

TwoOldGuys™ Study Guides

BI114 Biological Concepts for Teachers

Preface

This text arose out of an attempt to improve the teaching of science in grades K through 12. Initially, the laboratory portion of biology for education majors was modified to model for the teacher candidate how actually to engage the students in the processes of science. For the last several decades, some of us have emphasized to teacher candidates in our classes that science is discovery-based, hands-on activities, and that in scientific experiments there are no wrong answers. This approach does not require the teacher candidate to know the answers, but only to direct their future students in discovering the answers. The teacher can discover the answers at the same time as the students, and must understand that the answers can change each time the experiment is run. It is encouraging that there seems to be a swing in resource materials for the elementary teacher from demonstration science (with explicit 'correct' answers) to discovery exercises (without explicit correct answers). However, among my current students, I am still seeing an entry level expectation that there ought to be implicit correct answers.

The expectation of implicit correct answers in science may be an unintended consequence of the development of content standards; for example, *Indiana's Academic Standards* (Indiana State Board of Education, 2000). We as practicing scientists understand the dynamic nature of science knowledge, and therefore the tentative nature of our 'correct' answers. Yet our traditional teaching methods apparently do not communicate this to non-science students well, raising questions as to how well we are communicating the nature of the science enterprise to our introductory science students. Recognizing this problem, there has been a call, or even challenge, to reform science education, with

widespread agreement "that reform in science education should be founded on 'scientific teaching,' in which teaching is approached with the same rigor as science at its best." (Handelsman *et al*, p 521). One response to this suggestion of how to structure the solution was to expand the reform beyond the teaching of science to K through 12 students. "A particular challenge, which was not noted by Handelsman *et al.*, is reorienting our role in the training of secondary science teachers - indeed, in training teachers throughout the K-12 enterprise." (Bonner, p. 288). Bonner also suggested that a more effective approach than traditional lecture would be "engaging these students in the process of thinking about the information" (p. 288).

I had been considering ways to reorient our role in the training of teachers throughout the K-12 enterprise, beyond the modeling of the science approach to discovery learning in the laboratory setting. My thinking was that we should be able to present science content in such a way that we could engage the teacher candidates in thinking both about the information and about the presentation of the information to their future students. The latter, plus my inferred hypothesis behind the Indiana Academic Standards, led to the hypothesis that science content should be presented to the teacher candidate in age-appropriate steps, following the ability of their future students to grasp the [concepts](#) based on cognitive development, rather than using the more familiar logical or historical development of the concepts. The factual knowledge base for the concepts would then be relegated primarily to the hands-on, discovery laboratory exercises where the emphasis is not on facts but on processes for finding facts. In June 2003, I proposed a new course (at Ancilla College in Donaldson, Indiana) designed to test this hypothesis. The concept of presenting college level content via age-appropriate steps from K to 12 and beyond has been well received by several populations of teacher candidates. The next step is to record the implementation of the

concept in text form, and assess its effect on populations of teachers exposed to the presentation. This text is part of that process.

The organization of the text follows the above described pedagogic design through a somewhat traditional outline of subject content, followed by appendices suggesting (A) some possibilities for the teacher to assess student learning of science in the elementary classroom, (B) suggesting some laboratory exercises suitable for the elementary classroom, most of which have been tested in that setting, and (C) a paraphrased statement of the Science Standards other than ‘the Living Environment.’

Standards

There is a reason and a rationale for using the “Indiana Academic Standards, Science” as a basis for the presentation in this text. The reason is that Ancilla College, where the course which led to the development of this text is being taught, is located in Indiana. The rationale, after the fact, is that “Indiana’s public school science standards are some of the best in the nation, according to an education reform group that ranks the state as one of only seven whose standards earned an ‘A’ (AP news story published in the LaPorte, Indiana, *Herald-Argus* Friday, December 9, 2005: p. 6).” The news release further stated that “A report released Wednesday by the Thomas B. Fordham Foundation ... found that ... only seven states – California, Indiana, Massachusetts, New Mexico, New York, South Carolina and Virginia – earned an ‘A.’ [And] ... also found that Indiana was one of only three states that received an ‘A’ on both the 2000 and 2005 analyses prepared by the Washington, DC,-based group. California and Massachusetts also received an ‘A’ both years.”

The standards for the seven states ranked as “A” quality can be found at the following:

California –

www.cde.ca.gov/be/st/ss/index.asp

Indiana –

www.doe.state.in.us/standards/welcome.html

Massachusetts –

www.doe.mass.edu/frameworks/current.html

New Mexico –

www.ped.state.nm.us/standards/index.html

New York –

usny.nysed.gov/teachers/nyslearningstandards.html

South Carolina –

www.myschools.com/offices/cso/Science/Sciencet.htm

Virginia –

www.pen.k12.va.us/go/Sols/science.html

There are also National Science Education Standards, which can be found at the following:

www.nsta.org/standards

Works Cited

Bonner. J. J. "Changing Strategies in Science Education." *Science* vol. 306 (2004): p. 288.

Handelsman, J., et al. "Scientific Teaching." *Science* vol. 304 (2004): p. 521-2.

Indiana State Board of Education. *Indiana's Academic Standards, Science, Teacher's Edition*. Indianapolis, IN: Indiana State Board of Education, 2000.