



21st century skills

Rethinking How Students Learn

Solution Tree | Press

a division of



Solution Tree

Copyright © 2010 by Solution Tree Press

All rights reserved, including the right of reproduction of this book in whole or in part in any form.

555 North Morton Street
Bloomington, IN 47404
800.733.6786 (toll free) / 812.336.7700
FAX: 812.336.7790

email: info@solution-tree.com
solution-tree.com

Visit go.solution-tree.com/21stcenturyskills to view chapter 6 and 11 graphics in full color and to access live links to tools and materials.

Printed in the United States of America
14 13 12 11 10 1 2 3 4 5



Library of Congress Cataloging-in-Publication Data

21st century skills : rethinking how students learn / [edited by] James Bellanca, Ron Brandt.

p. cm. -- (Leading edge)

Includes bibliographical references and index.

ISBN 978-1-935249-90-0

1. Learning ability. 2. Learning strategies. I. Bellanca, James A., 1937- II. Brandt, Ronald S. III. Title: Twenty-first century skills.

LB1134.A22 2010

370.15'23--dc22

2010002492

Solution Tree

Jeffrey C. Jones, CEO & President

Solution Tree Press

President: Douglas M. Rife

Publisher: Robert D. Clouse

Vice President of Production: Gretchen Knapp

Managing Production Editor: Caroline Wise

Senior Production Editor: Suzanne Kraszewski

Copy Editor: Rachel Rosolina

Proofreader: Sarah Payne-Mills

Cover Designer: Orlando Angel

Text Designer: Amy Shock

Acknowledgments

Assembling a coherent book from the ideas of a group of highly individualistic and creative thinkers is never easy. Our efforts to develop this volume were facilitated by the cooperative spirit of the contributing authors and the editorial staff at Solution Tree Press. In fact, the book's development has been a model of the skills we seek to promote: collaboration, communication, creative and critical thinking, and lots of problem solving.

Special thanks go to Robb Clouse, Solution Tree Press publisher. Robb became the third musketeer in identifying potential authors, establishing criteria, selecting the articles, and making helpful suggestions. We also appreciate the support and attention to detail of Gretchen Knapp, vice president of production, and Suzanne Kraszewski, senior production editor.

Table of Contents

| | |
|--|------|
| About the Editors | vii |
| Preface <i>Ron Brandt</i> | ix |
| Foreword 21st Century Skills: Why They Matter, What They Are, and How We Get There <i>Ken Kay</i> | xiii |
| Introduction <i>James Bellanca and Ron Brandt</i> | 1 |
| Chapter 1 Five Minds for the Future <i>Howard Gardner</i> | 9 |
| Chapter 2 New Policies for 21st Century Demands <i>Linda Darling-Hammond, Interviewed</i> <i>by James Bellanca</i> | 33 |
| Chapter 3 Comparing Frameworks for 21st Century Skills <i>Chris Dede</i> | 51 |
| Chapter 4 The Role of Professional Learning Communities in Advancing 21st Century Skills <i>Richard DuFour and Rebecca DuFour</i> | 77 |
| Chapter 5 The Singapore Vision: <i>Teach Less, Learn More</i> <i>Robin Fogarty and Brian M. Pete</i> | 97 |
| Chapter 6 Designing New Learning Environments to Support 21st Century Skills <i>Bob Pearlman</i> | 117 |
| Chapter 7 An Implementation Framework to Support 21st Century Skills <i>Jay McTighe and Elliott Seif</i> | 149 |

| | | |
|------------------------|--|-----|
| Chapter 8 | Problem-Based Learning: The Foundation for 21st Century Skills <i>John Barell</i> | 175 |
| Chapter 9 | Cooperative Learning and Conflict Resolution: Essential 21st Century Skills <i>David W. Johnson and Roger T. Johnson</i> | 201 |
| Chapter 10 | Preparing Students for Mastery of 21st Century Skills <i>Douglas Fisher and Nancy Frey</i> | 221 |
| Chapter 11 | Innovation Through Technology <i>Cheryl Lemke</i> | 243 |
| Chapter 12 | Technology Rich, Information Poor <i>Alan November</i> | 275 |
| Chapter 13 | Navigating Social Networks as Learning Tools <i>Will Richardson</i> | 285 |
| Chapter 14 | A Framework for Assessing 21st Century Skills <i>Douglas Reeves</i> | 305 |
| Afterword | Leadership, Change, and Beyond the 21st Century Skills Agenda <i>Andy Hargreaves</i> | 327 |
| Index | | 349 |

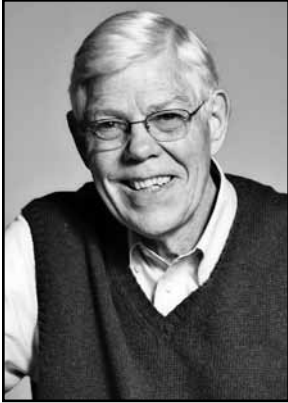
About the Editors

James Bellanca and Ron Brandt



James Bellanca, MA, is founder and CEO of International Renewal Institute, Inc., and acting director of the Illinois Consortium for 21st Century Skills. He founded SkyLight Professional Development in 1982. As its president, he mentored more than twenty author-consultants as he led SkyLight in pioneering the use of strategic teaching in comprehensive professional development. Bellanca coauthored more than twenty books that advocated the application of thinking and cooperating

across the curriculum with the theme “not just for the test, but for a lifetime of learning.” Currently, Bellanca is building on the theories of cognitive psychologist Reuven Feuerstein to develop more effective responses to the learning needs of students whose academic achievement continues to lag. A longtime proponent of teaching that is aligned with the advocated best practices of 21st century skills, Bellanca’s most recent publications include *Designing Professional Development for Change: A Guide for Improving Classroom Instruction*; *Enriched Learning Projects: A Practical Pathway to 21st Century Skills*; *Collaboration and Cooperation in 21st Century Schools*; *200+ Active Learning Strategies and Projects for Engaging Students’ Multiple Intelligences*; and *A Guide to Graphic Organizers: Helping Students Organize and Process Content for Deeper Learning*.



Ron Brandt, Ed.D., was editor of publications for the Association for Supervision and Curriculum Development (ASCD), Alexandria, Virginia, for almost twenty years before his retirement in 1997. During his career at ASCD, he was best known as executive editor of *Educational Leadership* magazine. In the 1980s, he promoted the teaching of thinking in elementary and secondary schools, collaborating with Robert Marzano and a team of other educators in development of a book, *Dimensions of Thinking*, and a related teacher training program, *Dimensions of Learning*. He is also the author or editor of numerous other publications. Before joining the staff of ASCD, he was a teacher and principal in Racine, Wisconsin; director of staff development in Minneapolis, Minnesota; and for eight years was associate superintendent of the Lincoln Public Schools in Lincoln, Nebraska.

Preface

Ron Brandt

Educators are faced once again with a daunting challenge: this time, it is to equip students with 21st century skills. Critics oppose the idea on the grounds that emphasizing skills such as critical thinking and problem solving will erode the teaching of important content, including history and literature. Their concern may be valid, but their position that “skills can neither be taught nor applied effectively without prior knowledge of a wide array of subjects” (Common Core, 2009) is not. Both knowledge *and* skills are needed, and they are interdependent; advocates and critics agree about that. And the authors of this book know from experience that effective teaching involves students *using* skills to acquire knowledge.

No generation can escape the responsibility of deciding what students should learn by analyzing what adults are called upon to do. When the United States was young, citizens of New England were taught to do simple calculations, write letters, and read the Bible. In the 1900s, as farming grew in complexity, high schools in rural areas began teaching vocational agriculture. With the current blitz of fast-moving developments in technology, schools are beefing up their science and mathematics programs.

The obvious need for education to relate to society’s demands was satirized in a delightful little book published seventy years ago that told how, in Paleolithic times, schools supposedly came to teach fish grabbing and saber-toothed tiger scaring (Benjamin, 1939). The book’s purpose was not to belittle efforts to match curriculum to societal needs; rather, it used gentle humor to warn how difficult it can be to keep up these efforts. When Paleolithic educators finally decided to

add a course in tiger scaring, for example, they could locate only two harmless, moth-eaten old tigers for students to scare.

So trying to foresee students' future needs is not being trendy; it is a necessity. But, of course, it is only the beginning. The hard parts are, first, determining how these new demands fit in relation to the existing curriculum; second, finding ways they can be taught *along with content*; and then, managing the complex process of implementation. This book is intended to help you with these momentous tasks. Like the fictitious Paleolithics in Benjamin's book, we may not be completely successful in these efforts, but we must accept the challenge.

References

- Common Core. (2009). *A challenge to the Partnership for 21st Century Skills*. Accessed at www.commoncore.org/p21-challenge.php on November 5, 2009.
- Benjamin, H. R. W. (1939). *The saber-tooth curriculum*. New York: McGraw-Hill.



Ken Kay

Ken Kay, JD, has spent the past twenty-five years bringing together the education, business, and policy communities to improve U.S. competitiveness. He is president of the Partnership for 21st Century Skills, the nation's leading advocacy organization focused on infusing 21st century skills into education and preparing every child to succeed in the new global economy.

He also serves as the CEO and cofounder of e-Luminate Group, an education consulting firm.

Throughout his career, Kay has been a major voice and premier coalition builder on competitiveness issues in education and industry—particularly policies and practices that support innovation and technology leadership. As executive director of the CEO Forum on Education and Technology, he led the development of the StaR Chart (School Technology & Readiness Guide), used by schools across the country to make better use of technology in K–12 classrooms. A lawyer and nationally recognized coalition builder, Kay has also facilitated initiatives by universities and technology leaders to advance research and development policy and by computer industry CEOs to advance U.S. trade and technology policy.

In his foreword, Kay presents the Framework for 21st Century Learning advocated by his group. He responds to three key questions—(1) Why are the skills listed in the framework needed for learning in the future? (2) Which skills are most important? and (3) What can be done to help schools include these skills in their repertoire so that 21st century learning results?—and argues for realigning the teaching-learning relationship so that it focuses on outcomes.

Foreword

21st Century Skills: Why They Matter, What They Are, and How We Get There

Ken Kay, President, Partnership for 21st Century Skills

The writer Malcolm Gladwell (2000) astutely describes how and why social change happens when we arrive at a “tipping point,” the moment when a critical mass of circumstances come together and sets us on a new and unstoppable course. Scientists, economists, and sociologists all use this term to describe moments when significant change occurs and results in a new reality that is markedly different from the old.

I believe we are on the threshold of a tipping point in public education. The moment is at hand for a 21st century model for education that will better prepare students for the demands of citizenship, college, and careers in this millennium.

I am honored that the editors have asked me to introduce this book and set the context with the overarching theme of 21st century skills, using the Framework for 21st Century Learning developed by the Partnership for 21st Century Skills (2009a). This book is a compilation of reflections on the possibilities for 21st century learning by some of the most thoughtful educational minds in the United States. It is gratifying that so many of them are engaged in envisioning and

substantiating more robust approaches to educating young people, particularly since those of us in the Partnership have worked since 2001 on the same exciting project.

The vision for 21st Century Learning offers a holistic and systemic view of how we can reconceptualize and reinvigorate public education, bringing together all the elements—21st century student outcomes and 21st century education support systems—into a unified framework.

The vision for 21st century learning developed by the Partnership for 21st Century Skills (2009a), summarized in figure F.1, offers a compelling context for the chapters in this volume. This vision offers a holistic and systemic view of how we can reconceptualize and reinvigorate public education, bringing together all the elements—21st century student outcomes and 21st century education support systems—into a unified framework. For us, the starting point for this framework is actually the end result:

the outcomes—in terms of mastery of core academic subjects, 21st century themes, and 21st century skills—that should be expected of students once they leave school to venture successfully into higher education, workplaces, and independent life. It's only when we understand these outcomes that we can then begin building the supporting infrastructure that will lift the education system to commanding heights. The *raison d'être* for the support systems—standards and assessments, curriculum and instruction, professional development, and learning environments—should be to achieve the results that truly matter for students.

Without a clear and thorough articulation of the outcomes that students need, reshaping the infrastructure is premature. Here's an analogy: if you are building a house, it doesn't make sense to order the plumbing fittings before the architect finishes the design specifications. In education, 21st century student outcomes *are* the design specs for the rest of the system.

The Partnership has crafted an all-encompassing vision for a 21st century education system. We don't have all the answers, however. As the contributions to this book make clear, there are many more wonderful ideas percolating that will strengthen the vision of 21st century learning and help transform every aspect of the system.

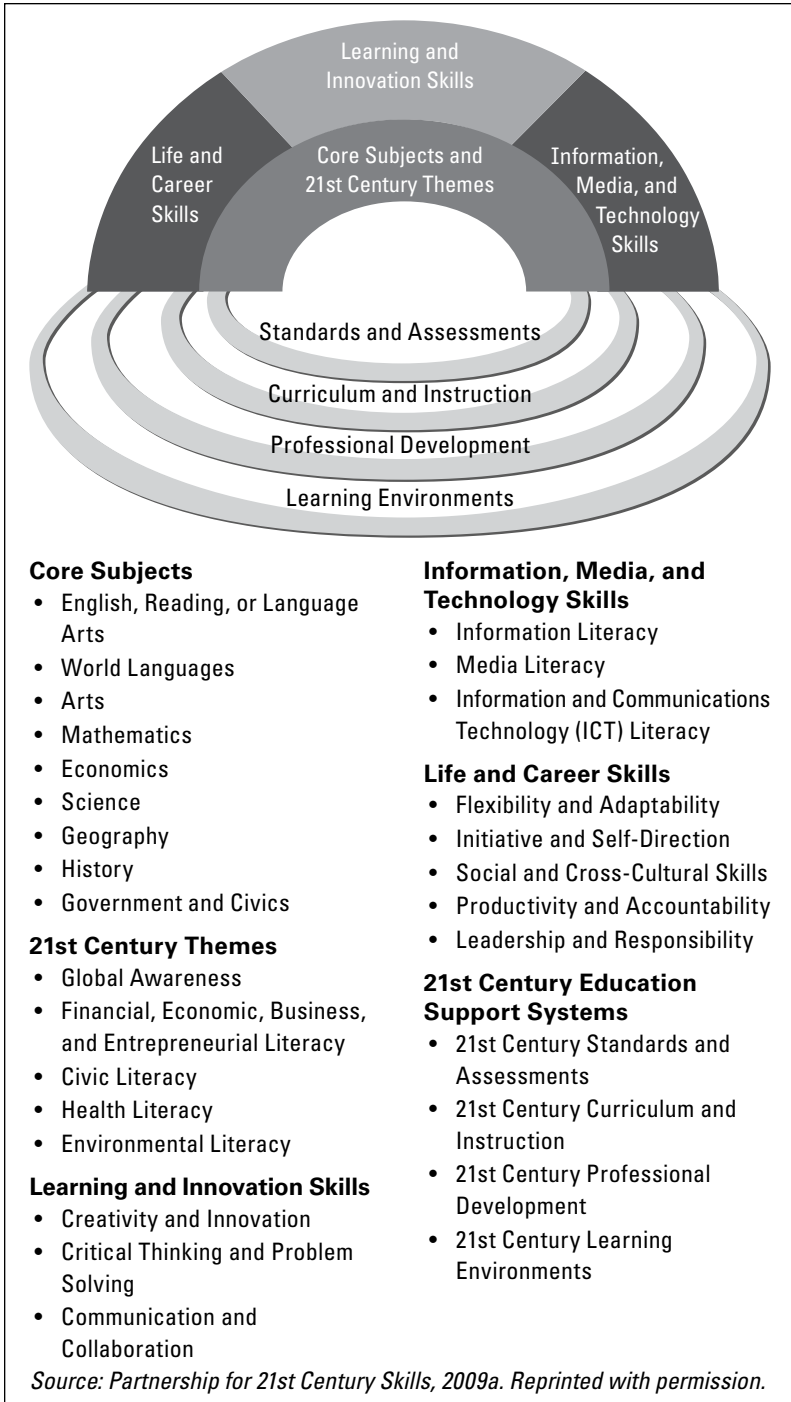


Figure F.1: The Partnership for 21st Century Skills Framework for 21st Century Learning.

We aren't rigid about the language used to describe 21st century skills, either. We say *adaptability*, for instance, while others prefer *resiliency*. We say *critical thinking*; others say *systems thinking*. No matter—we're all talking about the same concepts. On the other hand, the term *21st century skills* is not a vague and squishy catchword that can mean anything. Every element of our model has been defined, developed, and vetted by leading experts, scholars, educators, business people, parents, and community members.

