The Real Value of Writing to Learning in Biology

Steve Trombulak and Sallie Sheldon

Like many other college biology teachers, we first learned our trade as teaching assistants at large state universities where the emphasis was primarily on research. As a result, we first believed that in teaching our own courses, all we had to do to insure student learning was present organized lectures filled with 35-mm slides.

At Middlebury College, however, we discovered the writing-across-the-curriculum movement. One tenet of the movement is that writing is a valuable skill in all disciplines and that it will enhance learning in any discipline.

Having experienced great frustration teaching students to analyze concepts in ecology, evolution, and functional morphology, this seemed like a good idea. Several authors, including Joanna Ambron [2] and Michael Strauss and Toby Fulwiler [5], have argued that writing in science courses improves students’ comprehension, analytical skills, and ability to formulate hypotheses. However, with a few exceptions [4], the perception that writing exercises improve science comprehension is based on anecdotal testimony of apparent improvement in student performance.

Before implementing a writing program that is time consuming for both the teacher and the students, we decided to test empirically whether or not writing exercises improved learning in our lower-level biology courses. To simplify the experiment, we chose journal writing as the only form of exercise presented to the students [3].

At Middlebury College, science teachers face an additional challenge: increasing student appreciation of science. In 1987, 17 percent of the seniors graduated with no courses in the natural sciences and an additional 20 percent graduated with only one. Since then, graduation requirements have changed to include a minimum of two natural science courses. However, a change in requirements alone is unlikely to result in a positive change in attitude about a subject.

We believe it is important to instill an appreciation of science in students, in addition to teaching them facts and analytical skills. Not only may it influence the likelihood of their taking additional courses, but it may also change their perceptions of science after they’ve graduated and entered the ongoing debate about the role of science in society. Therefore, we also decided to look at whether journal writing, as a tool to encourage reflective observation, can influence a student’s attitude about a subject or course.

Testing the Effectiveness of Writing

During the spring semester 1988 we tested the efficacy of writing on learning and appreciation in two biology courses: general ecology, a freshman-level course with a required laboratory section (Sheldon); and vertebrate biology, a sophomore-level course with an optional lab (Trombulak). We taught our courses as usual until the midterm exam halfway through the 13-week semester.

At the midterm, we each followed the same procedure in our respective
courses. We divided our students into writing and nonwriting groups of approximately equal number and matched according to grade on the midterm exam, sex, and, in the case of vertebrate biology, whether or not they were enrolled in the lab. Each student then filled out a survey (Figure 1), based on a Likert Scale [1], to assess their present attitudes about the course.

We then gave the students in the writing group a spiral-bound notebook. After each of the remaining lectures in the semester, we asked the students in this group to write for at least five minutes during the day about something related to the lecture. We gave them suggestions on what to write about, for example: What were the three most interesting things you heard in lecture today? What do you like or dislike about dinosaurs? Why might an annual plant be more successful than a perennial? How is a bird like a mammal? Is herbivory more like predation or parasitism?

We did not require the students to write on the suggested topic nor did we collect the notebooks to see if the work was being done. To avoid the ethical problems of providing only some students in a course with a potential learning opportunity, we told the students in the nonwriting group that they were also welcome to do the writing exercises. Of the 51 students in the two nonwriting groups, only one did any writing, and this person made only one entry.

We gave the students a second survey at the end of the course. This survey included all of the questions on the first survey (Figure 1) plus three additional questions (Figure 2).

**Effects on Grades**

The simple writing exercise we employed had a mixed effect on learning as measured by letter grades. In vertebrate biology, students who did the writing exercises performed better than the nonwriting group by two-thirds of a grade (Mann-Whitney U-test, $n_1 = 13$, $n_2 = 12$, $U = 40$, $P = 0.038$). In general ecology, however, the students in the writing group did not perform any differently than those who were not in the group ($n_1 = 36$, $n_2 = 31$, $U = 638$, $P = 0.305$).

