecture topic is covered in class. It is our opinion that the use of microtheme assignments enhances the classroom experience for students as well as instructors, in addition to providing a medium for better learning for students (Yule, Wolf & Young, 2010). Students come to class having read and written about particular anatomy and physiology principles. The instructor can readily assess the topics students understand and then focus the lesson on more difficult concepts requiring higher order thinking such as chemical bonding, action potential, and nerve impulse transmission. Since the students are better prepared, they understand the concepts more quickly. Instructors can more promptly get through the basic material and have time for students to ask more questions and participate in discussions about the course content.
References