We invite individuals and organizations to use our framework to spark a lively national dialogue about all of the elements required for enriching 21st century minds. It is particularly important to engage educators and representatives of the business community in this dialogue (Wagner, 2008). It's critical for states, districts, and schools to have these conversations and agree on the student outcomes they value—and then to create systems that can deliver.

Why Do We Need a New Model for Education in the 21st Century?

The forces instigating the inevitable changes on the horizon in education have been building for some time:

- **The world is changing**—The global economy, with its emerging industries and occupations, offers tremendous opportunities for everyone who has the skills to take advantage of it. There has been a dramatic acceleration in global competition and collaboration over the past thirty years, spurred by information and communications technology. The service economy, which is driven by information, knowledge, and innovation, has supplanted the industrial economy and reshaped businesses and workplaces. More than three-quarters of all jobs in the United States are now in the service sector. Manual labor and routine tasks have given way to interactive, nonroutine tasks—even in many traditionally blue-collar occupations. Technology has replaced workers who perform routine work, while it complements workers with higher-level skills and empowers them to be more productive and creative (Autor, Levy, & Murnane, 2003). Advanced economies,

innovative industries and firms, and high-growth jobs increasingly reward people who can adapt and contribute to organizations, products, and processes with the communications, problem-solving, and critical-thinking skills that enable them to customize their work and respond to organizational expectations (Partnership for 21st Century Skills, 2008).

In this era of rapid change, the social contract prevalent for a good part of the last century doesn't exist anymore. Doing well in school no longer guarantees a lifelong job or career as it did for previous generations of Americans.

Today, people can expect to have many jobs in multiple fields during their careers. The average person born in the later years of the baby boom held 10.8 jobs between the ages of eighteen and forty-two, according to the U.S. Bureau of Labor Statistics (Bureau of Labor Statistics, U.S. Department of Labor, 2009). The new social contract is different: only people who have the knowledge and skills to negotiate constant change and reinvent themselves for new situations will succeed. Competency in 21st century skills gives people the ability to keep learning and adjusting to change. Twenty-first-century skills are the ticket to moving up the economic ladder. Without 21st century skills, people are relegated to low-wage, low-skill jobs. Proficiency in 21st century skills is the new civil right for our times.

- **U.S. schools and students have not adapted to the changing world**—Our current public education system is not preparing all students for the economic, workforce, and citizenship opportunities—and demands—of the 21st century. Many students do not receive the family and societal support they need to stay in school. On top of that, many students are

The forces instigating the inevitable changes on the horizon in education have been building for some time:

- The world is changing.
 - U.S. schools and students have not adapted to the changing world.
 - The United States has no clear sense of purpose or direction for securing our future economic competitiveness.
-

not engaged or motivated in school learning that seems out of step with their lives and irrelevant to their futures. The high school dropout rate has reached crisis proportions, with only 70 percent of students—and only 50 percent of minorities—graduating from high school on time and with a regular diploma (Swanson, 2009).

Alarming, we now face two achievement gaps—one national and one international. Nationally, Black, Hispanic, and disadvantaged students perform worse than their peers on national assessments (see, for example, Grigg, Donahue, & Dion, 2007; Lee, Grigg, & Donahue, 2007; National Center for Education Statistics, 2009), dragging down the collective capacity of the future workforce. This is especially troubling as the demographics of the United States are shifting, with minority populations growing at a much faster pace than the rest of the population (U.S. Census Bureau, 2008).

Internationally, American students score lower than the average on the Programme for International Student Assessment (PISA), the benchmark assessment in reading, mathematics, and science for the developed countries of the world (see, for example, Organisation for Economic Co-operation and Development, 2009). PISA results are telling because these assessments measure the applied skills—what we call *21st century skills*—of critical thinking and problem solving. Even the best U.S. students cannot match their peers in other advanced economies on PISA.

Even if all students earned a high school diploma and mastered traditional academic subjects, they *still* would be ill prepared for the expectations of the new economy. Today, a different set of skills—21st century skills—increasingly powers the wealth of nations. Skills that support innovation, including creativity, critical thinking, and problem solving, are in great demand (Casner-Lotto & Barrington, 2006; Conference Board, 2007; Lichtenberg, Woock, & Wright, 2008), yet employers report substantial deficiencies in these and other applied skills among even college-educated entrants into the workforce.

Educational attainment is no longer a guarantee of either academic or skills proficiency (van Ark, Barrington, Fosler, Hulten, & Woock, 2009).

- **The United States has no clear sense of purpose or direction for securing our future economic competitiveness**—The United States remains the most competitive nation on the planet, but “creeping complacency” could erode this dominance (International Institute for Management Development, 2009; Scott, 2009). Science, technology, engineering, and mathematics (STEM) experts in industry and higher education have been warning for years that the United States is losing ground when it comes to preparing an adequate supply of workers for these critical fields. Competitor nations in Asia and Europe have gotten the message that skills matter, and they are catching up. Concerted international efforts—and marked success—at improving education and 21st century skills mean that the United States is no longer unrivaled in producing highly qualified, nimble, and ambitious workers for the new economy. In addition, the substantial economic growth fueled by information technology since the late 1980s and early 1990s is likely to max out without investment in intangible workforce assets, including ideas, knowledge, and talent (van Ark et al., 2009).

What Should a 21st Century Education Look Like?

Meeting the challenges we face requires a new model for education—one in which every aspect of our education system is aligned to prepare Americans to compete.

The Partnership for 21st Century Skills has spent the better part of a decade developing a robust Framework for 21st Century Learning (shown on page xv in figure F.1) that responds to the changing demands young people face today. Sustained and enthusiastic support from leading education organizations, the business community, and policymakers—and reality checks with parents, frontline K–12 and postsecondary educators, and community organizations—have shaped this framework into a comprehensive, intentional, and purposeful vision for 21st century education (Trilling & Fadel, 2009).

The graphic is powerful because it communicates at a glance the integration of core academic subjects, 21st century themes, and 21st century skills, with the educational support systems clearly aligned to these student outcomes. The Framework for 21st Century Learning offers a compelling, responsive, and viable direction for public education—starting now—for a number of reasons.

The Framework Focuses on Results That Matter

A 21st century education must be tied to *outcomes*, in terms of proficiency in core subject knowledge and 21st century skills that are expected and highly valued in school, work, and community settings.

A 21st century education must be tied to *outcomes*, in terms of proficiency in core subject knowledge and 21st century skills that are expected and highly valued in school, work, and community settings.

It is a national travesty that a majority of U.S. students leave high school without the core competencies that employers and postsecondary educators cite as the most critical for real-world performance and advanced learning. Critical thinking, problem solving, creativity, and the other 21st century skills are the tools people need to move up the economic ladder.

With 21st century skills, students will be prepared to think, learn, work, solve problems, communicate, collaborate, and contribute effectively throughout their lives. Some say these kinds of skills are not unique to the 21st century. This is true. We call them out for three reasons.

First, these skills are rarely incorporated deliberately throughout the curriculum, nor are they routinely assessed. This status quo relegates these skills into the “nice to have” rather than the “must have” domain in education, which means they are taught unevenly. It is more likely that young people pick up these skills by chance in everyday living and job experiences and, yes, sometimes in school—if they are lucky enough to have good mentors or are astute enough to recognize and build these skills on their own. We simply can no longer afford to continue this haphazard approach to developing the most critical skills if we are to remain a competitive nation.

Second, these skills are essential for *all* students today, not just an elite few. In bygone economies, Americans lived in a hierarchical

world with an assembly-line mentality. Top managers and experts took on the lion's share of the thinking, problem solving, decision making, and communicating for their organizations. They gave orders, and most workers were expected simply to follow directions. This is not so today. Competitive organizations have flattened management structures, increased their use of technology, created more flexible work arrangements, and given greater responsibility to frontline workers and collaborative project teams. Such significant organizational and behavioral shifts have boosted productivity and innovation (Black & Lynch, 2004; Gera & Gu, 2004; Pilat, 2004; Zoghi, Mohr, & Meyer, 2007). With these realities, students who do not master 21st century skills will never fulfill their economic potentials.

In this flattened structure, every worker has more information and tools at his or her disposal—and much greater autonomy in using them. In exchange, workers are expected to be self-directed and responsible for managing their own work. As a manager at Apple told me, any employee who needs to be managed is no longer employable. The same shift of responsibility to individuals applies to personal life. There are fewer authority figures to take care of people or tell them what to do. Today, people have to manage their own health care, arming themselves with information, making choices about coverage, acting as their own advocates, and partnering with health-care providers to manage their health. Likewise, participating in civic life requires people to seek out information to understand issues on their own. The decline of print journalism, for example, means that the latest local news may not be delivered to the doorstep every day.

Third, the skills that employers and postsecondary educators say are required for success have converged. Even entry-level employees now are expected to use 21st century skills to accomplish their work (Casner-Lotto & Barrington, 2006; Conference Board, 2007; Lichtenberg, Woock, & Wright, 2008). Most jobs that pay a living wage today require at least some postsecondary education—and this is particularly the case for the 271 jobs with high-growth potential over the next ten years, according to the U.S. Department of Labor (Bureau of Labor Statistics, U.S. Department of Labor, 2008).

Most students aspire to college because they understand this. Indeed, there has been a significant increase in the proportion of the

labor force with at least some level of higher education (Carnevale & Desrochers, 2002). Twenty-first-century skills are equally important for successful transitions to college and workforce training programs. Among the components of college readiness presented by the Bill & Melinda Gates Foundation are “academic behaviors” and “contextual skills and awareness” (Conley, 2005, 2007), which reflect the kinds of skills captured in the Framework for 21st Century Learning. All students should be prepared with the skills they need to do well, whatever route they decide to take in the future.

The Framework for 21st Century Learning also incorporates several new 21st century themes that might not seem familiar. Again, employers and educators—along with parents, policymakers, and community advocates—identified these themes and skills as crucial. Typically, though, they are not emphasized in public education. These themes are grounded in everyday life as people across the United States are living it now. They want schools to integrate these new themes, which blend content and skills, to better prepare young people to thrive in a complex world.

For example, global awareness is a new essential in the global economy. Americans need a secure understanding of global issues that affect them as citizens and workers. They need to be able to learn from and work collaboratively with people from a range of diverse cultures and lifestyles. They need to be able to communicate in languages other than English.

Likewise, financial, economic, business, and entrepreneurial literacy are new imperatives. Guaranteed pensions are a rarity today, so the responsibility for retirement planning, saving, and investment management falls on individuals. Recent crises in the banking, credit, and mortgage industries—and the severe recession—underscore the importance of understanding how economic forces impact people’s lives. Failure to make responsible financial choices could adversely affect individuals’ quality of life for years. At work, people need to know how they fit in and contribute to a larger organization, and they need to bring an entrepreneurial mindset to their lives. By recognizing opportunities, risks, and rewards, they can enhance

their workplace productivity and career options and take changing circumstances in stride.

Finally, the Framework for 21st Century Learning articulates several skills that definitely break new ground, at least in education: creativity and innovation, flexibility and adaptability, leadership and cross-cultural skills—for *all* students. These are the kinds of skills that set people apart. Small leaps of imagination can result in tremendous personal and organizational advances. A willingness to respond positively to change leaves people open to new possibilities and more comfortable with the inevitable vagaries of life. Taking on leadership roles gives people more control over their lives, while cross-cultural skills strengthen their effectiveness in interacting with others they encounter in school, work, and the community.

These new skills also differentiate leading from lagging organizations and nations. They undergird every aspect of competitiveness: ingenuity, agility, and continuous improvement; the capacity to turn bold ideas into innovative products, services, and solutions; and the ability to champion worthwhile endeavors, overcome obstacles, and bridge cultural divides.

Taken together, the combination of core academic subjects, 21st century themes, and 21st century skills redefines rigor for our times. Many Americans have been advocating a more rigorous education to prepare students for college and career readiness—a position that we share.

However, *rigor* traditionally is equated with mastery of content (core subjects) alone, and that's simply not good enough anymore. Knowledge and information change constantly. Students need *both* content knowledge *and* skills to apply and transform their knowledge for useful and creative purposes and to keep learning as content and circumstances change.

I've heard John Bransford, a noted professor of education and psychology at the University of Washington and the coauthor of *How People Learn: Bridging Research and Practice* (2000) and *How Students Learn: Science in the Classroom* (2004), put it this way: In the United States, we tell students the same thing a hundred times.

On the 101st time, we ask them if they remember what we told them the first hundred times. However, in the 21st century, the true test of rigor is for students to be able to look at material they've never seen before and know what to do with it.

Infusing 21st century skills into core subjects actually ratchets up rigor. Recalling facts or terms from a textbook, or performing simple processes or procedures, places a low level of cognitive demand on students. Demonstrating deeper understanding through planning, using evidence, and abstract reasoning, for example, is more demanding. Making connections among related ideas within the content or among content areas, or devising an approach to solving a complex problem, requires extended thinking and even higher cognitive demand (Webb, 1997).

The connection between skills and rigor shows up on international assessments such as PISA. Students who can apply critical thinking and problem solving to math and science content perform better than those who cannot. In a 21st century education system, rigor must refer to mastery of content *and* skills.

As I see it, then, there are plenty of convincing indicators that proficiency in 21st century skills is the right result for our time. Enriching minds for the 21st century requires organizing the public education system around this goal.

The Framework Recognizes That Educational Support Systems—Especially Professional Learning Experiences—Are Vital

The vision for 21st century learning is situated in reality: producing the results that matter in terms of student outcomes in 21st century skills requires every aspect of the education system to be aligned toward this goal.

The vision for 21st century learning is situated in reality: producing the results that matter in terms of student outcomes in 21st century skills requires every aspect of the education system to be aligned toward this goal.

While this might seem to be a monumental aspiration, the evidence suggests that states are prepared—even very willing—to take on this work. By October of 2009, fourteen states (Arizona, Illinois, Iowa, Kansas, Louisiana, Maine, Massachusetts, Nevada, New Jersey, North

Carolina, Ohio, South Dakota, West Virginia, and Wisconsin) had committed to retooling their standards and assessments, curriculum and instruction, professional development, and learning environments to support 21st century skills outcomes. The states and districts that are making real progress are those that take a holistic and systemic approach, articulating the skills they value and aligning every other part of their systems to move in this direction.

Many of these states face daunting challenges. Major industries are restructuring and eliminating jobs. The recent economic downturn has exacerbated this problem, and seriously affected state budgets and schools. Nevertheless, these states have carefully examined the framework and endorsed it as their model for building a 21st century education system. They realize that they must reinvent their education systems to renew their workforces and their economies. West Virginia, for example, is revising and refocusing its standards, assessments, instruction, professional development, teacher preparation, preK, and technology programs around the Partnership's Framework for 21st Century Learning.

Professional development is far and away the most important part of the work. Steve Paine, superintendent of schools in West Virginia, tells me that 80 percent of his efforts are devoted to improving teacher effectiveness in delivering 21st century instruction. He has it right. Articulating the skills that matter is only the first step. States and districts cannot assume that teachers can break out of the 20th-century box without sustained professional development. The West Virginia Department of Education has put a full-court press on this mission, initially training every teacher in the state during in-depth summer sessions on 21st century skills and in follow-up web-based coaching during the school year. The state also has a dynamic, interactive website, Teach 21, with a wealth of resources to assist teachers in their everyday classroom practices.

At the Partnership, we've developed detailed content maps and online resources that add layers of specificity to 21st century learning for teachers. These resources promote the kinds of hands-on, inquiry-based learning and development of higher-level thinking skills that the most effective teachers employ (Darling-Hammond et al., 2008). Indeed, many classroom teachers and educators who work closely

with students in schools are leading the way in delivering this kind of instruction. All of the teaching resources are available at a dedicated website: Route 21 (www.21stcenturyskills.org/route21/).

The entire supporting infrastructure of education must be modernized to establish the conditions for 21st century teaching, learning, and outcomes. And, as we have learned from previous standards-setting initiatives, ignoring the infrastructure puts an undue burden on students. It is unfair and unproductive to expect students to meet new and higher expectations if the supporting infrastructure does not exist. To help states, districts, and schools move forward, we have developed and updated our MILE guide with implementation guidance and self-assessment tools (Partnership for 21st Century Skills, 2009b).

All of the critical elements of an education system contribute to 21st century skills outcomes, and they cannot be left to chance.

The Framework Resonates With Policymakers, Educators, the Business Community, Community Organizations, and Parents

Plenty of organizations have developed models for improving education. Not many have had the courage to vet their models with thousands of people from every walk of life. Our model of core subjects, 21st century themes, and 21st century skills has been put to this test.

