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The Critical Thinking Biology Final

During my first five years of teaching Biology II for majors, I gave my students a typical multiple choice/ matching/short essay comprehensive final exam. The subject matter of the course focused on biological organization from organisms to ecosystems. Each year my students would beg for a study guide or a chance to review old tests before the exam, and it became increasingly obvious that they were engaging in a form of study I called "bulimic biology." In this form of study, there was no critical thinking or application of knowledge to new circumstances, only prolonged gorging of the mind with disjointed biological facts that were later regurgitated on a test and promptly forgotten. Any relevance this material might have had to the everyday life of the student was lost in the purging stage, if not before.

In a lunch conversation with our reference librarian, I described my frustration with this method of evaluation, and she offered an idea for a possible solution. Her suggestion was a research project. At first, this seemed improbable as I did not see how I could evaluate students' knowledge over the entire semester in one project. However, I began to search for examples of other institutions engaging in similar forms of evaluation. I gained access to a wealth of materials from local, regional, and national honors organizations; here I found examples of many types of research projects requiring extensive critical thinking skills, as well as research and writing skills. I knew I was on the right track, but I would have to make some adaptations since my course was not an honors course.

The result was a research project that required individual students to reach back into each unit of the course and find information relevant to a current dilemma involving one organism. The first topic I chose was "Endangered Species," and each student was given an endangered species of Texas to research. I provided significant structure to the project by creating a rubric that outlined specific information required in the final report. This information included:

- taxonomy of the organism
- external morphology with visuals
- internal morphology with reference to specific organ systems studied
- reproductive strategy
- nutritional requirements and feeding behavior
- role in the food web
- predator/prey relationships and competitive relationships
- role in nutrient cycling
- special adaptations, making it unique and interesting
- reasons for its endangerment, and
- steps being taken to avoid extinction.

Students were required to submit a written paper with bibliography and present a ten-minute PowerPoint summary presentation in class. I was astounded by the effort students put into this type of final and even more surprised by the positive feedback. Most students welcomed the chance to do something research-oriented; and I discovered that although they had individual projects, students worked together to perfect their library research methods and PowerPoint skills. The top students even pinpointed relationships between assigned organisms and incorporated this information into their research and presentations, often asking to present in sequence in order to dove-tail their information.

One drawback to scheduling these presentations at the end of the semester is the temptation for some students to skip class when they are not presenting and study for other final exams. A

grading grid ensured full participation by the class during presentations. Students were asked to rank each presenter's data for each of the assigned information categories. Ten points of the students' grades involved completion of the data sheet evaluating the entire class.

I also used a similar sheet to evaluate each student, with ten possible points in each of ten assigned categories of information. By making clear notes and assigning point values to each category, students could see exactly how they were evaluated. This removed most of the subjectivity from grading.

Over the past five years, student grades on these presentations have followed a bell curve. Those with excellent study skills and motivation began research early and provided detailed information on their subject. Less academically inclined students often waited until the last minute; and while their PowerPoint presentations were often good, the written portion of the final was skeletal and incomplete. Each semester I have changed the topic to minimize borrowing information from previous finals. Topics have included keystone species, nuisance species, and exotic species.

Student feedback has been very positive, and many students have returned years later to tell me that they still vividly remember these projects. They often have expressed appreciation for the chance to do research and write in a biology course, and I have concluded that the use of different evaluation methods gives a more balanced picture of student ability. Multiple-choice exams may provide some insight into students' abilities, but the research project is a clear indicator of how well they understand the relationships between the different subjects covered during the semester.

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