

Incorporating Writing-to-Learn Strategies into an Animal Reproduction Course^{1,2}

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Abstract

The objectives of this project were to determine whether incorporating writing-to-learn (WTL) strategies into an animal reproduction course affected student performance. Mean scores for papers, exams and quizzes were similar ($P > 0.05$) for students who participated in WTL ($80.6 \pm 2.06\%$, $72.1 \pm 1.59\%$ and $68.9 \pm 1.76\%$, respectively) to those that did not (control (CON); $79.7 \pm 2.00\%$, $71.8 \pm 1.55\%$ and $68.7 \pm 1.72\%$, respectively). Enrollment in a CON or WTL course did not affect ($P > 0.05$) the final percentage of total points acquired or final letter grade in the course. Of students enrolled in a WTL course, those with a score above the average mean score on the daily writing assignments achieved a higher ($P < 0.0001$) percentage ($83.3 \pm 1.59\%$) and final grade (2.9 ± 0.16 [A=4 to F=0]) compared to those with a score below the average mean score ($68.5 \pm 1.81\%$ and 1.5 ± 0.18 for final percentage and grade, respectively). In conclusion, student performance did not differ between students enrolled in a WTL course compared to those that were not; however, students in a WTL course who performed above the average mean score on daily writing assignments had better final grades in the course compared to those who performed below average. Therefore, students who did well on WTL assignments also did better on overall course performance.

Introduction

In the classroom of a science course, instructors often struggle to balance two over-arching objectives for student learning: to learn basic facts about the subject matter and to learn how to critically think and solve problems. Writing-to-learn (WTL) is a group of practices and strategies that are designed to use informal writing to facilitate learning in any particular subject area (Connaly, 1989; Rivard, 1994); WTL may address both of these objectives. Although communication is often thought of as being the primary purpose of writing, the writing process may also be used to learn course material and clarify ideas for the student. Writing may enhance learning in science courses (Emig, 1977; Gere, 1985; Langer, 1986).

Hurd (1991) suggested that discrete knowledge should not be learned for its own sake. Instead, students fare better when they are asked to use that discrete knowledge to problem-solve (Resnick and Kopfer, 1989). Aaron (1996) reported that the incorporation of writing assignments into an animal science class gave students increased opportunities to practice communication skills the students will need in their futures. Aaron (1996) further asserted that "writing to learn" was perhaps even more intriguing to those in the animal science field than "learning to write". Therefore, the objectives of this project were to determine whether incorporating WTL strategies into an animal reproduction course affected student performance as measured by scores on assessments and final course grades and to determine whether performance on WTL activities was correlated with final course grades. The hypothesis was that incorporating WTL strategies during the course would improve overall learning of subject matter which would be reflected in assessments.

Methods

Physiology of Reproduction (ADS 4613) is a required course for all students in the Animal and Dairy Sciences major and is predominantly taken during their junior year, although a few sophomores and several seniors take it each semester. This course has been taught by the same instructor every semester since Fall 2009, including all semesters in this experiment. Although this course is a lecture-based course, there is a corresponding but separately-graded laboratory course: Practices in Physiology of Reproduction (ADS 4611). This laboratory course is also required of all Animal and Dairy Science majors and students are advised to take it concurrently with ADS 4613. Both of these courses are also cross-listed as 6000-level graduate courses. There are, on average, 1 to 2 graduate students enrolled each semester although they are predominantly non-Animal and Dairy Science majors (i.e., biological science, biochemistry, and poultry science majors). Both courses

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are open to non-majors. With approximately 350 undergraduate students in the Department of Animal and Dairy Sciences, there are typically 42 students enrolled each fall semester (two laboratory sections of corresponding ADS 4611 offered) and 24 students enrolled each spring semester (one laboratory section of corresponding ADS 4611 offered). There was only one section of ADS 4613 taught each semester and thus students did not have a choice in instructor, type of course (regarding treatment), or were not aware that writing was going to be incorporated into the course.