We developed the framework in concert with our nearly forty membership organizations, including the National Education Association and its 3.2 million members. We took the framework on road tours, reaching out to policymakers, educators, business people, community organizations, and parents. We listened to their comments and strengthened the themes and skill sets. We surveyed business people and parents, who strongly agree that 21st century skills are vital for success today (Casner-Lotto & Barrington, 2006; Partnership for 21st Century Skills, 2007). They also believe by overwhelming margins that schools should teach 21st century skills. Their beliefs are based in reality—the expectations of workplaces, the demands of citizenship, and the challenges of life that they face

every day. We've been informed by the surveys and reports of other organizations, which confirm our findings.

This is not a small point. A major difference between 21st century skills advocacy and other improvement initiatives, such as the 1980s push to revamp education, is that the leaders of this movement include policymakers, educators, *and* the business community. We are speaking with a united voice. Together, we have taken the time to gauge the interest and attitudes of key stakeholders in public education. And we have strived to build broad-based support for our model from the top down and the bottom up. In many states, governors, leaders in state education agencies and state boards of education, local school boards, business people, community organizations, educators, parents, and the voting public are engaged and energized by our model.

We are speaking with a united voice. Together, we have taken the time to gauge the interest and attitudes of key stakeholders in public education.

There is much more work to do to build public understanding nationwide—in every district, community, and family. Yet the support we already have, plus the accomplishments of our fourteen leadership states, gives us the opportunity to engage in a vigorous national conversation about new student outcomes for the 21st century—and to bring more supporters on board.

State, district, and school leaders and their communities will want to examine the changes their economies have experienced over the past twenty years. They'll want to think through the new skills students will need for the next twenty years and beyond. And once they articulate these new skills in their own words, they will be ready to align their education systems to make their vision a reality.

The Future of Learning

This book is another telltale sign that we've reached a tipping point in education. That so many notable minds are thinking hard about the future of learning is a signal that we just might be on the cusp of bold action.

At stake at this moment are the nation's competitiveness and all that goes along with it: a strong democracy, international leadership,

lasting prosperity, and better prospects for generations to come. It is as true today as ever in our history that the American people are the engine of economic growth. In this time, for this era, however, they need to be equipped with knowledge and skills to compete in the 21st century.

In meeting rooms and classrooms across the country, I have met thousands of people who are ready to take on this challenge. The broad public support for the Framework for 21st Century Learning suggests the strong potential for building political will for a 21st century education system. It is exciting that the framework has generated this kind of interest, but it is far too early to proclaim victory.

We need to move from consensus about the *vision* of 21st century learning to a thorough understanding of and commitment to the *outcomes* of 21st century learning.

We need to move from consensus about the *vision* of 21st century learning to a thorough understanding of and commitment to the *outcomes* of 21st century learning. There is a danger, in fact, that a “21st century education” or “21st century skills” could mean anything. Many people equate technology-rich classrooms or modern schools or rigorous core subjects with

21st century learning, regardless of whether students are mastering 21st century skills. In reality, the ability to use digital devices in no way means that students know anything about global awareness or health literacy, learning and innovation skills, life and career skills, or even media literacy skills. Similarly, many educators claim that they already teach 21st century skills, even though these skills are not systemically infused into standards and assessments, curriculum and instruction, or professional development and learning environments.

The most important next step is to agree on outcomes in terms of proficiency in 21st century skills. And it’s not enough to want these outcomes—it’s essential to plan the entire education system intentionally and transparently around them. A great place to start is to use the lens of 21st century outcomes to aggressively pursue the ideas in this book.

Acknowledgments

Special thanks to the former and current members of the Partnership for 21st Century Skills board and strategic council for their tremendous support of 21st century skills, and to Martha Vockley for her special contributions to the development of this foreword.

References

- Autor, D. H., Levy, F., & Murnane, R. J. (2003, November). The skill content of recent technological change: An empirical exploration. *Quarterly Journal of Economics*, 118(4), 1279–1333.
- Black, S. E., & Lynch, L. M. (2004, February). What's driving the new economy?: The benefits of workplace innovation. *The Economic Journal*, 114, 97–116.
- Bureau of Labor Statistics, U.S. Department of Labor. (2008, June 27). *Number of jobs held, labor market activity, and earnings growth among the youngest baby boomers: Results from a longitudinal survey*. Washington, DC: Author. Accessed at www.bls.gov/news.release/pdf/nlsoy.pdf on December 8, 2009.
- Bureau of Labor Statistics, U.S. Department of Labor. (2009). *Occupational projections and training data, 2008–09 edition*. Accessed at www.bls.gov/emp/optd/optdtabi_5.pdf on December 8, 2009.
- Carnevale, A. P., & Desrochers, D. M. (2002, Fall). The missing middle: Aligning education and the knowledge economy. *Journal for Vocational and Special Needs Education*, 25(1), 3–23.
- Casner-Lotto, J., & Barrington, L. (2006). *Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century U.S. workforce*. New York: The Conference Board. Accessed at www.21stcenturyskills.org/documents/FINAL_REPORT_PDF09-29-06.pdf on June 18, 2009.
- Conference Board. (2007). *CEO challenge 2007: Top 10 challenges* (Research Report 1406). New York: Author.
- Conley, D. T. (2005). *College knowledge™: What it really takes for students to succeed and what we can do to get them ready*. San Francisco: Jossey-Bass.
- Conley, D. T. (2007). *Toward a more comprehensive conception of college readiness*. Eugene, OR: Educational Policy Improvement Center. Accessed at www.gatesfoundation.org/learning/Documents/CollegeReadinessPaper.pdf on June 18, 2009.
- Darling-Hammond, L., Barron, B., Pearson, P. D., Schoenfeld, A. H., Stage, E. K., & Zimmerman, T. D., et al. (2008). *Powerful learning: What we know about teaching for understanding*. San Francisco: Jossey-Bass.
- Donovan, S., Bransford, J., & Pellegrino, J. W. (Eds.). (2000). *How people learn: Bridging research and practice*. Washington, DC: National Academies Press.

- Donovan, S., & Bransford, J. (2004). *How students learn: Science in the classroom*. Washington, DC: National Academies Press.
- Gera, S., & Gu, W. (2004, Fall). The effect of organizational innovation and information technology on firm performance. *International Productivity Monitor*, 9, 37–51. Accessed at www.csls.ca/ipm/9/gera_gu-e.pdf on June 18, 2009.
- Gladwell, M. (2000). *The tipping point: How little things can make a big difference*. Boston: Little, Brown.
- Grigg, W., Donahue, P., & Dion, G. (2007). *The nation's report card: 12th-grade reading and mathematics 2005* (NCES 2007-468). U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office. Accessed at <http://nces.ed.gov/nationsreportcard/pdf/main2005/2007468.pdf> on December 7, 2009.
- International Institute for Management Development. (2009). *IMD world competitiveness yearbook*. Lausanne, Switzerland: Author.
- Lee, J., Grigg, W., & Donahue, P. (2007). *The nation's report card: Reading 2007* (NCES 2007-496). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Accessed at <http://nces.ed.gov/nationsreportcard/pdf/main2007/2007496.pdf> on December 7, 2009.
- Lichtenberg, J., Woock, C., & Wright, M. (2008). *Ready to innovate: Key findings*. New York: The Conference Board. Accessed at www.artsusa.org/pdf/information_services/research/policy_roundtable/ready_to_innovate.pdf on June 18, 2009.
- National Center for Education Statistics (2009). *The nation's report card: Mathematics 2009* (NCES 2009-451). Washington, DC: Institute of Education Sciences, U.S. Department of Education. Accessed at <http://nces.ed.gov/nationsreportcard/pdf/main2009/2010451.pdf> on December 7, 2009.
- Organisation for Economic Co-operation and Development (2009). *Top of the class: High performers in science in PISA 2006*. Paris: Author. Accessed at www.pisa.oecd.org/dataoecd/44/17/42645389.pdf on December 7, 2009.
- Partnership for 21st Century Skills. (2007). *Beyond the three Rs: Voter attitudes toward 21st century skills*. Tucson, AZ: Author. Accessed at www.21stcenturyskills.org/documents/P21_pollreport_singlepg.pdf on June 18, 2009.
- Partnership for 21st Century Skills. (2008). *21st century skills, education & competitiveness: A resource and policy guide*. Tucson, AZ: Author. Accessed at www.21stcenturyskills.org/documents/21st_century_skills_education_and_competitiveness_guide.pdf on June 18, 2009.
- Partnership for 21st Century Skills. (2009a). *Framework for 21st century learning*. Tucson, AZ: Author. Accessed at www.21stcenturyskills.org/documents/framework_flyer_updated_april_2009.pdf on November 1, 2009.

- Partnership for 21st Century Skills. (2009b). *The MILE guide: Milestones for improving learning & education*. Tucson, AZ: Author. Accessed at www.21stcenturyskills.org/documents/MILE_Guide_091101.pdf on December 8, 2009.
- Pilat, D. (2004, December). *The economic impact of ICT: A European perspective* (IIR Working Paper 05–07). Paper presented to the Conference on IT Innovation, Tokyo. Accessed at www.iir.hit-u.ac.jp/iir-w3/event/WP05–07pilat.pdf on June 18, 2009.
- Scott, M. (2009, May 19). Competitiveness: The U.S. and Europe are tops. *Business Week*. Accessed at www.businessweek.com/globalbiz/content/may2009/gb20090519_222765.htm on June 18, 2009.
- Swanson, C. B. (2009, April). *Cities in crisis 2009: Closing the graduation gap*. Bethesda, MD: Editorial Projects in Education. Accessed at www.edweek.org/media/cities_in_crisis_2009.pdf on December 7, 2009.
- Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. San Francisco: Jossey-Bass.
- U.S. Census Bureau. (2008, August 14). *An older and more diverse nation by midcentury*. Washington, DC: Author. Accessed at www.census.gov/Press-Release/www/releases/archives/population/012496.html on December 7, 2009.
- van Ark, B., Barrington, L., Fosler, G., Hulten, C., & Woock, C. (2009). *Innovation and U.S. competitiveness: Reevaluating the contributors to growth*. New York: The Conference Board.
- Wagner, T. (2008). *The global achievement gap: Why even our best schools don't teach the new survival skills our children need—and what we can do about it*. New York: Basic Books.
- Webb, N. L. (1997, April). *Criteria for alignment of expectations and assessments in mathematics and science education* (Research Monograph 6). Madison, WI: National Institute for Science Education. Accessed at http://hub.mspnet.org/media/data/WebbCriteria.pdf?media_000000000924.pdf on June 18, 2009.
- Zoghi, C., Mohr, R. D., & Meyer, P. B. (2007, May). *Workplace organization and innovation* (Working Paper No. 405). Washington, DC: U.S. Bureau of Labor Statistics.

© 2010 Solution Tree Press. All rights reserved.

Introduction

James Bellanca and Ron Brandt

Initiatives for significant change in an important sector of society often come mostly from outsiders. That is the case with the movement known as 21st century skills, spurred by the Partnership for 21st Century Skills. The Partnership includes large corporations, national professional organizations, and state offices of education. These agencies are concerned because they foresee a need for people with skills that go beyond those emphasized in today's schools. Elected leaders, including President Obama and many state governors, agree that this change is essential if U.S. students are to remain competitive in the global job market.

To accomplish its goals, the Partnership has delineated a Framework for 21st Century Learning that it would like to see each state adopt as the preeminent agenda for improving teaching and learning (see figure F.1 on page xv of the foreword by Ken Kay, president of the Partnership for 21st Century Skills). The redesign of policies in partner states is expected to begin with modification of current educational standards. Next, the Partnership wants to see practices aligned with the standards, with the result that students will show that they have developed the necessary skills.

In fact, desired practices that are intended to garner these outcomes are beginning to show. Early adopting teachers, principals, district leaders, and school boards have begun to put the framework into place. There are individual teachers who have changed their classrooms into technology-rich learning places. Their students experiment, do projects, take risks, and solve meaningful problems.

Although the number of whole schools that are attuned to the 21st century skills agenda falls short of those that continue to be mired in the practices and content of the 20th century, pockets of change are emerging. This is especially true in states that are members of the Partnership. In some states, the leaders of schoolwide change are charter schools organized to escape the “same old, same old” model of teaching and learning. In others, they are public schools that are redefining the teaching-learning connection.

At the district level, systemic reform for 21st century learning has a higher mountain to climb. In Tucson, Arizona, and Warrenville, Illinois, school leaders, starting with the school board and central administration, have gone public with a vision for 21st century learning and districtwide strategic plans. These plans are driving step-by-step actions that include new building designs, curriculum changes, long-term professional development for leaders and teachers, and the integration of technology in each school.

At the state level, West Virginia, an early 21st century skills partner, leads an increasing number of state offices of education in promoting 21st century skills. West Virginia has created a user-friendly website, Teach 21 (<http://wvde.state.wv.us/teach21/>), that offers 21st century *power standards*—instructional guides, unit plans, and sample project-based learning ideas—across content and special needs areas. West Virginia has also prepared a cadre of teacher leaders to facilitate teachers’ use of project-based learning throughout the school year. Individual teachers and schools, such as tiny Washington District Elementary School in Buckhannon, are encouraged to revise instruction and assessment to align practice with this rich collection of resources and put project-based learning into daily practice.

Illinois has taken a different tack. When the Illinois State Board of Education formally signed on as a member of the Partnership, a group of education and business leaders formed an independent consortium to engage school districts in planning for implementation of the Partnership’s Framework. The Illinois Consortium’s vision includes plans to link multidistrict collaboratives that will provide long-term professional development and systemic change for member schools.

The Consortium’s leadership, working closely with Illinois State Board of Education officials, is connecting its “bubble up” innovation process with the State Board’s direction-setting initiative. The bubble-up process, named at New Trier East High School (Winnetka, Illinois) by then associate superintendent Mary Ida Maguire, encourages diverse constituent groups—teachers, parents, and administrators—to generate ideas for improvements to be funded for the next school year. The best ideas determined within each group rise to the top. A committee with members selected at random from each of the basic groups set criteria, agree on the best ideas, and make recommendations to the school board’s budget committee. The Consortium’s thirty member board of directors uses the bubble-up process to identify innovative projects for which it will pursue implementation funds.

On the national stage, a handful of professional organizations, most notably the National Council of Teachers of English, National Science Teachers Association, the National Council for Social Studies, and the American Library Association, have collaborated with the Partnership to develop online resource guides for integrating 21st century skills into content areas. Other organizations, such as the National Education Association and Association for Supervision and Curriculum Development, have taken steps to raise member awareness.

With the chapters in this volume, we begin the process of filling in the vision established by the Partnership. We know this collection will not be the last word on the subject, but we believe it is a valuable next step.

Our first task in envisioning this volume was to identify key issues that would contribute to the dialogue. We then identified a group of authors, each with the experience and farsightedness required to address these issues. We asked them to help answer three basic questions that would illuminate the theme of 21st century skills: (1) Why are the skills listed in the framework needed for learning in the future? (2) Which skills are most important? and (3) What can be done to help schools include these skills in their repertoire so that 21st century learning results?

Chapter Overviews

In his foreword, Ken Kay, president of the Partnership for 21st Century Skills, presents the Framework for 21st Century Learning advocated by his group. He responds to our three key questions and argues for realigning the teaching-learning relationship so that it focuses on outcomes.

In chapter 1, Howard Gardner identifies five types of minds society should encourage in future generations, three primarily cognitive and two in the human sphere. He outlines the major features of each type, the ways they can be shaped, and ways they could be distorted. He concludes by offering suggestions for how the five types might be integrated in a single, thriving human being.

In an interview for chapter 2, Linda Darling-Hammond calls for major policy changes to guide development of 21st century schools. She advocates deep alignment of standards, curriculum, instruction, and assessment; strengthening professionalism among teachers and school leaders; redesign of school time to allow for increased participation in professional decisions by teachers; and equitable distribution of resources among all schools. She insists that the United States must take a more balanced approach to school reform and that these changes are essential if the United States is to restore its lost leadership for educational excellence.

In chapter 3, Chris Dede compares several prominent lists of 21st century skills. He asks, “How diverse are these definitions for 21st century skills?” and notes that a lack of clarity about the nature of 21st century skills could be problematic. His examination illuminates what the various frameworks have in common and what each uniquely adds to the overarching concept.

In chapter 4, Richard and Rebecca DuFour discuss school settings for teaching 21st century skills. They observe that the most appropriate environment for teaching the life and career skills espoused by the Partnership for 21st Century Skills is a professional learning community (PLC) that models these skills. On this basis, they argue that the PLC is an essential tool for bringing about the changes that 21st century skills advocates envision.

In chapter 5, Robin Fogarty and Brian Pete carry the discussion to Singapore, where they have worked as educational consultants with the nation's ambitious "Teach Less, Learn More" initiative. Fogarty and Pete share the thoughts and feelings of teachers torn between the old ways of authoritarian, competitive schools and the new ways of shared decision making and collaborative study that encourage students to construct meaning rather than memorize facts.

