Learning 21st-century **skills** requires 21st-century **teaching**

Globalization, economic necessity, and low civic engagement compound the urgency for students to develop the skills and knowledge they need for success. The interconnectedness of our global economy, ecosystem, and political networks require that students learn to communicate, collaborate, and problem solve with people worldwide. Employers demand fewer people with basic skill sets and more people with complex thinking and communication skills (Levy & Murnane, 2005). Low levels of civic engagement highlight the recognition that rote learning about government is not a sufficient way for students to learn how and why to be engaged citizens (Levine, 2012).

But the movement toward 21st-century skills — as any movement — must define its objective, to wit, the skills that comprise the movement. Based on several hundred interviews with business, nonprofit, and education leaders, Tony Wagner (2008) proposes that students need seven *survival skills* including:

- Critical thinking and problem solving;
- Collaboration and leadership;
- Agility and adaptability;
- Initiative and entrepreneurialism;
- Effective oral and written communication;
- Accessing and analyzing information; and
- Curiosity and imagination.

The Assessment and Teaching of 21st-century Skills consortium (AT21CS), organizes skills, knowledge, and attitudes into four categories: ways of thinking, ways of working, tools for working, and living in the world (2012).

Regardless of the skills included or the terms used to describe them, all 21st-century skills definitions are relevant to aspects of contemporary life in a complex world. Most focus on similar types of complex thinking, learning, and communication skills, and all are more demanding to teach and learn than rote skills. These abilities are also commonly referred to as higher-order thinking skills, deeper learning outcomes, and complex thinking and communication skills.

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If students aren't acquiring the necessary knowledge and skills, it's because schools aren't teaching them.

By Anna Rosefsky Saavedra and V. Darleen Opfer

Why students aren't learning them

The outdated, transmission model of education, through which teachers transmit factual knowledge to students via lectures and textbooks, remains the dominant approach to compulsory education in much of the world (OECD, 2009). Through the transmission model, students can learn information, but typically don't have much practice applying the knowledge to new contexts, communicating it in complex ways, using it to solve problems, or using it as a platform to develop creativity. Therefore, transmission is not the most effective way to teach 21st-century skills. Students are not developing them because they are not being explicitly taught (Schleicher, 2012) and because they are more difficult to assess than factual retention (AT21CS, 2012).

Nine lessons

Despite the challenges, we can educate students differently. Learning scientists have taught us nine lessons relative to teaching 21st-century skills. All of the lessons are about how students learn 21st-century skills and how pedagogy can address their needs. Many of the lessons — especially transfer, metacognition, teamwork, technology, and creativity — are also 21st-century skills in themselves.

#1. MAKE IT RELEVANT. To be effective, curriculum must be relevant to students' lives. To make curriculum relevant, teachers must begin with generative topics or topics that have an important place in the disciplinary or interdisciplinary study at hand and that resonate with learners and teachers (Perkins, 2010).

Technology allows students to transfer skills to different contexts, reflect on their thinking and that of their peers, practice addressing their misunderstandings, and collaborate with peers.

The relevance of a specific topic is clearer to students when they understand how it fits within the big picture. In his book *Making Learning Whole* (2010), teaching and learning expert David Perkins uses baseball as an analogy to explain that players must know how hitting, catching, and running bases

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contribute to the game. Similarly, students need to understand how statistics fit into the bigger picture of mathematical thinking, and they must have a sense of the value of mathematical thinking in the first place. Once they see the big picture, they also must understand how each of the knowledge-, skill- and attitude-based objectives contribute to understanding the big picture, how they all fit together.

#2. TEACH THROUGH THE DISCIPLINES. Learning should occur through the disciplines, including native and foreign languages, hard and social sciences, mathematics and the arts. In addition to learning the knowledge of the discipline, students also must learn the skills associated with the production of knowledge within the discipline. For example, through scientific study, students should learn why science is relevant and what kinds of problems they can solve through scientific methods, as well as how scientists carry out experiments, how they reach conclusions, what they do with the knowledge they gain from the process, and how they communicate their findings.

Students benefit from believing that intelligence and capacity increase with effort and that mistakes and failures are opportunities for self-inquiry and growth rather than indictments of worth or ability.