In an effort to meet the objectives, two semesters of ADS 4613 were taught as conventional without (CON; Spring 2013 and Fall 2013; $n = 67$) and two semesters were taught with WTL strategies (WTL; Spring 2014 and Fall 2014; $n = 64$). During the CON semesters, students were required to write 2 formal scientific papers. For each paper, they were allowed to choose 1 of 4 topics to write about, papers must have been at least 1,000 words and have included at least 3 peer-reviewed journal articles as sources. Students were encouraged to participate in the instructor-facilitated peer exchange of papers for editing (up to 6% of final grade (3 of 45 points) given for successfully completing this portion). These formal writing assignments were the only writing assignments graded in the course (excluding long-answer type questions on exams) and the one-time peer review was the only option for feedback prior to students' receiving the final assignment grade.

During the WTL semesters, students were also required to write 2 formal scientific papers that followed the same assignment requirements, choice of topics, and grading rubric. However, students were asked to participate in a pre-writing process. The same 6% of final grade (3 of 45 points) was allocated to the following: 1) turning in a paragraph describing why they were choosing the topic they were and how this may affect them in their future, 2) completing an outline of their papers in which the instructor gave feedback about content, 3) turning in a draft of the body of the paper in which the instructor gave feedback about content, and 4) an in-class peer exchange with 3 classmates. Classmates were tasked with making suggestions on content as well as editorial-type corrections.

In addition to participating in this writing process for the 2 formal writing assignments, students during the WTL semesters also completed daily short writing assignments. These were called tickets to class because they were due at the start of each class period as the students entered the classroom (18 total were due) and the topics were related to what was being discussed in class that day. During the first approximately two thirds of the semester, the topics were directly related to the book chapter to be discussed and were designed to encourage students to read and think about the chapter before class. During the last one third of the semester, the topics were more introspective and required more critical thinking. The following are examples of tickets to class: draw, label and list functions of the components

of the male reproduction system, create an outline of the next chapter, write a paragraph summarizing the process of ovulation, discuss how artificial insemination may impact global food security, and describe 10 management factors that may improve reproductive efficiency.

Tickets to class were graded using a simple 2-point system: if it was not turned in a 0 was given, if it was not typed and/or did not address all that was asked and/or lacked detail a 1 was given, and a 2 was given if all points were addressed and students included sufficient detail. They were not graded on quality of writing but instead, exclusively on content. In most cases, the instructor skimmed the assignment and assigned the points. To make this daily assignment feasible, additional feedback was not routinely provided and only monthly summation of scores were posted using the online course management system.

As with all aspects of the course, students were welcome to schedule appointments to discuss grades or progress. Tickets to class were required to be typed to reduce the temptation to quickly write something just before class just to complete the assignment. This was important because the purpose of these tickets was not really the ticket itself, it was to encourage students to read and think about the material before class so they could understand the discussion and come prepared with questions. The assignments were to facilitate learning of the material and thus fell into the category of WTL processes.

Final grades were calculated slightly different due to the additional writing requirements of the WTL semesters. However, all semesters had 3 exams, 10 or 11 quizzes, 1 presentation (with a partner) and writing assignments made up 15 to 25% of the final grade. The grading scale followed the following format: A = 90 to 100%, B = 80 to 89%, C = 70 to 79%, D = 60 to 69%, and F < 60%. During all semesters, similar questions and consistent format were followed for quizzes and exams.

Data were analyzed using the GLM procedure of SAS (SAS software version 9.3, SAS Institute Inc., Cary, NC). Means were separated using the PDIF option of the LSMEANS statement. For a portion of the analysis, those students in the WTL semesters were categorized into either below or above the mean score for the tickets to class. This category was used to assess quality (essentially effort and completeness) of the tickets to class and whether it impacted overall performance in the course. Student letter grades were transformed to a number system for analysis (A = 4, B = 3, C = 2, D = 1, and F = 0). Pearson correlation coefficients were determined using the CORR procedure of SAS. Least-square means and standard errors are reported. Statistical significance was declared at $P < 0.05$.