In chapter 6, Bob Pearlman takes a walk through innovative school buildings designed for collaborative learning. He reminds us that the familiar box-based design of most current schools was suited for an outdated factory-model agenda. He shows us that form follows function in these innovative buildings as well—but the functions are now engagement, problem solving, and communication.

In chapter 7, Jay McTighe and Elliott Seif address the question of how to infuse 21st century outcomes into the overcrowded curriculum left over from the previous century with a systematic approach that takes advantage of the principles and practices of Understanding by Design. Using familiar concepts adapted from *Schooling by Design*, the authors outline five interrelated components: (1) the mission of schooling, (2) the principles of learning, (3) a curriculum and assessment system, (4) instructional programs and practices, and (5) systemic support factors. They examine how each of these components can help schools transform themselves to implement a viable approach to teaching and learning that ends in the acquisition of 21st century skills for all students.

In chapter 8, John Barel shows that problem-based learning is an ideal way to develop 21st century skills. He describes how teachers shift their standards-based curriculum from direct instruction of passive students to active engagement of problem solvers and question askers. His concrete examples illustrate ways problem-based inquiry can be adapted for meaningful use with students of all ages, talents, and challenges.

In chapter 9, David Johnson and Roger Johnson point out four important challenges of the 21st century: (1) greater global interdependence, (2) the increasing number of democracies throughout the world, (3) the need for creative entrepreneurs, and (4) the importance

of interpersonal relationships that affect the development of personal identity. They discuss how cooperative learning, constructive controversy, and problem-solving negotiations will play a central role in teaching students the competencies and values they need to cope with these challenges and lead productive and fulfilling lives.

In chapter 10, Douglas Fisher and Nancy Frey describe three ways for teachers to respond to the extreme shifts in technological advancement and student needs for the 21st century: (1) considering functions rather than tools, (2) revising technology policies, and (3) developing students' minds through intentional instruction.

In chapter 11, Cheryl Lemke introduces three important innovations of 21st century learning: (1) visualization, (2) democratization of knowledge, and (3) participatory cultures for learning. She provides an impressive demonstration of ways technology permits greater balance between a visual approach and traditional language-based communication.

In chapter 12, Alan November reinforces Pearlman's rationale for redesigned schools. He cautions against using expensive technology to continue the trend of schools as managers of student learning. It's time, he says, to redesign not only the physical structure but the culture of schools. Technology makes it possible for students to become less dependent on schools and take more responsibility for managing their own learning.

In chapter 13, Will Richardson calls attention to the explosion of social network technologies. This powerful new landscape is fraught with danger, he says, but it is also rich with potential for learning. Richardson describes the rise of the virtual, global classroom, the challenge of this unrestricted learning, its potentials and pitfalls, and how educators can make the shift to network literacy in order to improve the quality of students' learning experiences.

In chapter 14, Douglas Reeves tackles the challenging problem of assessment. He argues that the new outcomes envisioned by advocates of 21st century skills can properly be measured only by abandoning standardized tests. He offers three criteria for determining how

educators can know students are learning 21st century content and skills and shows how these might apply in practice.

In the afterword, Andy Hargreaves concludes the collection by asking tough questions about the 21st century skills movement. He uses metaphor to illuminate the historic ways that change has occurred in education and will occur in the future. He categorizes the emphasis on 21st century skills as the Third Way. He lists positive and negative results from each of the prior ways and looks ahead to an even more desirable Fourth Way.



Bob Pearlman

Bob Pearlman has been a key leader of national educational reform efforts in his unique thirty-year career as a teacher, codirector of computer education, teacher union leader and negotiator, foundation president, and director of education and workforce development. Pearlman's experience and expertise includes whole-district reform, new school development,

business-education partnerships and coalitions, school-to-career and workforce development, union–school district negotiations, school restructuring and technology, project-based learning, professional development, educational finance, and school-site assessment and accountability. Pearlman is currently a strategy consultant for 21st century school and district development. He served as the director of strategic planning for the New Technology Foundation from 2002 to 2009. Pearlman consults in the United States and in the United Kingdom on 21st century learning, focusing on new school development and districtwide implementation of 21st century skills.

In this chapter, Pearlman takes a walk through innovative school buildings designed for collaborative learning. He reminds us that the familiar box-based design of most current schools was suited for an outdated factory-model agenda. He shows us that form follows function in these innovative buildings as well, but the functions are now engagement, problem solving, and communication.

Visit go.solution-tree.com/21stcenturyskills to view the graphics in this chapter in full color and to access live links to tools and materials.

Chapter 6

Designing New Learning Environments to Support 21st Century Skills

Bob Pearlman

Visit any number of new school buildings across the United States, and behind the beautiful, new (and sometimes green) facilities, you will still see the same old 700- to 900-square-foot classrooms, superbly designed for a teacher to stand in front of a class of thirty students set in neat rows, listening, taking notes, and doing worksheets. Yes, you might see wiring for computers and interactive whiteboards at the head of the classroom, but other than that, little has changed.

Go across the pond to England, where they are six years into the eighty-billion-dollar Building Schools of the Future (BSF) program to replace or renovate every secondary school in that country, and you will see some significant innovations beginning to emerge. The aspirations of many local education authorities are high: “BSF is being seen as the catalyst for transformation of education in [England]. BSF is not simply a buildings programme, and must not result in ‘old wine in new bottles’” (Hertfordshire Grid for Learning, 2009). What you see, however, in the first wave of new builds and renovations, is still mostly the same “old wine”—traditional education. But because the United Kingdom’s process is so much deeper, involving so many

more institutions, companies, local education authorities, and student voices, some significant innovations are emerging.

The United States has always had pockets of innovation in schooling, and the first decade of the 21st century is no exception. But it is happening mostly through the work of not-for-profit school development groups. Little innovation has issued from the federal or state governments. Elliot Washor (2003), cofounder of Big Picture Learning, studied these trends and found little innovation in school facilities:

Three themes emerge from a review of research and literature on school facilities design. First, facilities designs have been shown to have an impact on learning. Second, these designs have been shown to have an impact on students and others who work in the schools. Third, there have been few innovations in school facilities design. (p. 10)

Hasn't anything changed? Are students today different from their parents? Do they come to school with different capabilities and interests for learning than previous generations? Have new technology tools enabled more learner-centered approaches to education (Watson & Riegeluth, 2008)? Has the new flat world significantly expanded the knowledge and skills that students need to be successful workers and citizens?

If these changes are real, then schools are now enabled to move away from teacher-directed whole-group instruction to create learner-centered workplaces for a collaborative culture of students at work. Many new school designs in the United States and the United Kingdom have done this. A review of best practice illuminates these new 21st century learning environments and school facilities to help school designers and developers and education, civic, and business leaders launch the next generation of innovative schools.

The Digital Natives Are Restless

A torrent of publications are illuminating the new behaviors and capabilities of today's students, from Don Tapscott's *Growing Up Digital: The Rise of the Net Generation* (2001), to Marc Prensky's *Digital Natives, Digital Immigrants* (2001), to the more recent work of Frank S. Kelly, Ted McCain, and Ian Jukes, *Teaching the Digital Generation: No More Cookie-Cutter High Schools* (2008).

A key thesis in all of these publications is that students learn best when they are engaged and that students can now do most of the work. Prensky urges moving from “telling/lecturing” to the “new” pedagogy of kids teaching themselves with the teacher’s guidance” (Prensky, 2008).

Is this any surprise? These students are millennials—digital natives, social networkers, keen to work on their own or in collaboration with others. At home they are likely to be equipped with computers, Internet access, iPods, and smartphones. At school, they typically sit at small desks, push a pencil or pen, and do worksheets.

New Skills and Pedagogy for the 21st Century

There is a growing recognition in the United States and other countries that 21st century knowledge and skills not only build upon core content knowledge, but also include information and communication skills, thinking and problem-solving skills, interpersonal and self-directional skills, and the skills to utilize 21st century tools, such as information and communication technologies. The Partnership for 21st Century Skills (2003) has defined and articulated these 21st century skills. (See Ken Kay’s foreword on page xiii of this volume.)

New standards in the United States, United Kingdom, and other countries often stress creativity, critical thinking, problem solving, communication, and so on; however, few curricula bring these standards to life as learning outcomes, and few countries assess them either in national or state tests or in classroom practice. Practitioners have made headway at the classroom level, however, by emphasizing projects, authentic assessment with rubrics that are transparent to students, products, presentations, and exhibitions.

We are now more than a decade into the standards and accountability movement in the United States and the United Kingdom, and already the limitations of a standards-based school accountability system that focuses on basic skills in a fast-changing, globalizing world have been revealed. Calls for change are coming from many places.

In the United Kingdom, the Innovation Unit, supported by the Paul Hamlyn Foundation, published *Learning Futures: Next Practice in Learning and Teaching* (2008), which “sets out the reasons why innovation in pedagogy is needed in order to inspire young people”:

There is a new argument taking centre stage. It is no longer the usual debate over standards and structures but instead a discussion about how young people best learn in the 21st century, and how we can make schools (and those who work in them) catalysts for vibrant engagement, not simply achievement. By looking at how young people choose to learn, what motivation and love of learning mean in the context of school, and how we can give more emphasis to student engagement and voice, there is an almost inevitable sharpening of focus upon what goes on in and out of the classroom. This is a focus on new pedagogy, a domain which has not been prominent in recent secondary school initiatives, but forms the locus of a new programme of work. (Paul Hamlyn Foundation and the Innovation Unit, p.3)

Innovators in the United States and abroad have adopted a new pedagogy—project-based learning (PBL), coupled with performance assessment—as the best way to engage and challenge students and provide them with the learning experiences that lead to 21st century knowledge and skills.

Project- and Problem-Based Learning—Keys to 21st Century Learning

How do schools move, as Marc Prensky urges, from “telling/lecturing” to the “new’ pedagogy of kids teaching themselves with the teacher’s guidance” (Prensky, 2008)? According to Paul Curtis, chief academic officer for the New Technology Foundation, what is needed is “a new type of instruction that better reflects the goals we want each student to achieve, demonstrate, and document” (Pearlman, 2006).

Since 2001, the New Technology Foundation (NTF), based in Napa, California, has helped fifty-one communities in ten states launch and implement 21st century high schools based on the model and practices of New Technology High School in Napa, California. The New Tech network’s experience is that students best work, produce, and construct knowledge through project-based learning (PBL).

The Buck Institute of Education, which shares the same rigorous PBL methodology as NTF, defines standards-focused PBL as “a systematic teaching method that engages students in learning knowledge

and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks” (Buck Institute of Education, 2003).

Projects at New Tech schools are typically one to three weeks long. New Tech teachers start each unit by introducing students to a realistic, real-world project that both engages their interest and generates a list of information students need to know. Projects are designed to tackle complex problems, requiring critical thinking. Some examples of projects include presenting a plan to Congress on solving the oil crisis, or inventing, under contract from NASA, new sports that astronauts can play on the moon so they can get exercise.

Through projects, New Tech teachers are able to embed all the learner outcomes (content and 21st century skills) and assess against them. Learner outcomes are the same across all subjects and interdisciplinary courses. Projects have associated rubrics for content, collaboration, written communication, oral communication, critical thinking, and so on, and are all posted online for students so they can decide on their own whether to achieve basic, proficient, or advanced work.

Assessment for Learning

Effective assessment for learning provides students with just-in-time information about their own learning and links it to information on the criteria needed to do better. At New Tech schools, students access an online grade portal. Grades on projects and all learner outcomes are updated whenever new assessment information is available. The usual composite course grades are also available per subject, and across courses for the skills of the learner outcomes. Students and their parents can look at their grades anytime, from anywhere.

Self-assessment is a critical element of assessment for learning. Students look at their grades on a daily basis and check the online rubrics for a project’s criteria for basic, proficient, and advanced work. By making the assessment criteria transparent and understandable,

Innovators in the United States and abroad have adopted a new pedagogy—project-based learning (PBL), coupled with performance assessment—as the best way to engage and challenge students and provide them with the learning experiences that lead to 21st century knowledge and skills.

students are then able to make their own decisions about what performance target or level they wish to accomplish. Such just-in-time feedback, coupled with the assessment criteria, provides students with the information needed to foster self-directed behaviors.

Self-assessment is a critical element of assessment for learning.

At the end of a project, student teams present to an external audience of community experts and parents. They are assessed on their product and on their communication skills (oral and written). New Tech students also assess their team members on their collaboration skills and get to see how their peers assessed them on their collaboration skills. They also write reflections on what they learned and how the project can be improved.

From Innovative Pedagogy to Innovative School Facilities

Schools must embrace a new pedagogy today that will engage 21st century students and enable them to acquire and master 21st century skills. Once they embrace the necessary changes in pedagogy, they realize the need for change in the physical learning environment. “Instead of starting from the physical, you need to start with the program you know you need to have,” says Betty Despenza-Green, former principal of the Chicago Vocational Career Academy. “Then you can see how your existing structure won’t let you do that. And then you do the work of making physical changes” (Davidson, 2001).

Elliot Washor (2003) urges school developers to “translate pedagogical designs into facilities” (p. 22). Kenn Fisher, director of learning environments at Rubida Research, links pedagogy and space for the design of new learning environments (Fisher, 2005). Fisher further divides pedagogy into five distinct aspects: delivering, applying, creating, communicating, and decision making, all of which inform the new environments.

Designing 21st century schools and new learning environments starts with defining the outcomes. We must ask, “What knowledge and skills do students need for the 21st century?” But real design needs to go much further and address the following questions as well:

- What pedagogy, curricula, activities, and experiences foster 21st century learning?

- What assessments for learning, both school-based and national, foster student learning of the outcomes, student engagement, and self-direction?
- How can technology support the pedagogy, curricula, and assessments of a 21st century collaborative learning environment?
- What physical learning environments (classroom, school, and real world) foster 21st century student learning?

After defining these outcomes, the key design issues might be illustrated as depicted in Figure 6.1.

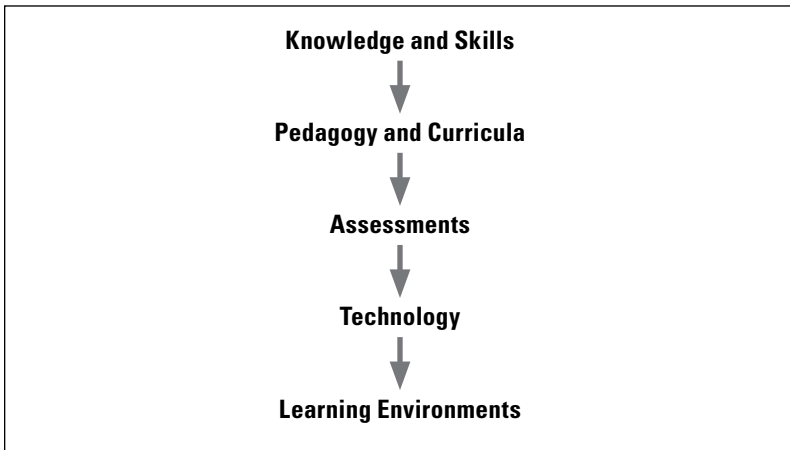


Figure 6.1: Design criteria for 21st century collaborative learning environments.

What Does 21st Century Learning Look Like?

Walk into a classroom in any school in any country today and what you will mainly see is teacher-directed whole-group instruction. Walk into a classroom at a New Technology High School and you will see *students at work* on their own learning—students writing journals online, doing research on the Internet, meeting in groups to plan and make their websites and their digital media presentations, and evaluating their peers for collaboration and presentation skills.

Walk into a classroom in any school in any country today and what you will mainly see is teacher-directed whole-group instruction.

Another teacher's students are also there, in a team-taught interdisciplinary course.

This classroom learning environment looks a lot different. It's double the size with a double group of students, two teachers, and a double-block period for an interdisciplinary course. The classroom is populated by worktables and rolling chairs, not individual student desks. Every student has access to a desktop or a laptop. The tables can be put together as needed for collaborative student project groups, or for teachers-led workshops or seminars constructed around student "need to knows." The classroom, or student workroom, can also serve as a design workshop or even as a space for end-of-project student presentations. The classroom can be set up to accommodate project teams, seminars, or workshops for some of the students while others continue working.

There is also a lot of glass. Glass walls or large glass windows make visible to the students and to visiting adults that this is a school where all students are at work.

Gareth Long (n.d.), a U.K.-based senior consultant on new secondary schools and school learning environments, writes on his work developing new secondary campuses in the Cayman Islands:

The new learning environments being built are designed to promote total agility [*sic*] and be capable of continuously reconfiguring themselves. They will allow project based learning rather than discipline based learning and will able teachers to respond to the "blurring" between phases and specific subjects. The ongoing trend towards longer lessons and interdisciplinary coursework reduces the need for student movement and increased effective use of spaces to allow for a variety of teaching and learning styles. They are also being designed for 24/7/360 use.

