Do We Really Need a Textbook in a Science Course?

An excerpt from an article by Larry Dukerich, Modeling Workshop founding leader

While students need a source of information to reinforce and supplement what they learn in the classroom, we argue that traditional textbooks are not well suited to meet this need.

Traditional texts are designed to please textbook selection committees primarily in California, Florida and Texas. This one-size-fits-all approach makes them encyclopedic compilations of factual information. Despite the fact that there is far too much material in most textbooks to be meaningfully addressed in a school year, teachers feel enormous pressure to "cover" too many of the chapters in the text they have to use.

Bruce Alberts, in his article "Restoring Science to Science Education"[1] writes:

> Take for example my field of cell biology, where for grades 5 to 8, the National Science Education Standards produced by the National Academies in 1996 emphasized understanding the essence of cells as the fundamental units of life, rather than learning the technical names of cell parts. The California state standards, on the other hand, stress all of these names. As a result, the adopted textbook for 7th grade contains five pages with 12 cell parts highlighted as key terms: including endoplasmic reticulum, Golgi body, lysosomes, mitochondria, and ribosomes. Because this 700-page book is forced by the California state standards to cover much of biology in similar detail, there is not enough room to explain most of these cell parts. Thus, for example, for the highlighted word "endoplasmic reticulum," the book simply states that "The endoplasmic reticulum's passageways help form proteins and other materials. They also carry material throughout the cell." Why should memorizing these two sentences be of any interest or importance to a 12-year-old? And what if anything will even the best students remember a year later?

Textbooks manage to both tell too much and too little. They are filled with all sorts of extraneous information intended to interest and motivate students; however, there is little evidence that it does either. For a teacher whose approach is to gradually develop the chain of evidence supporting a concept, textbooks "spoil the story" by simply telling the student the concept. Unfortunately, to save space, the authors seldom provide much of the evidence that led to the development of the concept in question. They practice the Sergeant Joe Friday approach, "Just the facts, ma'am, just the facts" so as to spare the students the burden of working through the evidence themselves. For example, most chemistry texts delve into the inner workings of the atom in chapter two, long before students have even seen why it is useful to view matter as a collection of particles. This approach runs counter to what we know about how students learn. The NSES content standard B (Physical Science) states:

> "It is logical for students to begin asking about the internal structure of atoms, and it will be difficult, but important for them to know "how we know." Quality learning and the spirit and practice of scientific inquiry are lost when the evidence and argument for atomic structure are replaced by direct assertions by the teacher and

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[1] *Issues in Science and Technology*, Summer 2009

> text. Although many experiments are difficult to replicate in school, students can read some of the actual reports and examine the chain of evidence that led to the development of the current concept of the atom." (p 177)

Students need to see that science is a way of figuring out how the physical world works rather than as a collection of facts neatly packaged in a textbook. Here's an egregious example from a recent high school chemistry text.

> Because students have trouble relating microscopic and macroscopic views, we start our discussion with the atom and bypass the traditional historical approach text taken by many texts. (This is not to say that we do not value the study of the history of chemistry; in fact, we believe that history helps the material come alive.) Pictures from scanning tunneling microscopes can now "show" us atoms. Therefore, we begin with "We believe in atoms because we can see them."[2]

The message here is that students need not waste their time trying to reason through the evidence that led scientists to conclude that atoms exist. They can simply accept that the pictures of the little bumps on a surface of a sheet of metal are atoms because the authors tell them so.

It's not that the written word has little appeal to today's students. It's just that with the wealth of resources available on the web, today's students are less likely than ever to choose a *text* as their source of information. Textbooks are 20th century solutions to 21st century problems. [Networked digital information can be created, managed, read, critiqued, and organized very differently and often more effectively than information in textbooks.] Information provided in textbooks does not have this utility.

Proponents of Modeling Instruction suggest that students learn more by *doing* science than by *reading* about it. **We think that the money schools spend on texts would be better spent equipping labs with robust tools for students to collect and analyze data**. We can provide students with links to web-based resources such as articles and simulations to supplement what they learn in the classroom. Such resources are much more easily updated than the static information provided by a text that a school district can replace only every 6-7 years.

[Excerpted by Jane Jackson in 2017. The complete article is on the members-only section of the American Modeling Teachers Association website: http://modelinginstruction.org.]

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[2] "Teaching Tip" from *World of Chemistry*, Zumdahl, Zumdahl, DeCoste, McDougall Littell, 2007