

Successful STEM Education and Education for Life and Work: Some Critical Connections and Implications

Background

Business, political, and educational leaders are increasingly asking schools to teach students skills such as problem solving, critical thinking, and collaboration. Such skills are often referred to as “21st century skills” or “deeper learning.” As argued in the 2012 NRC Report, *Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century*, these skills are best developed within the teaching and learning of academic subjects—and, in fact, are key to helping students master academic subject matter and being college and career ready. By engaging in deeper learning, students go beyond rote learning of facts and procedures to understand underlying principles. They know when and how to transfer their knowledge and skills to solve new problems and navigate new situations. This type of learning will be needed to meet the goals set by the new state standards for English language arts, mathematics, and science. And as technology reduces workplace needs for routine skills, success in coming years will demand people who can apply their knowledge and skills effectively to changing situations rather than rely solely on well-worn procedures. But, creating school environments that support deeper learning and the transferable knowledge and skills that result—known as “21st century competencies”—will require changes in teaching methods, curricula, and assessments.

Deeper learning, as defined in the report, is the process through which a person becomes capable of taking what was learned in one situation and applying it to new situations—in other words, learning for “transfer.” Through deeper learning, students develop expertise in a particular discipline or subject area. They don’t simply learn isolated procedures or pieces of knowledge; they also learn when and why to use their knowledge and skills. They recognize when new problems or situations are related to what they have previously learned, and they can apply their knowledge and skills to solve them. Through the process of deeper learning, students develop 21st century competencies. Instead of “skills,” the report uses the broader term “competencies” to include both knowledge *and* skills. Many foundations and organizations have developed lists of competencies that they believe to be important. The competencies vary widely—ranging from critical thinking and argumentation to flexibility and “grit”—but the report argues that they can be organized into three overarching domains:

- **the cognitive domain**, which includes thinking, reasoning, problem-solving, and related skills
- **the intrapersonal domain**, which involves self-management, including the ability to regulate one’s behavior and emotions to reach goals
- **the interpersonal domain**, which involves expressing information to others, as well as interpreting others’ messages and responding appropriately, and collaborating with others

The report argues that goals for deeper learning and 21st century competencies converge with goals in the new *Common Core State Standards* in English language arts and mathematics and the NRC *Framework for K–12 Science Education*. All three documents highlight the importance of helping students understand the general principles underlying specific content, a hallmark of deeper learning. And all three documents support cognitive competencies such as critical thinking, problem solving, and evidence-based argumentation. Coverage of other competencies—especially those in the interpersonal and intrapersonal domains—is uneven.

Developing the full range of 21st century competencies within the disciplines will require systematic instruction and sustained practice, a change in approach that will require additional instructional time and resources.

The report also discusses features of instruction that aid deeper learning and the development of transferable knowledge and skills. For example, instruction should help learners understand the general principles underlying the specific examples they are taught. In addition, teaching should emphasize not only content knowledge, but also how, when, and why to apply this knowledge. As students gain understanding of how to use their content knowledge to solve problems and address challenges—both inside and outside the classroom—they will become more motivated to engage seriously in deeper learning. As argued in the report, instruction should follow a set of research-based teaching methods that can be readily identified in successful STEM education instructional programs.

The report also discusses specific areas that need the attention of policymakers and funding agencies:

- **Curriculum.** Curriculum and instructional programs are needed that include research-based teaching methods to help students develop transferable knowledge and skills. Policymakers should support the development and use of curricula that foster instructional techniques that focus on the process of thinking rather than only the products.
- **Assessments.** The extent to which teachers will focus on helping students develop 21st century competencies will be strongly influenced by the degree to which these competencies are included in district, state, and national assessments. Currently, educational policies and accountability systems rely on assessments that emphasize recall of facts and procedures, posing a challenge to wider teaching and learning of 21st century competencies. However, recent policy developments offer an opportunity to address this challenge. With the support of the U.S. Department of Education, two large consortia of states are developing new assessments aligned with the *Common Core State Standards*. Through these consortia, states should work to ensure that these assessments—as well as those eventually developed based on new science standards—include tasks that call upon facets of 21st century competencies as applied in each major content area.
- **Teacher education.** New approaches to teacher preparation and professional development will be needed to help current and prospective teachers understand how to teach for deeper learning, as well as the role of deeper learning and 21st century competencies in helping students master core academic content. Currently, the instructional practices described in the report and that characterize successful STEM education are rarely reflected in the knowledge and practices of teachers and school administrators.
- **Research.** Foundations and federal research agencies should support studies to fill research gaps on teaching and learning for transfer.

For More Information

Download the *Education for Life and Work* report at http://www.nap.edu/catalog.php?record_id=13398.