What Do Students Say?

In the United Kingdom, much work has been done to solicit student input into the design process for new or renovated secondary schools.¹ This student input has been inspired by "The school I'd like" (Birket,

¹U.K. secondary schools go from year 7 to year 11 and sometimes include years 12 and 13.

2001), a national essay competition by *The Guardian*, for students across the United Kingdom (done in 1967 and 2001), followed by the books of the same name (Blishen, 1969; Burke & Grosvenor, 2003).

In the Knowsley Metropolitan Borough Council near Liverpool in North West England, during April to June 2005, School Works managed a participatory project involving local school communities in the design of eight new learning centers. Student participants identified key ways in which they learn:

- Looking
- Concentrating
- Thinking ahead
- Matching/comparing
- Creativity
- Listening
- Searching
- Negotiating
- Teamwork
- Learning

Knowsley's conclusion from student input and also from teacher and parent input was that pedagogy had to change to enable these learning modes, and that new learning environments and facilities should support these new modes (School Works, 2005).

Kids who have experienced the new pedagogy are even more emphatic in understanding their learning functions and the form that their learning environments need to take. Students from New Technology High School in Napa, California, commented on the design of a classroom of the future as participants with SHW Group architects in the 2009 Open Architecture Challenge (Open Architecture Network, 2008):

Colin: To really be engaged, I need to have an interactive environment where I feel connected to others but can find a place to get away and think, too. I need easy access to all of the tools I might want to use for learning. I need to be able to adjust the space to be more comfortable and to fit the activities we are doing.

Zaira: During project-based learning, we move through a variety of activities. We start with forming our teams and analyzing the problem. Then, we determine what we need to know and how to get the information. We have the research

phases, problem-solving phases, and presentation phases. For all of these activities, we need specific tools and need to be able to arrange the space accordingly. In addition, different teams are in different phases at different times, so we need the flexibility to have a variety of options in the same classroom.

“No More Classrooms!”: The Language of School Design

“Classrooms are out! No more classrooms! Don’t build them,” says Roger Schank, founder of the Institute for Learning Sciences at Northwestern University (Fielding, 1999). Schank sees three key student work modes: computer work, talk with others, and making something. These modes, he argues, require three distinct environments for learning: focused work environments, collaborative work environments, and hands-on project work environment.

Innovators no longer speak of classrooms. Instead they have changed the language in order to change the mental model, as urged by Elliot Washor and also Randall Fielding and Prakash Nair of DesignShare and Fielding Nair International. Fielding and Nair are coauthors with Jeffrey Lackney of *The Language of School Design: Design Patterns for 21st Century Schools* (2005), a book that has strongly influenced new design in many countries. Students now work in learning studios, learning plazas, and home bases. They shift as needed into many varied extended learning areas and collaboration zones. These include project-planning rooms, workrooms, and other breakout areas.

Kenn Fisher (2005) translates pedagogy into many learning spaces: the student home base, the collaboration incubator, storage space, specialized and focused labs, project space and wet areas, outdoor learning space, display space, breakout space, the individual pod, group learning space, presentation space, and teacher meeting space. Most innovative schools still feature specialized classrooms for making things, including art, engineering, media, and design labs.

Classrooms, libraries, and labs used to be the only spaces where students spent their school hours. Wireless, laptops, and project learning have changed that. Until a few years ago, laptops were not powerful enough to handle high-level applications. Likewise, wireless was not powerful enough to handle continuous Internet access by even a small

school of four hundred students in a one-to-one environment. Now it is. This has transformed all school spaces into potential extended learning areas, even the corridors and alcoves.

Technology in 21st Century Schools

The signature characteristic of 21st century schools is *students at work*. Pedagogy—a project-based curriculum and companion performance assessment—enables this new shape of schooling. But it is technology and new learning environments that support this new collaborative culture.

Students utilize new technology tools as investigators and producers of knowledge. The best 21st century schools provide every student with a computer, which increasingly means a laptop in a wireless environment. But personal computing by itself without the new pedagogy and learning environments, even when it is one computer for each student, is no solution at all. It doesn't work. Instead it often reinforces the old teacher-directed whole-group instruction.

The signature characteristic of 21st century schools is *students at work*.

Students in 21st century schools first use computers and Internet access to research their projects. They find the information they need through Internet research, but also through email communication and Skype video interviews of experts. Then, working individually or in a collaborative team, they construct products—models, booklets, videos, podcasts, websites, PowerPoints, digital portfolios, and so on. Finally, they utilize technology to present their findings, often to an authentic audience of community experts.

Computers, cameras, and interactive whiteboards all come to life as student tools in a 21st century PBL classroom. Newer Web 2.0 tools—including blogs, wikis, and social networking sites—add greatly to the student toolset for individual and collaborative work. Students utilize all these tools to be investigators and producers of knowledge.

However, equipping students with appropriate technology and tools is the beginning, not the end. They also need 24/7 access to their project information, project calendar, assessment rubrics, and their just-in-time assessments. If

Equipping students with appropriate technology and tools is the beginning, not the end.

they work in collaborative teams, they also need discussion boards, journals, email, and special evaluation tools.

The original New Tech High School in Napa, begun in 1996, built all these special technology tools and implemented them on a Lotus Notes platform. The New Technology Foundation took these tools and professionalized them into the New Tech High Learning System, a learning management system or learning platform specially designed for PBL schools. Since 2008, New Tech has developed that platform into a Web portal called PeBL. PeBL includes the online grade portal. The PeBL learning platform also provides teachers with the tools to design projects, assessments, and calendars and post them online for student access.

The New Learning Environments

New learning environments are needed to support technology-equipped students at work both individually and in collaborative teams, and to provide environments for what Roger Schank calls “focused work, collaborative work, hands-on project work,” and for presentation and exhibition (Fielding, 1999).

There has been significant work on these issues by DesignShare and architects Randall Fielding, Prakash Nair, and Bruce Jilk in the United States, and by many parties in the United Kingdom, including the Partnership for Schools (Pfs), the British Council on the School Environment (BCSE), the Specialist Trust, the Innovation Unit, and many individual architects and educators.

Five schools in the United States and the United Kingdom exemplify the best of the new learning environments. Each is original in its design and features:

- Columbus Signature Academy, Columbus, Indiana
- New Tech High @ Coppell, Coppell, Texas
- The Metropolitan Regional Career and Technical Center, Providence, Rhode Island
- High Tech High, San Diego, California
- New Line Learning Academy, South Maidstone Federation, Maidstone, Kent, England

Columbus Signature Academy

Columbus, Indiana, a small city forty-six miles south of Indianapolis, boasts the third-greatest assemblage of public and private architecture in the United States, behind New York City and Chicago. Years ago the CEO of Cummins Engine established a fund to support the architecture fees for all buildings built in the city, as long as the commissions went to a list of the ten top architects in the country.

The Bartholomew Consolidated School Corporation (BCSC) has benefited from this funding and the concomitant community spirit. BCSC hired CSO Architects, based in Indianapolis, to work with local educators to develop the new Columbus Signature Academy, launched in 2008 and built in two phases. The academy's program was to be modeled on that of New Tech High School, featuring project-based learning, collaborative teams, authentic assessment, and one-to-one computing. The story of the design process is captured by CSO in three videos available at www.csoinc.net/?q=node/172 (CSO Architects, 2008; for live links and to view graphics from this chapter in full color, visit go.solution-tree.com/21stcenturyskills).

Representatives from CSO visited four sites in California to see the actual implementation of the New Tech curriculum. The original New Tech High School in Napa has two distinct design characteristics that have been emulated in some form by all New Tech schools across the country. The first is the classroom footprint: it is typically double-sized, housing a double group of students in a two-teacher, team-taught interdisciplinary class in a double-block period (see the feature box on page 130 for examples of these interdisciplinary courses). Figure 6.2 (page 130) shows students in a learning studio at Columbus Signature Academy.

The second signature design characteristic is either no walls or glass walls separating classrooms from corridors and breakout spaces. This means that students and adult visitors walking the corridors can see what is going on everywhere. What they see are students at work on their projects. Recent projects have included projects on volcanoes, mitosis videos, electronic games, and motorized toys. This helps establish the collaborative culture of the school. (See figure 6.3, page 131, a 3-D floor plan of Columbus Signature Academy.)

Examples of Team-Taught Interdisciplinary Classes at New Tech High Schools

Global Issues: English and Geography

World Studies: English and World History

American Studies: English and U.S. History

Political Studies: English, U.S. Government, Economics

Scientific Studies: Physics and Algebra 2

BioLit: Biology and Literature

Environmental Studies: Environmental Science and Environmental Issues

Biotechnology Ethics: Biology and Psychology

The CSO team, which included John Rigsbee and Rosemary Rehak, was especially inspired by a dinner meeting with Ted Fujimoto, who as a young business leader in Napa was one of the founders of New Tech High. “We asked Ted what should be done differently,” recounted Rigsbee. “His response: ‘Fewer barriers. Like a corporate office. Collaborative office space. Teachers as project managers’” (personal communication, June 8, 2009).

Rigsbee continued, “We saw students work as a project team, then break loose and work as individuals. This describes our architect’s office, our design studios. That’s why we decided not to use the word *classroom* anymore. Instead we now call all these spaces *studios*.”



Figure 6.2: A learning studio for an integrated interdisciplinary class at Columbus Signature Academy. Reprinted with permission.

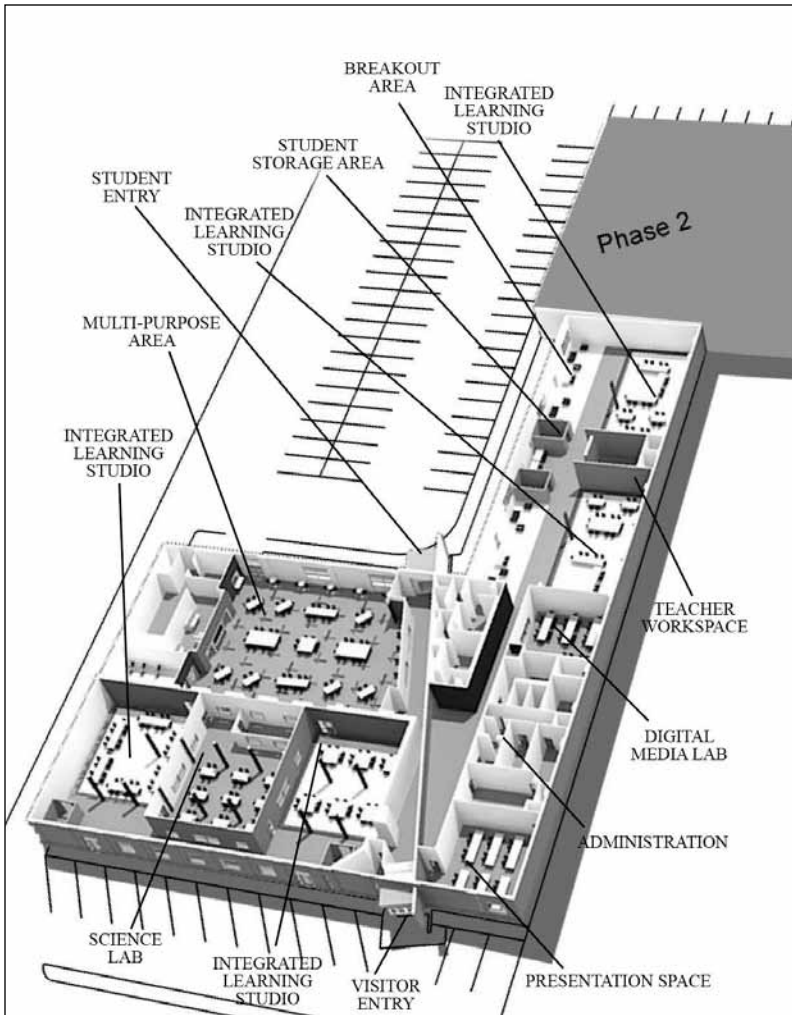


Figure 6.3: A 3-D floor plan of Columbus Signature Academy showing a double-sized integrated learning studio, presentation room, and multipurpose commons area. Drawing by CSO Architects. Reprinted with permission.

On their return, they brainstormed with BCSC personnel to plan the transformation of an auto parts warehouse into a model New Tech High campus. At 44,812 square feet, the academy is designed for four hundred students.

CSO designed these unique learning environments with integrated learning studios, breakout areas, distance learning and presentation

rooms, and project conference rooms for preparing presentations. There are specialty labs for science and graphic media. They also designed a large multipurpose room to serve as a cafeteria and commons area, and to house large-group meetings and presentations, science fairs, and student exhibitions.

CSO wanted as few walls as possible in the new building, so learning studios do not have a fourth wall and instead are open on one end with breakout spaces, which are used for informal individual and small-group work.

Phase two will add more integrated learning studios and more specialty labs, including for engineering. “We know so much more now,” says Rigsbee. “Our original plan was that students would go back to regular high schools for art, music, and physical education/fitness. Now students want their own specialty rooms, which we hope to provide in the phase two development.”

Furniture is also unique to allow studios to be arranged flexibly for large-group, small-group, or individual work as needed. Studios feature rolling tables and chairs. Tables flip up for post-its and other displays.

New Tech High @ Coppell

At New Tech High @ Coppell, Coppell, Texas, a new small high school launched in 2008, there are no students and no teachers. Instead, *learners* fill the classrooms and project rooms and are supported in their work by *facilitators*. The school has adopted a new language to describe the new roles of both students and teachers. Students are now learners responsible for their own learning; teachers are now facilitators, responsible for designing projects and assessments and guiding and coaching learners and learner teams on their project work.

Learners at New Tech High @ Coppell have a vast array of technology tools and learning spaces in which to do their work. (See figure 6.4, a student project team at work in the open space media library at New Tech High @ Coppell; to view images in full color, visit go.solution-tree.com/21stcenturyskills.) Learners say it is “more professional here” and “we have a big advantage over students at other schools” (personal communication, June 1, 2009). Other learners made the following comments:



Figure 6.4: A student project team at work in the open space media library at New Tech High @ Coppell. Reprinted with permission.

Courtney: We have a big advantage going into the professional world.

Morgan: My brother-in-law does the same stuff at work.

Claire: My Dad really got into giving me ideas on my project on the green revolution and hybrid cars.

Coppell Independent School District worked with SHW Group architects to renovate an old elementary school into the New Tech High @ Coppell. The following text describes these renovations:

In order to maximize the potential of the learners in the project-based model, the design had to accommodate a radical shift from the classroom layout in the existing elementary school, while recognizing a very modest budget. By strategically removing walls in some locations and opening up others with glass, the spaces transformed from stand-and-deliver classrooms, to energized multi-use spaces for collaboration and teaming that allowed the learners to engage in a variety of activities using wireless internet and moveable furniture.

To build on the educational initiatives of collaboration and transparency in the learning process, certain rooms open out to hallways and, in some cases, glass was inserted into existing walls so that visitors, learners, and facilitators can see the processes at work. Visitors to New Tech High @

Coppell might feel more like they are in an art gallery or a high-end book store or café than a typical classroom building.²

SHW Group developed spaces throughout the building to provide settings for individual, small-group, and large-group interactions. SHW called these settings small-group collaboration zones, project rooms, facilitator collaboration zones, single subject-matter learning environments, dual subject-matter learning environments, a digital media library, and large multigroup collaboration zones. (See figure 6.5, distinct activity zones at New Tech High @ Coppell.)

The designers took advantage of the planned robust wireless environment (both inside and outside) and the plan to issue every student a laptop for school and home use and made every space in the building external to the “classrooms” an extended learning area:

- Corridors—Learners and learner teams sit in the corridors to do their work.
- Alcoves—Student work groups use these little corner areas with soft furniture.
- Project planning rooms—Project teams plan their work and presentations in these small conference rooms with whiteboards. Learners call these spaces *workrooms*. New Tech High @ Coppell was the first New Tech High in the country to have small project planning rooms. Phase two of the construction added additional and bigger project planning rooms.
- Media library—Learners and learner teams do their work in this large area of open space with lots of comfortable furniture and some high-end equipment. (See figure 6.6, page 136, a picture of the digital media library at New Tech High @ Coppell.)

The single or dual subject-matter learning environments, which are characteristic of the New Tech model, provide spaces for large group, small group, or individual work, and can be repurposed for any working modality, or “interaction type,” using flexible tables and

²From SHW Group’s project narrative submission to the Council of Educational Facility Planners International for the 2009 James D. MacConnell Award.

