Chapter 1
Online Learning Environments, Scientific Argumentation, and 21st Century Skills

ABSTRACT
A workshop held at the National Academies in the United States in 2007 highlighted five broad categories of skills that appear valuable across a range of jobs for people working in modern global economies. Engaging students in scientific argumentation can support the development of these 21st century skills. Unfortunately, opportunities are rare in typical classrooms for students to learn how to engage in scientific argumentation. Over the past ten years several online environments have been developed to support students engaging with one another in scientific argumentation. This paper considers how engaging students in scientific argumentation through the activity structures and scripts in these online environments could also support the development of 21st century skills. More specifically, the paper considers how WISE Seeded Discussions, CASSIS, VCRI, and DREW can support students’ development of Adaptability, Complex Communication Skills, Non-Routine Problem-Solving Skills, Self-Management/ Self-Development, and Systems Thinking.
INTRODUCTION

The Workshop on Research Evidence Related to Future Skill Demands held at the National Academies in the United States in 2007 highlighted five broad categories of 21st century skills that appear valuable across a range of jobs, from low-wage service work to professional work, for people working in modern global economies. These five broad categories of skills include (1) adaptability, (2) complex communication and social skills, (3) non-routine problem solving, (4) self-management and self-development, and (5) systems thinking. Complex communication and social skills, for example, involve processing and interpreting both verbal and non-verbal information from others in order to respond appropriately. The full definition for each of these categories is provided later in this chapter. Research suggests that individuals learn and apply these broad skills within the context of specific domains and bodies of knowledge in school, the workplace, and other settings (National Research Council, 2008, 2000; Levy and Murnane, 2004). At work, development of these skills is intertwined with development of technical job content knowledge, but these skills can also potentially be developed through experiences in educational settings.

This chapter considers how engaging students in scientific argumentation in online environments inside and outside the classroom can help promote and support the development of 21st century skills. More specifically, this chapter (1) highlights the potential value and challenges of integrating scientific argumentation into school and university curricula, (2) outlines several technology enhanced learning environments that have been developed to support students engaging in argumentation (either scientific argumentation specifically or interpretations of argumentation that align well with many of the core commitments of scientific argumentation), and (3) discusses how the goals and activity structures of these environments can simultaneously support and promote the development of each of the 21st century skills as defined by the National Academies.

WHY SCIENTIFIC ARGUMENTATION?

Inquiry is at the heart of current efforts to help students develop scientific literacy (AAAS, 1993; NRC, 2000). True scientific literacy involves understanding how knowledge is generated, justified, and evaluated by scientists and how to use such knowledge to engage in inquiry in ways that reflect the practices of the scientific community (Driver Newton, & Osborne, 2000; Duschl & Osborne, 2002). Scientific inquiry is often described in this literature as a knowledge building process in which explanations are developed to make sense of data and then presented to a community of peers so they can be critiqued, debated, and revised (Driver et al., 2000; Duschl, 2000; Sandoval & Reiser, 2004; Vellom & Anderson, 1999). The ability to engage in scientific argumentation (i.e., the ability to examine and then either accept or reject the relationships or connections between and among the evidence and the theoretical ideas invoked in an explanation or the ability to make connections between and among evidence and theory in an argument) is therefore viewed by many as an important aspect of scientific literacy (Driver et al., 2000; Duschl & Osborne, 2002; Jimenez-Aleixandre, Rodriguez, & Duschl, 2000; Kuhn, 1993; Siegel, 1989).

Learning to engage in scientific argumentation is challenging for students. For example, students are often asked to generate an explanation for why or how something happens during activities designed to engage students in scientific argumentation. To do this, students must first make sense of the phenomenon they are studying based on the data available to them. Current research suggests that students struggle with this process (Abell, Anderson, & Chezem, 2000; Kuhn & Reiser, 2005; Sandoval, 2003; Vellom & Anderson, 1999) and often rely on their personal beliefs.
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