



INNOVATION ABSTRACTS

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Want to Cut Up Something Different in Biology? Try a Journal Article Dissection

One challenge in teaching introductory biology courses is making it clear to students that science is not just a staid old body of knowledge, but rather a process, a means of acquiring and adding to our body of knowledge. Most current introductory textbooks include at least a short discussion of "the scientific method" in Chapter 1, and most instructors lecture on the subject. However, without an abundance of examples in the text and in class, students acquire little real understanding of the process of scientific inquiry.

Laboratory exercises are one option for developing this understanding, as they can be conducted along the lines of scientific inquiry. Students may even be asked to write their laboratory findings in a short mock-up of a manuscript to be submitted for publication in a scientific journal. Here I describe an alternative approach, which involves analysis of the scientific methodology of published journal articles.

In teaching the scientific method, it is standard procedure to label a series of steps that scientists follow. Various authors and instructors may differ with regard to how many steps they use. However, we all recognize essentially the same process, the process ingrained in practicing researchers. Fragmentation of the process into a series of steps also dovetails nicely with the standard format used for publication in biological journals.

For the past four years, students in the first semester of a majors-level Principles of Biology sequence have been assigned "dissections" of short journal articles. As I present the steps of the scientific method, students find and discuss examples from their articles. This class meets for three lecture hours and four laboratory hours each week for two semesters, allowing plenty of time to examine various nuances of scientific methodology and considering a variety of examples. In the first part of the fall semester, I devote one-and-one-half weeks of lecture to scientific methodology, including a lecture on the basic principles of statistical inference. Two-and-one-half weeks of laboratory time are spent working with examples, including conducting simple statistical tests. The students are then ready to complete a series of four journal article dissections over the remainder of the fall semester. Each assigned article is read for clarification during the latter half of a laboratory session, and students

then have two weeks to submit written dissections. Students may work singly, or may collaborate with a partner. The top three grades constitute approximately 20 percent of both the lecture and laboratory course grades.

I recognize the following steps:

- Background information—usually composed largely or wholly of literature citations
- Objective—alternatively called a question and an hypothesis
- Test of hypothesis—may or may not be a controlled experiment
- Null hypothesis—to which statistical analyses are usually applied
- Results—a.k.a. data
- Level 1 conclusions—determining the validity of each null hypothesis
- Level 2 conclusions—deciding whether or not these results and analyses are consistent with the hypothesis being tested
- Publication

These steps can be recovered from the sections of a standard journal article as follows: The **Abstract**, of course, summarizes everything from background information to Level 2 conclusions; the **Introduction** begins with a discussion of the background information (although frequently some background information is not discussed until later), and ends with a statement of the objective; the **Materials and Methods** section includes a description of the test of hypothesis and sometimes states the null hypotheses; the **Results** section includes data together with the results of the tests of the null hypotheses, or Level 1 conclusions; and the **Discussion** section is organized around the Level 2 conclusions. Thus, the challenge for students is to know where to look to find these steps in the work they are dissecting and recognize the steps when they find them.

Locating the steps is only one part of dissecting an article, however. Students also are asked to use the objective to explicitly state the question and hypothesis of the research; to identify independent and dependent variables, and, if applicable, control variables and experimental and control groups or treatments; to formally state each null hypothesis and interpret, with statistical confidence levels, each null hypothesis test; and to identify in the discussion section any new hypotheses offered which might be tested in the future. Finally, I ask



that students end their written dissections with a critical appraisal of the work they have dissected. Four rounds of this and they are ready to write their own manuscripts, using simple scenarios and small data sets.

I follow four major guidelines when choosing the articles that will be dissected each year. First, for freshmen who generally are getting their first real exposure to actual research, succinct articles of two to five printed pages in length are my preference, as are articles addressing a single hypothesis. (However, an article addressing two or more hypotheses simultaneously may be used for a later assignment.) I look in the Notes or Short Communications sections of journals for articles of appropriate length. Second, as a field biologist not prone to manipulating conditions experimentally, I have no qualms about using articles based on similar such field work, but these articles do lack the opportunity to consider control variables and the difference between experimental and control groups; at the very least a mix of articles should be used. Third, students who have not yet taken an introductory statistics class may be taught to understand the general idea of *t*-tests, analyses of variance (ANOVAs), χ^2 -tests, and simple linear regression, but even many brief articles use more sophisticated statistical analyses that can overwhelm the students and should be avoided. Finally, the research subject matter must be comprehensible to the average freshman student. I find that simple behavioral and ecological papers work very well for the first assignments, while more latitude in subject matter develops as the semester progresses and more course material is covered.



This is scarcely the type of dissection freshman biology majors expect to do. The results, however, are a dramatically increased understanding of scientific methodology, developed well beyond that achieved by the old "read-Chapter-1-and-take-good-lecture-notes" approach. Although the work required to complete four consecutive assignments is substantial, students always have seemed to realize the practical value to them in their professions. One student recently admitted to medical school told me that the experience of dissecting journal articles was valuable preparation for his entrance exams. And, since biology majors can expect to be very involved with journal articles, if not as authors then at least as readers, we might as well ask our freshmen to roll up their sleeves and dig in.

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