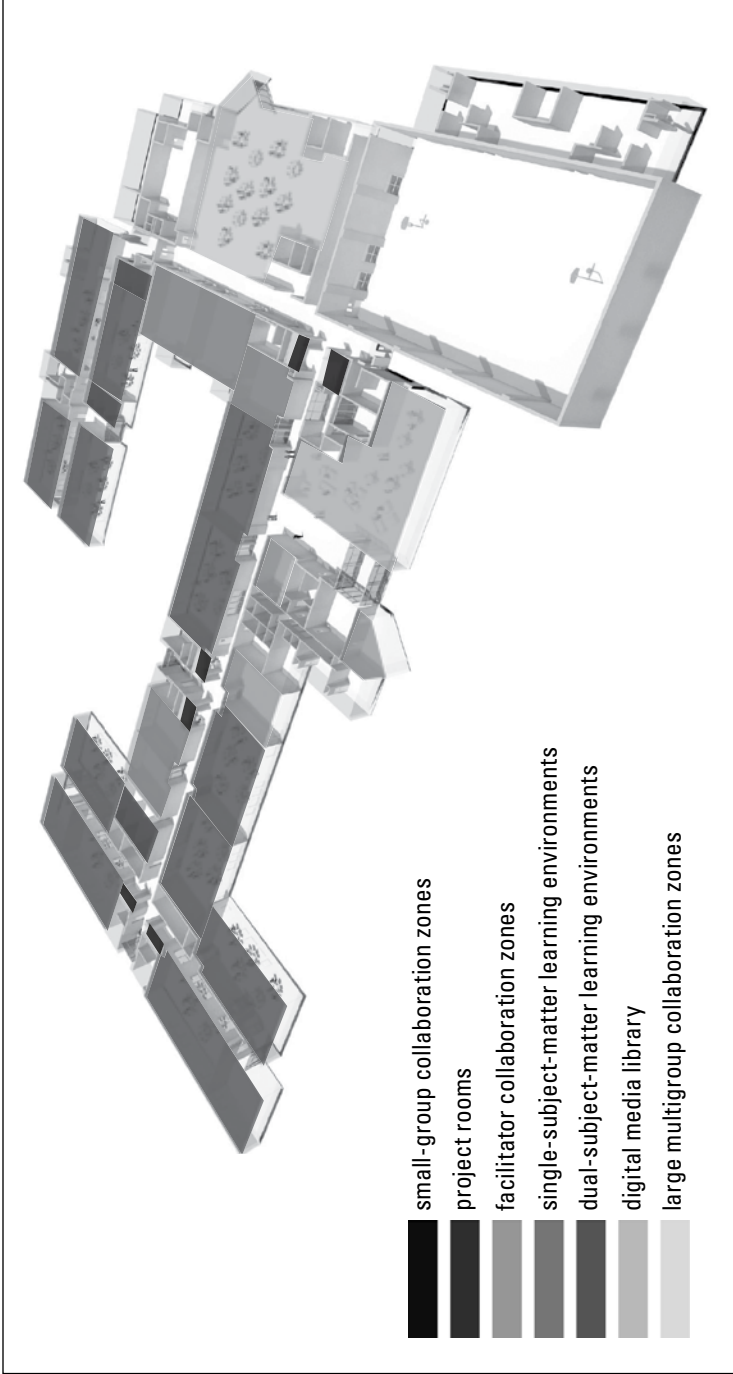


Figure 6.5: Floor plan showing the distinct activity zones in the renovation of New Tech High @ Coppell.
Drawing by SHW Group, Plano, Texas. Reprinted with permission.



Figure 6.6: Student collaborative project teams working in the digital media library at New Tech High @ Coppell. Reprinted with permission.

chairs. Because New Tech High @ Coppell is fully wireless, with 100 percent laptop and battery bays in every room, the rooms have few dangling power cords or other obstructions.

The Metropolitan Regional Career and Technical Center

The Metropolitan Regional Career and Technical Center (The Met) was founded in 1996 in Providence, Rhode Island, by Dennis Littky and Elliot Washor. The initial school site for one hundred students was housed in a downtown building. A second small Met of one hundred students opened in 1999 in a remarkable facility that includes classroom workrooms, project rooms, advisory rooms, and a large common room. Four additional small schools opened in 2002 on a common campus using a similar facility design for each small school.

Each one-hundred-student site (small school) at the Met has eight teachers in four learning groups and eight advisory groups. The small size is aimed at personalizing student learning. A key slogan and practice at the Met is “One kid at a time.” Students are organized into advisories of fifteen individuals at the same grade level, led by an advisor who stays with them through their four years.

At the Met, the curriculum is Learning Through Interests/ Internships (LTIs). Students work with expert mentors in the real world, two days a week, in internships that are based on the students’ interests, and come to school the other days to reflect on what they are learning on the job and work on their projects. Students work with their parents, teacher/advisor, and workplace mentor to develop their

own personal learning plan. Popular LTI sites include the Audubon Society, New England Aquarium, hospitals, theater companies, law firms, architecture firms, multimedia companies, and more. To the Met, LTI sites are part of their facilities. The school site is designed to support students working on their LTIs.

Classrooms/workrooms have state-of-the-art computers, peripherals, and presentation technologies for students to do their work and exhibit it. Workrooms also have tools for making scale models, structures, and products for exhibition. Students do projects related to their LTIs. One student worked on a team to develop a 2,400-square-foot museum exhibit, another developed a brochure for new mothers in the neonatal unit at a hospital, and another student did a video project that documented the work of the radiology department at a local hospital.

There are now more than sixty Met schools across the United States and many more internationally. Big Picture cofounder Elliot Washor has been the conceptual architect of the Met design. He identified key elements and functions of the school building: “We needed spaces for individual work, one-on-one, small group, advisory, large space, to make stuff, and to display student work,” Washor recalled (personal communication, June 8, 2009). The second Met building was then designed to include a commons, advisory rooms, project rooms shared by two advisories, conference rooms, meeting rooms, and wet lab space for art and science.

At the Public Street Met Campus, four distinct Met schools, each in their own distinct two-story building, share facilities (theater performance center and fitness center) across a campus. In the separate two-story buildings, the commons resides on the first floor and doubles as a cafeteria and an informal workspace. The advisory rooms are larger, now incorporating much of what the separate project rooms served in the past (see figure 6.7, a Met advisory room, on page 138). In addition, the second-story commons serves as an informal and purposeful workspace. (See figure 6.8, a floor plan of the Public Street Met buildings, on page 139.)

Learning environments are characterized by demountable walls, advisory rooms, project rooms, commons, meeting rooms, and more storage space for student projects. These spaces are intended to provide

a variety of options for students: quiet space, meeting space, commons space, and advisory space.

Furniture also supports individual and group work. Soft, cushioned seats are dispersed throughout. Chairs move up and down, conform to the contours of the body, and feature sled bottoms or gliders.

Future Met schools, says Washor, will likely include garage-door openings to workrooms and rooms for artists in residence in blacksmithing, metallurgy, pottery making, and other arts, crafts, and specialized technologies. Currently, Met schools find comfortable settings for these activities in the community.



Figure 6.7: Advisory room at the Met doubles as project room for Met students. Reprinted with permission.

High Tech High

High Tech High, San Diego, California, is a public charter high school launched in 2000 with a diverse student population of four hundred students that mirrors the San Diego Unified School District. High Tech High brings to life its design principles of personalization, intellectual mission, adult world immersion, and performance-based student work and assessment through its size and school organization, facilities, program, and technology.

High Tech High is now nine schools in the San Diego region, six in a family of schools (elementary, middle, and high school) in San

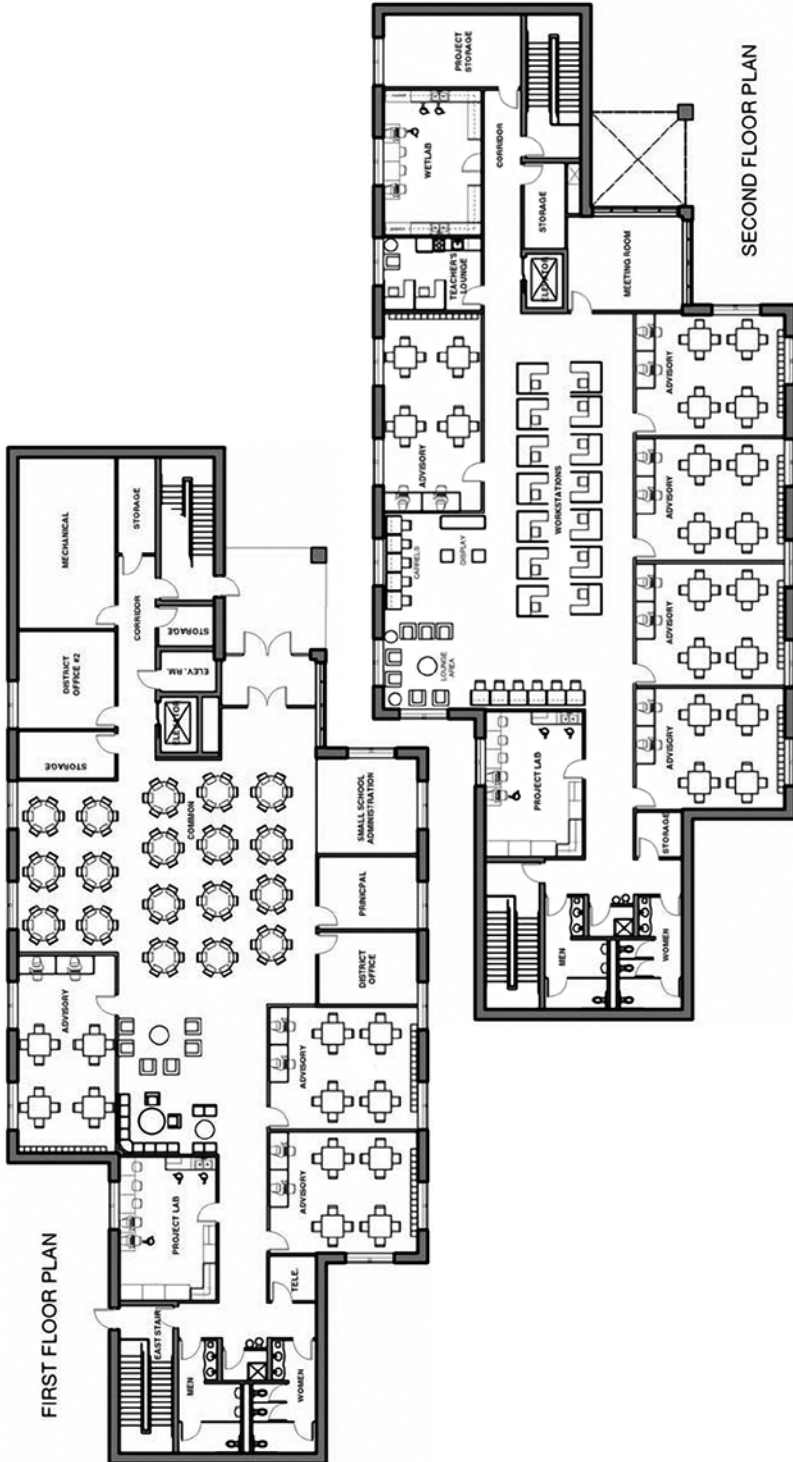


Figure 6.8: Floor plan of each of the Public Street Met buildings showing advisory rooms, project labs, and commons areas. Reprinted with permission.

© 2010 Solution Tree Press. All rights reserved.

Diego, a high school and middle school in North County, California, and a new high school in Chula Vista, California.

David Stephen, the conceptual architect for High Tech High, San Diego, working with the Stickler Group and Carrier Johnson, notes that “the original design sought to provide students with personal and small-group workspaces, use of technology, and a high-performance workspace. Key functions were inquiry-based learning, content delivery plus independent investigation, and building and fabricating things” (personal communication, June 8, 2009).

High Tech High originally featured seminar rooms, labs, project studios, small and large conference rooms, a commons area, and a great room. The great room had workstations and collaborative spaces for students. Stephen notes that “we moved away from the great room concept very quickly” because:

We needed the student workstations and workspaces to be much nearer the classrooms. Now our basic model is a set of four to six classrooms with glass walls clustered around a centralized studio work area for multipurpose activities, including presentations, student project work, fabrications, and so on. (personal communication, June 8, 2009)

In the middle school, says Stephen, classrooms are clustered in a neighborhood concept (see figure 6.9, a cluster area studio surrounded by four flexible classrooms at High Tech Middle).



Figure 6.9: Cluster area studio surrounded by four flexible classrooms at High Tech Middle, San Diego, California. Photo by Bill Robinson. Reprinted with permission.

Wireless technologies and laptops have made a difference. In the new High Tech High in Chula Vista, four classrooms are clustered around a common studio work area (see the video of the new Chula Vista campus at www.hightechhigh.org/dc/index.php). Each classroom is separated by a removable wall to another classroom to enable team teaching by two teachers. (See figure 6.10, a floor plan of High Tech Middle, which is now common in High Tech High buildings as well.) Each classroom has thirteen laptops for student use, and students can bring their own laptops to school.

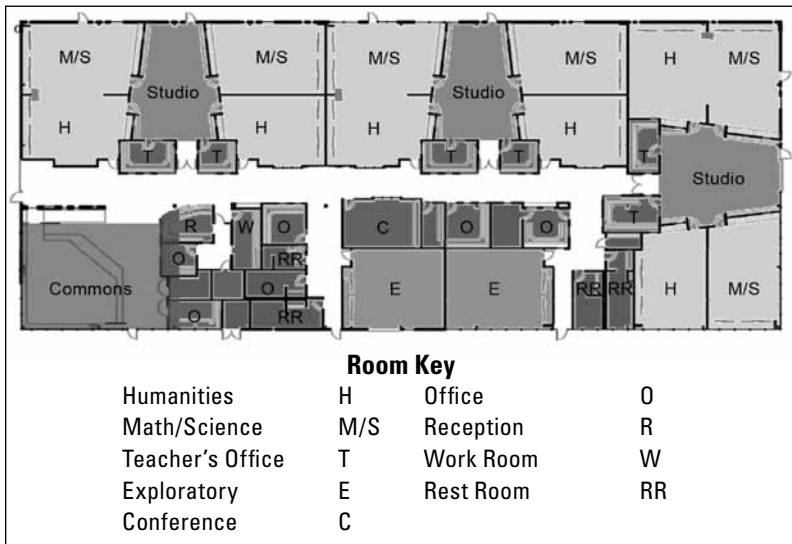


Figure 6.10: Floor plan showing clusters of four integrated classes surrounding a studio area at High Tech Middle. Drawing by David Stephen. Reprinted with permission.

“It’s all about ownership,” says Stephen. “Kids and teachers need a sense of place . . . where everyone knows one another.” The commons provides a place for whole-school gatherings, student presentations, and an informal student work area.

Project studios have also evolved over the years. Originally these were separate from the seminar rooms; now every classroom includes the functionality of a project room. Specialized labs, what High Tech High calls “exploratories,” include biotechnology, engineering or “fabrication,” art, music, multimedia, and digital arts. “Furniture is really key,” says Stephen. “It helps to turn atriums, corridors, and alcoves into work areas for individual students and for project teams.”

New Line Learning Academy

One of the most interesting new learning environments comes from school innovator Chris Gerry, executive principal of the South Maidstone Federation in Maidstone, Kent, England. The county of Kent, which lies east of London and runs all the way to the English Channel, is the largest local authority in the country, with over six hundred schools. Gerry was formerly principal at Hugh Christie Technology College, where he first grouped ninety students engaged in project-based learning in a large open space, which he now calls a learning plaza.

Gerry is opening new buildings for New Line Learning (NLL) Academy and Cornwallis Academy in 2010 and refining his ideas in a pilot site developed by architect Philip Gillard of Gensler, a global architecture, design, planning, and consulting firm. The heart of the design is a learning plaza large enough to house ninety or 120 students. (See the animated plaza video at www.newlinelearning.com/new-builds/view/146/New-build-at-NLL-Academy or visit go.solution-tree.com/21stcenturyskills for direct links and full-color graphics.) Modular and mobile lecture-style seating is used to accommodate larger groups and divide plaza space. Each academy will house eight learning plazas. (See figure 6.11, the learning plaza prototype at New Line Learning Academy.) According to Gensler (2009):

The “Plaza” concept was devised with the Academy to provide a higher degree of collaboration between teachers and pupils through an IT rich, flexible environment that promotes and enables a variety of static and fluid learning settings to occur simultaneously within the physical fabric—from individual personalised learning, to group based activities and a whole plaza scenario of 120 pupils—whilst providing a safe and secure home base. [The concept utilizes] technology such as 360° projection and large display areas, biometric lighting techniques to control and vary the ambience of individual spaces, and flexible and adaptable furniture to allow a variety of work mode settings orientated around sizes of user groups and activities being undertaken.



