Old Problems, New Solutions: Teaching Thinking in Intro Biology Labs by Forcing Connections

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Our department has recently completed a 3-year overhaul of its introductory; biology labs, which serve approximately 250 students, both majors and non-majors. We have aimed for a transition from old-fashioned "cookbook" labs to more investigative-oriented exercises (although we have retained and enlivened some of the "classical" preps), and have updated both lecture information and lab presentations to make them a more integrated whole. Our ultimate aims were to make both the lecture and lab more concept-based and to emphasize the interrelatedness of the material from lecture to lab and from lab to lab. We also decided to use improved computer technology to further our goals by making information access more user-friendly and relevant. In addition, we use computer simulations as hypothesis-testing tools.

We designed a new, smaller, concept-based alternative course especially for non-majors (Evolutionary Ecology). Because this course has a relatively small enrollment (fewer than 60 students), we have a greater flexibility in the labs. For example, some labs last for two weeks, during which students come in on their own time and run a series of experiments of their own design.

In the 250-student course, we revised lectures to specify and reiterate concepts. Concepts are always illustrated with factual examples. During the labs, we de-emphasized facts -- concepts are more important. There are fewer tidbits of information to memorize, but more thinking is required of the students. We have incorporated experimental design or appropriate elements (such as hypothesis testing, or even simply practicing observation skills) wherever possible. We have also incorporated some statistical analysis (using the Essence of Statistics software written by J. L. Gould and G. F. Gould; available in Mac and PC formats from W.H. Freeman, 41 Madison Ave., New York, NY 10010) with the emphasis on interpreting the results of the tests rather than on understanding the mechanics and assumptions. We determined that experimental design was not the most appropriate pedagogical technique in all cases, so we retained some classical and classical-type preps (pithed frog physiology labs, organismal diversity survey). We were able to eliminate many of the cookbook elements and focus on conceptual information. In these types of labs, we incorporated more live or fresh material and used fewer preserved specimens. To accommodate those students with ethical objections to the physiology labs, as well as those who were not very interested in vertebrate systems, we designed two physiology labs as alternatives to frog pithing exercises. The alternative to the vertebrate circulation lab is a plant transpiration lab in which students investigate the impact of environmental factors, plant physiological or morphological factors, or chemical factors on the rate of transpiration. The alternative to the vertebrate muscle/nerve lab is a computer-based lab in which students test their visual discrimination abilities. Students identify individual and gender-related differences in color perception and other elements of visual processing. Details of the physiology labs are available upon request.

Although we have had to sacrifice the amount of information we give the students in lab, we believe this is outweighed by the benefits of this approach. Students have to think their way through lab; the quality of their interpretations is more important than the quality of their results. Ultimately, by continually reinforcing concepts and themes, both between lecture and lab and among the labs, we encourage students to question and evaluate what they are being taught.

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