Why is there a difference between these two classes? We doubt that it has anything to do with the subject matter. It seems more likely that it is related to the type of students in these courses and their reasons for enrolling. General ecology is required for the biology major, satisfies a general distribution requirement for the college, and has a large proportion of freshmen.

Ten of 31 (32 percent) in the general ecology writing group failed to do any of the writing assignments. However, when we compared the performance of those who wrote to those who did not, regardless of their group, writing did not have a significant effect ($n_1 = 45$, $n_2 = 22$, $U = 464$, $P = 0.676$).

Vertebrate biology is not required, does not satisfy any distribution requirement, and has few freshmen. Since

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**Excerpts from notebook entries responding to the question, "What is the most interesting thing you learned today?"**

It never occurred to me that, since organisms have no idea whether or not they are eating toxic food, some method of detoxification of diet is essential to survival. It follows therefore that all blood from the intestinal region must be channelled to the liver and detoxified before it is circulated through the rest of the body.

If you think about it, muscle attachment is extremely important. If a muscle is attached at one end of a bone and at the opposite end, what movement can occur? None. That’s why when studying Agnathans, the first known vertebrate group, it’s important that we understand the composition of the axial musculature.

The most interesting thing I learned was the differences between the three types of muscle fibers. Different actions need different muscle fibers.

It was interesting to learn that Agnathans have only one single circulatory system where the blood goes from the heart to the gills to the body and back to the heart; whereas humans have two and the blood must come back to the heart after going to the lungs before going to the body.
Figure 1

**Survey given at midterm and the end of the semester.**

Please pick a number from the scale that matches how much you agree or disagree with each statement.

**Scale**

1 = Strongly agree
2 = Agree
3 = Neutral
4 = Disagree
5 = Strongly disagree

1. The subject matter in this course is interesting.
2. I enjoy coming to lecture.
3. I enjoy coming to the lab.
4. The required reading in this course is interesting.
5. I am learning a lot from this course.
6. The lecture material in this course is clear and understandable.
7. The reading adds to my understanding of the lecture material.

Figure 2

**Additional questions for survey at end of semester.**

1. Which group were you assigned to: notebook or non-notebook?
2. Whichever group you were assigned to, how many writing entries did you make?
3. What is your student number?

all vertebrate biology students take the course out of interest rather than obligation, they may be more likely to do the assignments and perhaps benefit from them. All of the students in the vertebrate biology writing group did at least some of the writing assignments and the more writing they did, the more their grade improved (a regression done on the equation $y = 0.27x$, where $y$ is the amount of grade change and $x$ is the number of writing samples: $r^2 = 0.185, P = 0.032$).

These results suggest that the attitudes students have about specific assignments, based perhaps on their reasons for taking the class and their academic maturity, can strongly influence the effectiveness of a writing-to-learn program in biology.

**Effects on Attitudes**

More straightforward are the data on the effect of writing on overall attitude. In both classes, attitudes of students in the writing group did not differ from those in the nonwriting group, either before or after the experiment. In fact, students' attitudes did not change as measured before and after the experiment. However, our classes may not have provided a very good test of the influence of writing on overall attitude.

Students had reasonably good attitudes about the courses even before the experiment began (average responses to all seven questions in both groups in both classes lay between agree and strongly agree; see Figure 1). Perhaps it is noteworthy that the additional work requested of the students in the writing group did not decrease their positive feelings about the subject.

All in all, we are encouraged by the results. What we have shown is that at least in one situation, something as simple as optional, nongraded journal writing can significantly improve learning in biology. It is obvious, however, that the specific writing program used must be tailored to the class and the students involved.

It is unclear whether the distinguishing feature between our two classes was motivation, as we suggest, but at least our results offer encouragement to those involved in writing-across-the-curriculum programs and provide some quantitative basis for fine-tuning our efforts.

References