Chapter 6
Using Digital Resources to Support STEM Education

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ABSTRACT

Scientists and science educators recommend use of dialog and argumentation to support scientific ideas. Use of peer-reviewed publications, shared data, images, models, and multimedia presentations provide the resources needed to support scientifically based arguments and design of inquiry learning projects. Open source digital resources are freely available for scientists and their students. These provide the rich data needed to educate young scientists and promote digital literacy in the science community. This chapter defines the meaning of science literacy, reviews digital resources recognized by professional scientists, and offers strategies for mapping digital resources to Science education curricular.

INTRODUCTION

Rodger Bybee (2010), the developer of 5E model for teaching science says one doesn't study science, one experiences it. Science is something students do, not anything done to them. To be fully engaged in a science lesson, one must also be able to think like a scientist, engage in argumentative learning, and reach a high level of scientific literacy (National Academy of Sciences, 1996). To think and read like a scientist, students must be able to understand the nature of science and read with precision paying close attention to intricate detail. The reader must be able to interpret claims and arguments as well as synthesize complex information. Thinking like a scientist requires investigation, data collection, proposing claims and reporting conclusions. These practices are not complete until the scientist can communicate ideas with clarity and effectiveness. Earlier research in learning and cognition shows the importance of making connections between new ideas and prior knowledge. Mental models, taxonomies, and flowcharts are useful tools for assimilation of new knowledge and accommodating for mismatches that don't seem to fit. Bransford, Brown, and Cocking (1999) distinguish novices from experts with the ability to organize knowledge into systematic categories. An example of this would be DeLuca's (2011) study on students' learning and higher order thinking skills based on data analysis of renewable energy sources. The topic

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of study is a highly relevant social issue situated within systematic data collection. The results of the study suggest the importance of a scientist's personal reflection combined with application of conceptual/procedural knowledge to authentic problem solving. DeLuca's study is categorized as a type of disciplined inquiry which is based on the work of Jerome Bruner. Bruner (1977) emphasizes the importance of providing structure built on clear relationships between cultural concepts and scientific ideas. Bruner later refers to this as "disciplined understanding" (Bruner, 1977, p. 122). It is not enough to have factual information. A student's knowledge must be structured so that he or she can expand understanding within the context of a problem or particular cultural setting. This perspective led to Bruner's seminal work in discovery learning and later "disciplined inquiry", (Bruner, 1979, p. 123-124). According to Bruner, a student is motivated to learn based on curiosity and is rewarded by uncovering of answers. Thus it could be said, reading and thinking like a scientist requires the careful organization of facts, figures, and concepts, and construction of new knowledge, all of which undergird scientific literacy.

Curriculum Standards and Scientific Literacy

By building frameworks of scientific knowledge, students are able to identify main categories and see relationships across and between ideas. National Science Education Standards (National Academy of Sciences, 1996) may provide a vehicle for adding focus, coherence, and rigor to the science curriculum. This chapter provides a rationale for using the framework of the standards as an organizer in support of digital resources for STEM education. To ensure science content, principles, and skills are adequately planned for classroom instruction, teachers and experts from across the U.S. worked collaboratively to develop the *Next Generation Science Standards* (NGSS Lead States, 2013). NGSS writing team is composed of science educators and scientists, including several Nobel Laureates. Standards can be accessed from the NSTA website (National Science Teachers Association, 2015) along with numerous instructional resources for K12 teachers. The standards are presented in table format and organized into categories for Elementary School, Middle School, and High School. Grade level is subdivided into categories for Physical sciences, Life sciences, Earth and Space sciences, and engineering, technology and applications of science. The standards are written on a K12 Framework with three components: 44 disciplinary Core Ideas, 7 Cross-cutting Concepts, and 8 Science and Engineering Practices.

The writing teams for the NGSS (NGSS Lead States, 2013) have worked closely with writers of Common Core English Language Arts standards to incorporate reading and literacy. Developers of Common Core Standards place special emphasis on reading informational text in science as well writing in technical subjects. While writing in the form of argumentation, information and explanation, and narrative is emphasized across all content areas within the curriculum (Cope, Kalantzis, Abd-El-Khalick, & Bagley, 2013), argumentation and information/explanation would be most important for teaching science. For example, in Grades 6-8 to meet standards in the Common Core State Standards ELA Science and Technical, students must:

A. Introduce claim(s), acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
B. Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
C. Use words, phrases, and clauses to create cohesion and clarify the relationships

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