Chapter 50
Teaching a Socially Controversial Scientific Subject: Evolution

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ABSTRACT

This chapter explores teachers' and students' acceptance and understanding of evolutionary theory by using conceptual ecology (Toulmin, 1972) as a theoretical lens. Demastes, Good, and Peebles (1995) describe the conceptual ecology for evolutionary theory. Acceptance of evolutionary theory is part of this conceptual ecology, and this conceptual ecology also contains the following five components: (1) prior conceptions related to evolution (understanding of evolutionary theory); (2) scientific orientation (degree to which the learner organizes his/her life around scientific activities); (3) view of the nature of science; (4) view of the biological world in competitive and causal terms as opposed to aesthetic terms; and (5) religious orientation. A complex web of connections among components of conceptual ecology for evolutionary theory influences one's acceptance and understanding of evolutionary theory. Therefore, studying the relationship between acceptance and understanding of evolutionary theory as a part of the conceptual ecology for evolutionary theory is more promising than studying acceptance of evolutionary theory in isolation. Moreover, studying acceptance of evolutionary theory as an integral part of the conceptual ecology may enable us to explain why some teachers and students show a high degree of acceptance and others show a low degree of acceptance.

INTRODUCTION

Evolution as a unifying theme in biology education has been supported by major science education policy documents and understanding of evolution has been considered as an important part of scientific literacy (American Association for the Advancement of Science, 1993; National Research Council, 1996). Major science education organizations such as National Association of Biology Teachers (2011) and National Science Teachers Association (2003) in the United States have also supported evolution as a unifying theme in biology. More recently evolution has been identified as one of four disciplinary core ideas in life sciences in "A Framework for K-12 Science Education: Practices,

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Crosscutting Concepts, and Core Ideas" (NRC, 2012). According to this new framework which will serve as the basis for the next generation of science education standards biological evolution includes four components:

- Evidence of Common Ancestry and Diversity
- Natural Selection
- Adaptation
- Biodiversity and Humans

The framework takes a learning progressions approach and describes what students need to know by the end of grades 2, 5, 8, and 12 for each component. It is clear that evolution continues to be considered as a major or overarching idea in life sciences curriculum, but it is less clear to what extent evolution has been taught in actual classroom settings and how students handle learning the evolution content.

There is a difference between teaching a socially controversial scientific subject and a non-socially controversial scientific subject.

Educators need to consider these five integrated domains when teaching evolution:

- The conceptual domain
- The epistemic domain
- The socio-cultural domain
- The religious domain
- The legal domain

The first three domains are important to consider in teaching other science content as well, but the last two domains become particularly important when it comes to teaching evolution.

The Conceptual Domain

The conceptual domain includes both scientifically accepted major evolutionary ideas and students' alternative conceptions about evolution. It is well known that students hold intuitive conceptions of the natural world and these conceptions are often in conflict with the scientifically accepted conceptions (Driver, 1981; NRC, 2007). After decades of research on misconceptions we now know that students' minds are not *tabula rasa* or *empty vessels*. Students do have alternative conceptions. Students' alternative conceptions need reorganization in order to accommodate the scientifically accepted contemporary views. Many researchers emphasized that students' prior conceptions might interfere with the learning (e.g., Bransford, et al., 1999; Chinn & Brever, 1993; Pintrich, et al., 1993). Pintrich et al. (1993) suggested that prior knowledge can play two contradictory roles during the learning process. They contemplated that prior knowledge can either impede the learning process through students' alternative frameworks, or it can facilitate it by providing students a conceptual basis for evaluating the validity of newly encountered ideas.

Ausubel's frequently quoted statement captures the importance of students' intuitive conceptions during the learning process in a dramatic way. This quote appears before the preface of the book that Ausubel co-authored with Novak and Hanesian (Ausubel, Novak, & Hanesian, 1978).

If had to reduce all of educational psychology to just one principle, it would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly.

Common students' alternative conceptions about evolution include the following ideas (Werth, 2012):

- All evolutionary change is adaptive.
- Evolutionary change is progressive.
- Evolutionary change is teleological (goal-directed).

Educators need to be aware that such ideas are common among students when teaching about

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