#3. DEVELOP THINKING SKILLS. Students can and should develop lower- and higher-order thinking skills simultaneously. For example, students might practice lower-order skills by plugging numbers into the equation like $E=MC^2$ as a way to understand the relationship between mass and energy. To deepen understanding of that relationship, teachers might ask students probing questions that require higher-order thinking to answer, such as "Why does the formula use mass instead of weight? Can I use my bathroom scale to determine mass? Why or why not?" (Schwartz & Fischer, 2006). Addressing these questions successfully, while more difficult, contributes to flexible and applicable understanding and is exactly what students need to do to successfully negotiate the demands of the 21st century.

Lower-order exercises are fairly common in existing curricula, while higher-order thinking activities are much less common. Higher-level thinking skills take time to develop and teaching them generally requires a tradeoff of breadth for depth. An approach popular in Finland and Singapore is to reverse the way students spend their time in the classroom and on homework at home. Instead of listening to lectures at school and doing problems at home, students can read content as homework and at school work on problems in groups while the teacher poses thought-provoking questions and coaches explicitly on development of higher-order thinking.

#4. ENCOURAGE LEARNING TRANSFER. Students must apply the skills and knowledge they gain in one discipline to another and what they learn in school to other areas of their lives. A common theme is that ordinary instruction doesn't prepare learners well to transfer what they learn, but explicit attention to the challenges of transfer can cultivate it.

Transfer involves three variable components:

1. What skills, concepts, knowledge, attitudes, and/or strategies might transfer?
2. To which context, situation, or application would they transfer?
3. How could the transfer take place? (Fogarty, Perkins, & Barell, 1992)

Examples of skills that might transfer include the ability to work in teams or understanding cause and effect. Contexts include other subjects or even future workplaces where the learner could use such knowledge or skills. Transfer can occur in one of two general ways: low road and high road. In a low-road transfer, students might apply what they know about using the equation *distance = velocity x time* to using the equation $E=MC^2$. A so-called high-road transfer requires deliberate abstraction and generalization about a particular concept. For example, through provocative questions about mass and motion, teachers ask students to make conceptual connections between scientific laws and real-life situations (Salomon & Perkins, 1989).

Transfer is hard to learn and students need support and practice to ensure that it happens. Yet the importance of transfer brings us back to the fundamental rationale for learning 21st-century skills in the first place — so students can transfer them to the economic, civic, and global contexts that demand them.

#5. TEACH STUDENTS HOW TO LEARN. There is a limit to what students can learn through formal schooling. Therefore, educating them for the 21st century requires teaching them how to learn on their own. To do so, students must be aware of how they learn. Flavell first coined the modern label *metacognition* in 1976 to describe learning to learn. Not only is learning to learn a critical skill in itself, activities that develop metacognition also help students to learn

9 lessons for 21st-century learning

#1. Make it relevant.

#2. Teach through the disciplines.

#3. Develop thinking skills.

#4. Encourage learning transfer.

#5. Teach students how to learn.

#6. Address misunderstandings directly.

#7. Treat teamwork like an outcome.

#8. Exploit technology to support learning.

#9. Foster creativity.

skills, knowledge, strategies, and attitudes more effectively (Pauli, Reusser, & Grob, 2007).

Teachers can develop students' metacognition by encouraging them to explicitly examine how they think. A group of Australian researchers found that when students wrote *thinking* in the middle of a blank piece of paper and then recorded their ideas about thinking, they became more self-directed learners and better thinkers (Ritchhart, Turner, & Hadar, 2009). Teachers also can reinforce students' metacognition by modeling it on a regular basis, talking through their own thinking as they address an example problem and then asking students to reflect on their model.

Students' development of positive mental models about how they learn, the limits of their learning and indications of failure are also important. Students benefit from believing that intelligence and capacity increase with effort and that mistakes and failures are opportunities for self-inquiry and growth rather than indictments of worth or ability (Dweck, 2000). Effective ways for teachers to cultivate students' progress in thinking include praising them for their effort and learning style rather than for their intelligence, as well as discussing mental models as part of other metacognition-building activities (Dweck, 2009).

#6. ADDRESS MISUNDERSTANDINGS DIRECTLY. Learners have many misunderstandings about how the world really works, and they hold onto misconceptions until they have the opportunity to build alternative explanations based on experience (Perkins & Grotzer, 2008). For example, children believe the world is flat until they learn otherwise. To overcome misconceptions, learners of any age must actively construct new understandings.