Figure 6.11: The learning plaza prototype at New Line Learning Academy shows the plaza divided in multiple ways for large-group, small-group, and individual learning. Reprinted with permission.

Gensler adopted a new language, adapted from Nair, Fielding, and Lackney (2005), to describe the different activity modes that take place in each environment and the degree of collaboration involved:

- Multiple intelligence—Allows for different work modes
- Studio—Allows for a mix of different work modes
- Campfire—Allows for class work
- Watering hole—Allows for small-group work
- Cave—Allows for self-study

Due to the pervasive technology and the flexible furniture, the plaza can be set up in many different configurations to aid the learning process. Furniture includes modular tables and mobile lecture-style

amphitheater seating to accommodate larger groups and divide plaza space. The learning plaza incorporates a ground floor, a mezzanine, and an outdoor area. The plaza ground floor provides spaces for project-based learning, group work, lectures, and has breakout areas and a vestibule. The plaza mezzanine provides spaces for independent learning, small-group work, a balcony for spectators of project-based learning, and an outdoor classroom. In addition to the learning plaza, there are specialist plazas that contain specialty equipment for art, technology, and science.

New Learning Environments for Students at Work

What do all have these new learning environments have in common? There is much in common among the physical designs discussed here. All these schools do PBL, though the practice is different in all. Each design seeks to provide spaces for individual work, small-group work, large-group work, lectures, presentations, breakouts, and whole-school or cluster meetings. Table 6.1 summarizes the main features of each school.

Linking Pedagogy and Space

Most new school building construction in the United States and the United Kingdom today is still pouring “old wine into new bottles,” replicating the 30-student, 900-square-foot classrooms that both support and often dictate teacher-directed whole-group instruction. These environments will not support student learning of 21st century skills and will be seen in the coming years as outmoded learning spaces requiring a building retrofit.

As school planners look to implement 21st century skills, they will increasingly link pedagogy and space and look to exemplars like Columbus Signature Academy, New Tech High @ Coppell, the Met, High Tech High, and New Line Learning Academy. These designs will be widely emulated and the experience of students, or learners, in these environments will inform the next generation of 21st century learning environment design.

Table 6.1: New Learning Environments in U.S. and U.K. Innovative Schools

| | Columbus Signature Academy | New Tech High @ Coppel | The Met | High Tech High | New Line Learning Academy |
|----------------------------------|---|---|--|--|--|
| Primary Student Work Area | Learning studio | Dual subject-matter learning environment | Advisory/project room | Clustered classroom/common studio | Learning plaza |
| Presentation Space | Presentation room | Large multigroup collaboration zones | Commons | Commons | Learning plaza |
| Large-Group Space | Multipurpose room | Large multigroup collaboration zones | Commons | Commons | Learning plaza |
| Extended Learning Spaces | Breakout area and project conference room | Corridor alcoves, project planning rooms, media library, and outdoor benches | Conference rooms, meeting rooms, and commons | Small and large conference rooms, common studios, and commons | Learning plaza, watering holes, and caves |
| Specialty Labs | Graphic, media, and science labs | Science | Fabrication | Biotech, engineering, art, music, multimedia, and digital arts | Art, technology, and science |
| Furniture | Rolling tables and chairs, and flip-up tables | Mix-and-match tables, office chairs, lounge chairs, and sofas in extended learning spaces | Cushioned seats, contour chairs, and flexible tables | Benches in extended learning spaces | Modular tables and mobile lecture-style amphitheater seating |

References

- Birkett, D. (2001, January 16). The school I'd like. *The Guardian*. Accessed at www.guardian.co.uk/guardianeducation/story/0,3605,422486,00.html on January 3, 2009.
- Blishen, E. (Ed.). (1969). *The school that I'd like*. Baltimore: Penguin.
- Buck Institute of Education. (2003). *Project based learning handbook*. Accessed at http://www.bie.org/index.php/site/PBL/pbl_handbook_introduction/#standards on January 3, 2009.
- Burke, C., & Grosvenor, I. (2003). *School I'd like: Children and young people's reflections on an education for the 21st century*. London: RoutledgeFalmer.
- CSO Architects. (2008). *K-12 Education: Columbus Signature Academy New Tech High. Episode one, two, and three*. Accessed at www.csoinc.net/?q=node/172 on December 18, 2009.
- Davidson, J. (2001). Innovative school design for small learning communities. *Horace*, 18(1). Accessed at www.essentialschools.org/cs/resources/view/ces_res/208 on January 3, 2009.
- Fielding, R. (1999). The death of the classroom, learning cycles, and Roger Schank. Accessed at www.designshare.com/index.php/articles/death-of-the-classroom/ on January 3, 2009.
- Fisher, K. (2005). *Linking pedagogy and space*. Melbourne, Victoria, Australia: Department of Education and Training. Accessed at www.eduweb.vic.gov.au/edulibrary/public/assetman/bf/Linking_Pedagogy_and_Space.pdf on January 3, 2009.
- Gensler design firm. (2009). *Brief, design, and prototype: South Maidstone Academies, Kent, UK*. London: Author.
- Hertfordshire Grid for Learning. (2009). *Building schools for the future—Introduction*. Accessed at www.thegrid.org.uk/leadership/bsf/intro.shtml on January 3, 2009.
- Kelly, F. S., McCain, T., & Jukes, I. (2009). *Teaching the digital generation: No more cookie-cutter high schools*. Thousand Oaks, CA: Corwin Press.
- Long, G. (n.d.). Schools of the future. *Gareth Long—Education blog*. Accessed at <http://garethl.com/29501.html> on January 3, 2009.
- Long, G. (2009, February 14). Student voice—thinking about learning environments. *Gareth Long—Education blog*. Accessed at <http://blog.garethl.com/2009/02/student-voice-thinking-about-learning.html> on December 18, 2009.
- Nair, P., Fielding, R., & Lackney, J. (2005). *The language of school design: Design patterns for 21st century schools* (2nd ed.). Minneapolis, MN: DesignShare. Accessed at www.designshare.com/index.php/language-school-design on May 1, 2005.
- Open Architecture Challenge. (2008). 2009 open architecture challenge: Classroom. Accessed at www.openarchitecturenetwork.org/competitions/challenge/2009 on December 18, 2009.

- Partnership for 21st Century Skills. (2003). *Learning for the 21st century*. Tuscon, AZ: Author.
- Paul Hamlyn Foundation and the Innovation Unit. (2008). *Learning futures: Next practice in learning and teaching*. London: Authors. Accessed at www.innovation-unit.co.uk/images/stories/files/pdf/learningfutures_booklet.pdf on January 3, 2009.
- Pearlman, B. (2006). 21st century learning in schools: A case study of New Technology High School. *New Directions for Youth Development*, 110. Accessed at www.bobpearlman.org/Articles/21stCenturyLearning.htm on January 3, 2009.
- Prensky, M. (2001, October). Digital natives, digital immigrants. *On the Horizon*, 9(5), 1–6. Accessed at www.marcprensky.com/writing/Prensky - Digital Natives, Digital Immigrants - Part1.pdf on January 3, 2009.
- Prensky, M. (2008, November/December). The role of technology in teaching and the classroom. *Educational Technology*, 48(6), 64.
- Secretary's Commission on Achieving Necessary Skills. (1991, June). *What work requires of schools: A SCANS report for America 2000*. Washington, DC: U.S. Department of Labor.
- School Works. (2005). *Knowsley school design festival: Learning centres for the future—Final report*. Accessed at www.knowsley.gov.uk/PDF/Design_Festival_Report.pdf on January 3, 2009.
- Tapscott, D. (1998). *Growing up digital: The rise of the net generation*. New York: McGraw-Hill.
- Wagner, T. (2008). *The global achievement gap: Why even our best schools don't teach the new survival skills our children need—and what we can do about it*. New York: Basic Books.
- Washor, E. (2003). *Innovative pedagogy and school facilities*. Minneapolis, MN: DesignShare.
- Watson, S. L., & Reigeluth, C. M. (2008, September/October). The learner-centered paradigm of education. *Educational Technology*, 38(5), 42–48.



Cheryl Lemke

Cheryl Lemke, M.Ed., is president and CEO of the Metiri Group, a consulting firm dedicated to advancing effective uses of technology in schools. Under her leadership, school districts across North America are using Metiri's innovative Dimensions21 system to benchmark their progress with 21st century learning. Prior to launching the firm, she was the executive

director of the Milken Exchange on Education Technology for the Milken Family Foundation. Lemke specializes in public policy for K–12 learning technology, working at many levels with governors, legislators, superintendents, business leaders, and teachers. As an associate superintendent for the Illinois State Board of Education, Lemke managed a center for learning technology with over one hundred staff members, translating the fifty-million-dollar annual budget into a new statewide network, professional development centers, community-based technology planning processes for Illinois schools, and online curriculum projects designed to help students learn. She also oversaw the development of state learning technology plans in both Illinois and Washington. Recognized nationally as a proactive leader in learning technology, and sought after as a consultant, speaker, and writer, Lemke has designed policy in the state house that translates into sound educational practice in the schoolhouse.

In this chapter, Lemke introduces three important innovations of 21st century learning: visualization, democratization of knowledge, and participatory cultures for learning. She provides an impressive demonstration of ways technology permits greater balance between a visual approach and traditional language-based communication.

Visit go.solution-tree.com/21stcenturyskills to view the graphics in this chapter in full color and to access live links to tools and materials.

Chapter 11

Innovation Through Technology

Cheryl Lemke

There is no turning back. The Internet has become integral to life in the 21st century—a place for work, play, communication, and learning. It is easy to lose sight of just how integral it has become, and how knowledge-based the world economy has become. The combination of human ingenuity and digital tools has led to innovations that have, in some cases, become viral (Foray & Lundvall, 1998). The statistics are staggering: in 2009, the mobile world celebrated its four billionth connection (Global System for Mobile Communications, 2009); over one trillion unique URLs have been registered in Google's index (The Official Google Blog, 2008); there have been nearly sixty-one million views to date of the YouTube most-watched video, *Guitar* (Jeong-hyun, n.d.; Shah, 2005); on average, nine hundred thousand blogs are posted every twenty-four hours (Singer, 2009); over 2.5 billion tweets have been sent (Reed, 2008); YouTube was sold to Google in 2006 for \$1.65 billion (Associated Press, 2006); over one hundred million users are logging onto Facebook every day; and approximately 2.6 billion minutes globally are dedicated to using Facebook daily, in thirty-five different languages (Singer, 2009).

Regardless of whether you find these statistics energizing or overwhelming, there is no question that the line between our digital and physical lives is blurring.

Outside of school, 96 percent of nine- to seventeen-year-olds embrace the Web 2.0 culture of social networking, blogging, twittering, GPS mapping, or interactive gaming at some level (National School Board Association, 2007). These youth communicate in real time through texting, instant messaging, and sharing of media files. According to the National School Board Association (2007), they typically spend about nine hours per week outside of school using social networking and ten hours watching television. But the reality is that there are significant variations among youth across the country with respect to the type and frequency of such digital media use (Jenkins, 2007). That holds true in schools as well, with significant differences in the type and frequency of technology use across states (*Education Week* and the Editorial Projects in Education Research Center, 2009b). A June 2009 Nielsen publication reported that, while children and youth do use electronic media in excess of six hours per day, using more than one medium simultaneously 23 percent of that time, they also enjoy reading books, magazines, and newspapers. Nielsen found that 77 percent of U.S. teens have their own mobile phone, 83 percent text message, and 56 percent use picture messaging. Teens average 2,899 text messages per month, which is fifteen times the average number of voice calls (191) they log each month. It would seem that email and phone calls are now considered their “father’s mode of digital communication,” not theirs (Nielsen Company, 2009).

The responsibility of educators is to ensure that today’s students are ready to live, learn, work, and thrive in this high-tech, global, highly participatory world. To that end, U.S. school systems are conspicuously out of sync with the culture of today’s society (U.S. Department of Education, 2009).

The responsibility of educators is to ensure that today’s students are ready to live, learn, work, and thrive in this high-tech, global, highly participatory world. To that end, U.S. school systems are conspicuously out of sync with the culture of today’s society.

While the more progressive educators are seizing this moment in history to launch a quiet Web 2.0 revolution in preK–12 education, the majority have yet to act. A 2009 national survey conducted by the Consortium on School Networking (CoSN) suggests that the majority of American school districts are at a crossroads with Web 2.0. While school district administrators clearly acknowledge the potential of Web 2.0

tools for learning, the majority of school districts have yet to turn that potential to their students' advantage. According to administrators who responded to the CoSN survey, the top three reasons for using Web 2.0 in school are to (1) keep students interested and engaged in school, (2) meet the needs of different kinds of learners, and (3) develop the critical-thinking skills of students. To date, that potential remains untapped. Instead, many school districts are checking student technologies (such as smartphones, cell phones, iPods, and iTouches) at the schoolhouse door (Lemke, Coughlin, Garcia, Reifsneider, & Baas, 2009).

At the same time, U.S. Secretary of Education Arne Duncan is calling for school districts to innovate using technology. At a national institute in 2009, he said, "Technology presents a huge opportunity . . . good teachers can utilize new technology to accelerate learning and provide extended learning opportunities for students." He went on to say, "We must take advantage of this historic opportunity to use American Recovery and Reinvestment Act funds to bring broadband access and online learning to more communities" (U.S. Department of Education, 2009).

Nationally, there is a call to action for smart, innovative, and informed leadership in 21st century learning in preK–12 education. The combination of crisis and vision has served America well more than once in its two-hundred-year history as it has evolved as a nation. A crisis is now before the United States in the form of the global economic downturn. The question is whether policy leaders will create an informed, collective vision for 21st century learning to turn that crisis into opportunity, and thus turn a new page in American education.

Innovation: The Fuel for a Knowledge-Based Economy

Economists claim that innovation is the fuel for today's global, knowledge-based economy and for its recovery. As such, innovation must play a dual role in America's preK–12 education system: as a foundational principle to the new educational system, and as a 21st century skill acquired by professionals and students alike. *Innovation* is defined here as a creative idea that has achieved sufficient social and/or professional acceptance so as to become the impetus for ongoing

ripples of creativity and change (Drucker, 2002). To build upon the ideas of author Malcolm Gladwell (2000), an innovation is an idea that has tipped and is viral, influencing the system within which it spreads.

21st Century Learning and Student Engagement

In a significant turn of events, business and government leaders are now acknowledging the critical importance of preK–12 education to the economic future of the United States. To that end, policy leaders are advocating for the transformation of preK–12 schools into 21st century learning environments. For the purposes of this chapter, *21st century learning* is defined as the combination of a set of discrete 21st century skills (for example, critical thinking, collaboration, information literacy, and so on), and academic standards to be implemented through digital innovations in the context of emergent research from the cognitive sciences on how people best learn.

In a significant turn of events, business and government leaders are now acknowledging the critical importance of preK–12 education to the economic future of the United States.

The intent of this chapter is to discuss three of the innovations rippling through our society that must inform America's bold new vision for 21st century learning. A key driver for this new vision is the current lack of student engagement in American schools that has contributed to an extremely high dropout rate nationally; nearly 30 percent of students who begin their ninth-

grade year of high school do not graduate (*Education Week* and the Editorial Projects in Education Research Center, 2009a). Some of the disconnect to learning is explained through the concept of *flow*, which is defined as learning with the intensity cranked up—when the learner is at the top of his or her game (Csikszentmihalyi, 1990). Teachers create opportunities for students to get into that flow by balancing the complexity of the task with the students' current repertoire of learning strategies. Too much complexity without the requisite strategies results in frustrated students unable to do the work. On the other hand, if highly capable students with strong learning strategies are given too simple a task, they rapidly become bored. Figure 11.1 depicts the concept of flow (adapted from Csikszentmihalyi, 1990; Schwartz, Bransford, & Sears, 2006).