Results and Discussion

Contrary to the hypothesis, incorporating WTL strategies did not improve mean scores on individual course assessments. Mean scores for formal scientific papers,

exams, and quizzes did not differ between students enrolled in a CON semester and those enrolled in a WTL semester (Table 1). In addition, overall percentage of points available in the course did not differ between students enrolled in a CON semester and those enrolled in a WTL semester (Table 1). Overall letter grade for the course did not differ between students enrolled in a CON semester and those enrolled in a WTL semester (Table 1). It has been noted that science teachers tend to use writing as a means of evaluation compared to social studies teachers who tend to use writing to extend the learning of their students (Langer and Applebee, 1987). This coupled with the observation that students put less emphasis on writing when the product of writing is determined to be more important than the process of writing (Marshall, 1984), may indicate that students majoring in the sciences in college have received many years of unintentional training to de-emphasize writing as a mechanism to learn. Rivard (2000) evaluated secondary education students in comprehension of science after assigning talking, writing, or a combination of both into classroom activities. Authors stated that talking was social, divergent, and generative while writing was personal, convergent, and reflective. Although they determined that writing appeared to enhance retention of co-constructed knowledge over time, students who discussed or talked and then wrote outperformed students who only wrote or did neither when evaluated with a delayed post-test. It may be that the initial talking activity to gain understanding was a necessary component to then realize the benefits of writing to learn. Regarding the current study, we speculate that the assignments may not have been the most ideal to improve learning or perhaps only ideal for some students depending on learning styles. But these results may also indicate that a few assignments in one class during their college career may not be enough for them to switch learning gears and benefit from WTL strategies.

Students submitted WTL assignments that were variable in content, quality, and completeness (or amount of detail). So, although WTL strategies were assigned to all students in the WTL-semester, not all students completed every assignment and among those that did, some exerted more effort compared to others. To further understand how doing complete work on WTL assignments may impact overall course grades, a subsection (only students enrolled in WTL semesters) were analyzed separately. Of these students, those with an above average mean score on the daily writing assignments achieved a higher percentage and final grade compared to those with a below average mean score (Table 2). The scores on the tickets to class were also correlated ($P < 0.0001$) with the final percentage ($R = 0.615$) and final letter grade ($R = 0.588$). Some educators suggest that WTL strategies may improve student learning because these assignments do not have a primary purpose of communication, and instead promote thinking (Howard, 1988). The incorporation of WTL strategies can only have an effect if students put

Table 1. Percentages of points available on course assessments between students enrolled in a conventional (CON) animal reproduction course or one with writing-to-learn (WTL) strategies.

Assessment	CON	WTL	P-value ¹
Scientific papers, %	79.7 ± 2.00	80.6 ± 2.06	0.98
Exams, %	71.8 ± 1.55	72.1 ± 1.59	0.88
Quizzes, %	68.7 ± 1.72	68.9 ± 1.76	0.96
Overall points, %	75.4 ± 1.42	76.8 ± 1.45	0.51
Final letter grade ²	2.2 ± 0.29	2.7 ± 0.24	0.30

¹ P-value determined by the GLM procedure of SAS (SAS Inst., Inc., Cary, NC) and when appropriate, means were separated using the PDIFF option of the LSMeans statement.

² Final letter grade was transformed to a numerical value for analysis (A = 4.0, B = 3.0, C = 2.0, D = 1.0, F = 0.0).

Table 2. Percentage of points available and final letter grade between students scoring above the average mean score on daily writing assignments and those scoring below the average mean score.

	Above average	Below average	P-value ¹
Overall points, %	83.3 ± 1.59	68.5 ± 1.81	< 0.0001
Final letter grade ²	2.9 ± 0.16	1.5 ± 0.18	< 0.0001

¹ P-value determined by the GLM procedure of SAS (SAS Inst., Inc., Cary, NC) and when appropriate, means were separated using the PDIFF option of the LSMeans statement.

² Final letter grade was transformed to a numerical value for analysis (A = 4.0, B = 3.0, C = 2.0, D = 1.0, F = 0.0).

forth some amount of time and thought into completing them, and thus have a chance of increasing learning of the subject matter. If students do not take these assignments seriously, it makes sense that they would not see the potential improvements in learning. These data support this explanation and lead to the question, "How do we increase student participation in these writing-to-learn strategies?" In other words, students must see the value in these types of assignments before they will readily participate.

Summary

In conclusion, student performance did not differ between students enrolled in a course with WTL strategies compared to those that did not; however, students who performed above average on daily writing assignments had improved final grades in the course compared to those who performed below average. Therefore, students who did well on writing-to-learn strategies also did better on overall course performance.

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