Textbooks rarely explicitly speak to misunderstandings, leaving the challenge of addressing them to the teacher (Schwartz & Fischer, 2006). Modeling misunderstandings and explicitly addressing them helps improve and deepen students' understanding. For example, teachers in a middle school modeled for students the problems created when a plant or animal goes extinct by connecting a group of students with one string of yarn that each held in their hand and then asking one of them to sit down to represent the disappearance of a plant or animal from the ecosystem. As students sat down others would feel the tug of the yarn. This concrete, tactile experience provided a forum through which teachers explicitly discussed with students different types of causal relationships and how these relationships played out in the model (Grotzer & Basca, 2003).

#7. TREAT TEAMWORK LIKE AN OUTCOME. The ability to collaborate with others is an important 21st-century skill and an important condition for optimal learning. As David Perkins points out, people do not learn to play baseball by themselves. "… [O]nly Superman could do it, and it wouldn't be much fun" (2010, p. 191). They should learn to play baseball from and with their peers and coach.

The relevance of a specific topic is clearer to students when they understand how it fits within the big picture.

Teachers can design instruction in many ways so students learn from and with others, developing their ability to work in teams and building other 21st-century skills. Students can discuss concepts in pairs or groups and share what they understand with the rest of the class. They can develop arguments and debate them. Together, students and the teacher can use a studio format in which several students work through a given issue, talking through their thinking process while others comment. Because the studio approach is so dominant in Asian countries — in contrast to U.S. teachers and parents who lament large class sizes — Asian teachers often express concern about class sizes getting too small to find enough different solutions to a problem to have an effective lesson (OECD, 2010).

#8. EXPLOIT TECHNOLOGY TO SUPPORT LEARNING. Technology also offers the potential to develop students' 21st-century skills by providing them with new ways to develop their problem solving, critical

thinking, and communication skills. Technology can help students practice transferring those skills to different contexts, reflect on their thinking and that of their peers, practice addressing their misunderstandings, and collaborate with peers.

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For example, the River City Multi-User Virtual Environment is a technology tool that has the look and feel of a video game. Based on U.S. ecology standards, the game places students into a 19th-century virtual environment where they behave as health scientists to help explain why people are getting sick. They collaboratively identify problems with their online peers, form and test hypotheses, and draw conclusions about underlying causes.

The Internet itself also provides a forum for developing students' 21st-century skills and knowledge. The nature of the Internet's countless sources, many of which provide inconsistent information and contribute substantive source bias, gives students opportunities to practice filtering out information from unreliable sources and synthesizing information from legitimate ones (Dede, 2005).

There is broad consensus that technology holds great promise for education. It has not yet lived up to this promise, in part, because teachers have not had the opportunity to learn to maximize its pedagogical value.

#9. FOSTER CREATIVITY. Creativity is prized in the economic, civic, and global spheres because it sparks innovations that can create jobs, address challenges, and motivate social and individual progress. Like intelligence and learning capacity, creativity is not a fixed characteristic that people either have or do not have. Rather, it is incremental, such that students can learn to be more creative.

Creative development requires structure and intentionality from teachers and students and can be learned through the disciplines (Robinson, 2001). If students find lessons relevant to their lives, they are more intrinsically motivated to learn and use their newfound knowledge and understanding creatively (Csikszentmihalyi, 2008; Sternberg, 2006). Encouragement helps students develop positive mental models about their ability to develop their creativity. Identifying creativity can help students recognize their own creative capacities when they might not otherwise. Teaching directly about the creative process and what animates or suppresses it contributes to creative development.

Conclusion

In this article, we explain why 21st-century skills are important and summarize what the science of learning tells us about how best to teach those skills. While there is some progress toward this goal, the remaining work necessary to progress from the transmission model to the 21st-century model has important implications for the entire educational system. Since education standards and the purposes of education are changing, curriculum frameworks, instructional methods, and assessment strategies must also change. Those changes in curriculum, instruction, and assessment have many important human capital implications, including those related to teacher training, professional development, career mobility, and general cultural standing of the teaching profession. This work will be demanding and complicated, and it will require from educators and policy makers at all levels precisely the sorts of skills that we deem critical for the next generation. However, if we believe 21st-century skills are the key to solving economic, civic, and global challenges and to engaging effectively in those spheres, then we must act upon the belief that using those skills to overhaul our education systems is possible. K

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