The research by Csikszentmihalyi (1990, 2002) shows that when that balance is perfected, students enter a flow experience in which

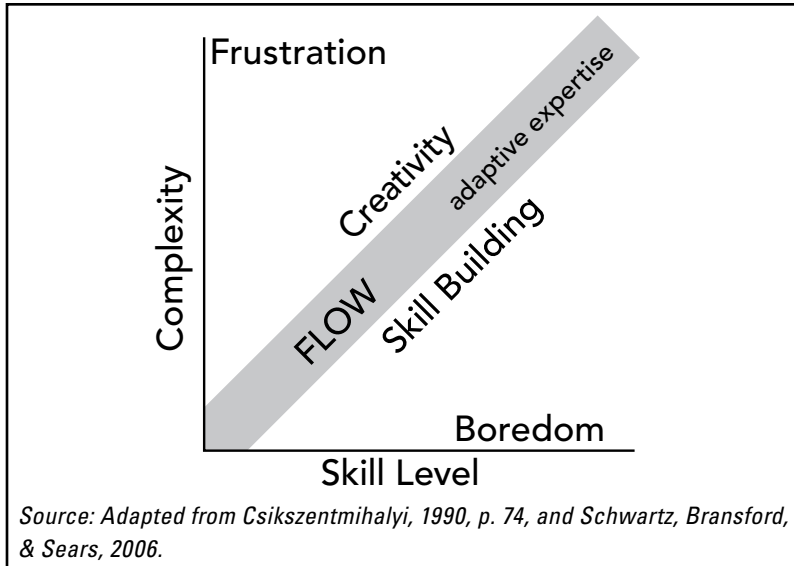


Figure 11.1: Developing adaptive expertise: Flow.

they are fully engaged, intrinsically motivated, and 110 percent invested in their learning. During flow experiences, many students report the sensation of time seeming to stand still as they engage in the experience. Leading cognitive science researchers suggest that the optimal flow experience balances skill level (that leads to efficiency in learning) with the level of task complexity (that leads to creativity and innovation). They contend that a balance between the two will lead to adaptive expertise in learners, which is necessary in dealing with the complexities of life in the 21st century.

The diagram in figure 11.2 (page 248) represents a framework for engaging students deeply in learning (Fredricks, Blumenfeld, & Paris, 2004; Lemke & Coughlin, 2008; Schlechty, 2002). In order to engage students fully in deep learning, they need to be motivated, curious learners who are in classrooms that scaffold that engagement through visualization, democratization of knowledge, and participatory learning.

Innovation One: Visualization

The link between visualization and learning can best be described as sense making. Physiologically, we are wired to swiftly process visuals, albeit differently than we process sound and text. Recent

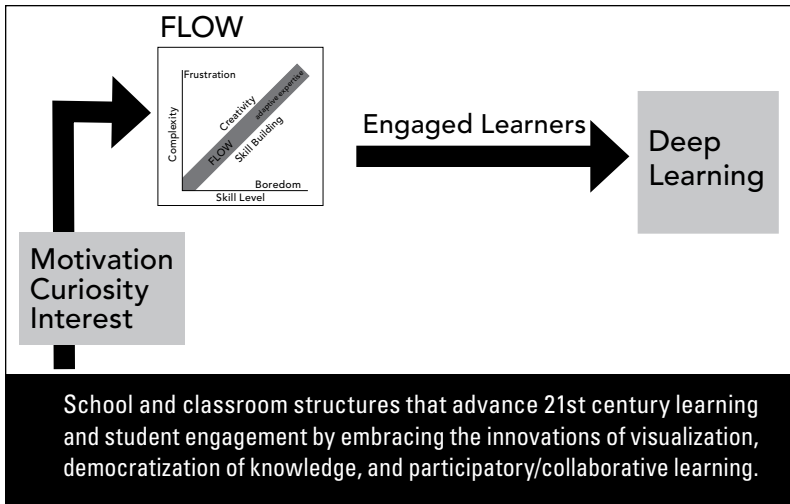


Figure 11.2: A framework for engaging students deeply in learning.
Reprinted with permission from Metiri Group.

technological advances through functional magnetic resonance imaging (fMRI) scans confirm a dual coding system through which visuals and text/auditory input are processed in separate channels, presenting the potential for simultaneous augmentation of learning. Our working memory, which is where we do all our thinking, processes visuals and text/sound differently. Both of these channels are extremely limited in their capacity.

The implications of this for education are many. First and foremost, it is important to acknowledge that people learn better from combining visuals with text and sound than through using either process alone, provided the design of learning resources follows certain multimedia principles (Mayer & Moreno, 2003).

This set of seven principles related to multimedia and modality is based on the work of Richard Mayer, Roxanne Moreno, and other prominent researchers (Chan & Black, 2006; Ginns, 2005; Mayer, 2001; Mayer & Moreno, 2003).

1. **Multimedia Principle:** Student retention is improved through a combination of words (verbal or text) and visuals, rather than through words alone, provided it doesn't introduce redundancy of content.

2. **Spatial Contiguity Principle:** Students learn better when corresponding text and visuals are physically integrated rather than separated.
3. **Temporal Contiguity Principle:** Students learn better when corresponding text and visuals are temporally synchronized rather than separated in time.
4. **Split-Attention Principle:** Students learn better when extraneous words, pictures, and sounds are excluded rather than included.
5. **Modality Principle:** Students learn better when text is presented auditorily as speech rather than as on-screen text.
6. **Individual Differences Principle:** Design effects from these principles are higher for low-knowledge learners than for high-knowledge learners, and they are higher for high-spatial learners than for low-spatial learners.
7. **Direct Manipulation Principle:** As the complexity of the materials increases the impact of direct manipulation of the learning materials (animation, pacing) on transfer also increases.

Students engaged in learning that incorporates high-quality multimodal designs outperform, on average, students who learn using traditional approaches with single modes. This was borne out by a recent meta-analysis that revealed multimodality (the use of text or sound and visuals together) can positively shift achievement—provided the multimedia principles are followed.

The meta-analysis found that, with noninteractive multimodal learning, such as text with illustrations or lectures with graphics, a student performing at the 50th percentile would, on average, increase performance to the 71st percentile (a gain of 21 percentiles). With interactive multimodal activities, such as simulations, modeling, and real-world experiences, a student at the 50th percentile would, on average, increase performance to the 82nd percentile (a gain of 32 percentiles) (Lemke, 2008).

Students engaged in learning that incorporates high-quality multimodal designs outperform, on average, students who learn using traditional approaches with single modes.

Outside the classroom, the 21st century brings us a myriad of visual images in multimedia through a host of technology devices, at a rapid pace unparalleled in the history of mankind. Examples abound (for live links to the following examples, and to see a full-color version of this chapter, visit go.solution-tree.com/21stcenturyskills).

- *The New York Times* provides interactive media on the economic crisis that enables users to explore the recessions of past years and compare them to that of 2009 (Quealy, Roth, & Schneiderman, 2009).
- *The New York Times* also provided an interactive graphic during the 2008 presidential debates that innovatively displayed the candidate names mentioned by other presidential candidates during the series of debates leading up to the Iowa caucuses (Corum & Hossain, 2007).

Another interactive venue for learning through visualization is online gaming. It enables participants to join multiuser groups from around the world to interact competitively and cooperatively in games, such as *Civilization* and *World of Warcraft*, or interact via an avatar in *Second Life*. Visual media also enables us to exercise with interactive videos on the Wii; link up with friends via GPS mappings; capture and post visuals and video on YouTube; and access news in real time across the globe. A prime example of this last use was the coverage of recent protests and governmental reactions following the 2009 Iraqi elections. Real-time access occurred through Twitter posts, CNN news, and YouTube video and visuals from the smartphones of those present at the scene.

Every day, student users are exposed to visuals, videos, and animations embedded in television commercials and programming, multimedia sites, communications, interactive games, Web 2.0 tools, and presentations. Contrary to popular belief, students are not born with the full range of abilities required to interpret, think with, and build simple or complex multimedia communications that involve visuals, text, and/or voice and sound. They need to learn to become informed viewers, critics, thinkers, and producers of multimedia. Just as there is a grammar and syntax for text literacy, so there is for

visual/multimodal literacy. The use of visualization is yet another way in which teachers can scaffold their students' learning.

Three strategies teachers might consider in using technology to capitalize on the power of visualization and build students' visual literacy are as follows:

1. Develop students as informed consumers of information.
2. Engage students in thinking critically and creatively using visuals.
3. Engage students in communicating using visuals.

Develop Students as Informed Consumers of Information

Students need to be informed consumers of visuals. One of the ways to achieve this is to help students analyze how advertisers manipulate images. KCTS Channel 9 in Seattle has produced a website that provides middle school students with opportunities to see the process in action. One of the offerings on the Don't Buy It: Get Media Smart site—Secrets of a Magazine Cover Model Revealed!—offers glimpses into the making of a “girl next door” into a fashion model (KCTS Television, 2004; http://pbskids.org/dontbuyit/entertainment/covermodel_1.html). Figure 11.3 shows screen captures from the process. These and other programs provide teens with an understanding of the digital manipulations routinely done in advertising. This is especially important given the pervasiveness of the idealization of models' bodies by consumers, which can lead to low self-esteem and



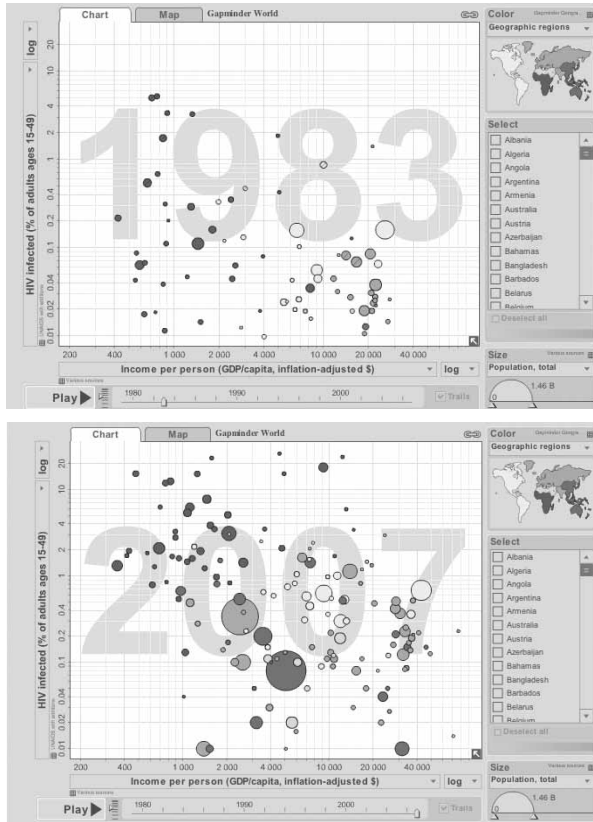
Figure 11.3: From “girl next door” to fashion model.

eating disorders among children, teens, and adults. This recognition of the potential for manipulation of media is an important first step in media literacy. An informed consumer recognizes that people are impacted emotionally, psychologically, physiologically, and cognitively by visuals and, thus, interpret media accordingly.

Engage Students in Thinking Critically and Creatively Using Visuals

Visualization can also be an extraordinary tool in a student's repertoire for critical and creative thinking. The more authentic the work, the better. Teachers and students alike can use readily accessible public datasets to engage in authentic investigations of open-ended questions concerning a range of topics. Examples abound. One digital tool that is particularly compelling for schools is free of charge on a website called Gapminder (www.gapminder.org). This visualization tool is built around a dataset from the United Nations. The dataset includes worldwide demographics, health, energy, politics, security, and other key elements (Gapminder Foundation, 2009). Each country is represented by a dot on the screen. Each continent has a unique color. The user determines the dataset to be charted on each of the axes and then watches as the tool shows the shifts in countries' positions across the years. For example, the two charts in figure 11.4 display the percentage of adults with HIV charted against the income per person for the countries of the world in 1983 and then in 2007. Students can use the visualization tool to track HIV infection in specific countries, with options for looking at specific demographics and/or income brackets within those countries. The full datasets are available for export to further analyze the data (Gapminder Foundation, 2009; visit go.solution-tree.com/21stcenturyskills for live links and to see full-color versions of the graphics in this chapter).

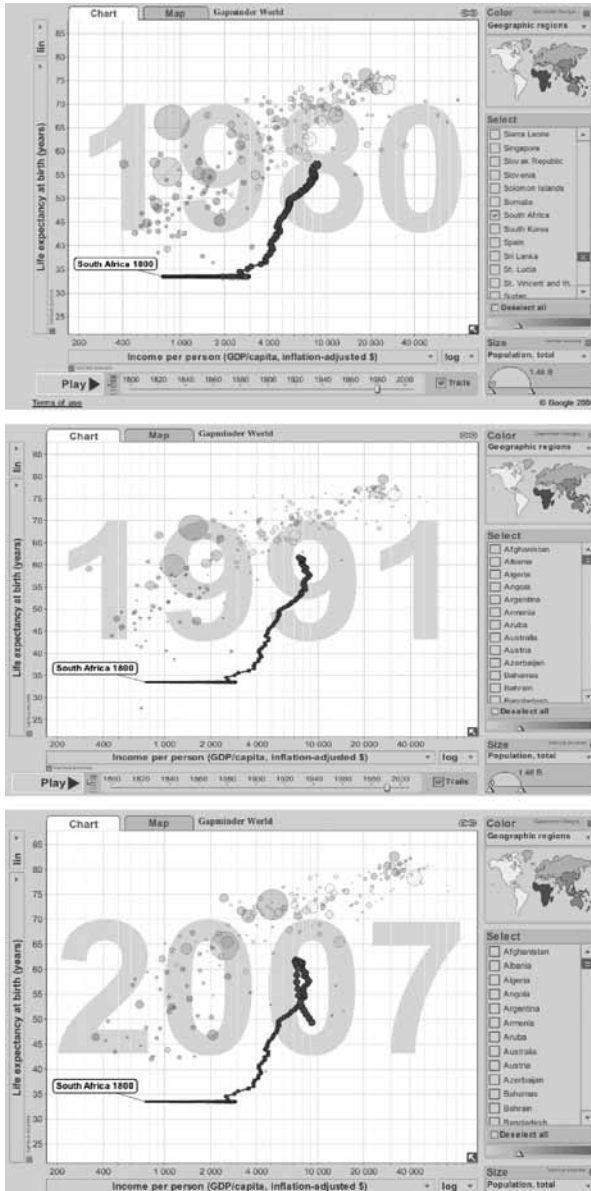
The teachable moments that can be created with this tool are unlimited. Take a look at our second example in figure 11.5 (page 254). It is three screen shots of a data run in which the average life expectancy of citizens in South Africa is charted in relationship to the average income per person over time. This chart shows a strong, steady increase for income and life expectancy in South Africa from 1932 to 1980. Then, in 1980, the income began slipping backward,



Source: Visualization from Gapminder World, powered by Trendalyzer from www.gapminder.org.

Figure 11.4: Charting the relationship over time between the percentage of adults with HIV in countries throughout the world in relation to the average income per person.

but the life expectancy continued to climb. In 1991, the upward trend in life expectancy reversed and began slowly decreasing; while at the same point in time, the income per person began slowly increasing. Those trends continued through 2007. Students exploring this data visualization quickly begin asking why the reversals happened in those specific years, and what factors caused the reversals. They might speculate that it was caused by a war, a natural disaster such as a famine or a tsunami, or perhaps industrialization. Students can rerun the scenario adding neighboring countries, zeroing in on



Source: Visualization from Gapminder World, powered by Trendalyzer from www.gapminder.org.

Figure 11.5: Life expectancy at birth by income in South Africa, 1800–2007.

particular years, charting new data elements, and, of course contextualizing their search through the use of other Web, print, and expert resources. This represents an extremely rich opportunity for critical thinking and problem solving with students.

Engage Students in Communicating Using Visuals

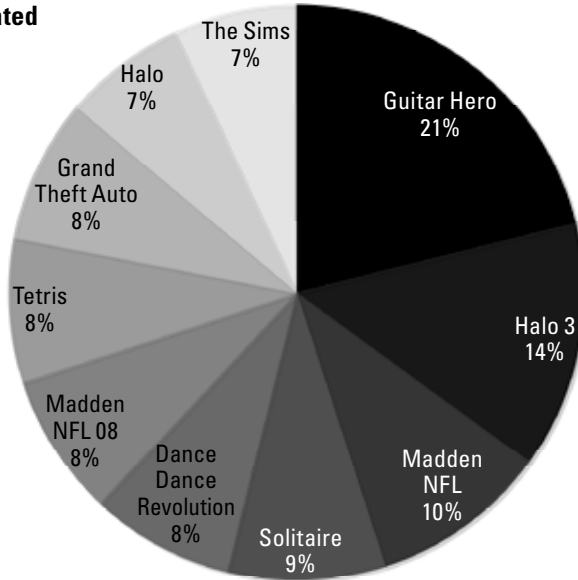
In addition to interpreting visuals, students should also understand how to create original visuals to communicate their ideas, represent their data, and tell their stories. Teachers can tap into websites that provide insight into which types of charts are most effective in displaying various types of datasets (see www.juiceanalytics.com/chartchooser/; visit go.solution-tree.com/21stcenturyskills for live links and to see a full-color version of the graphics in this chapter). As with any visual product, students need to adhere to the principles of multimodal design as described on pages 248–249. For example, in following the Spatial Contiguity Principle, charts should, where possible, integrate text into the design rather than using legends. In figure 11.6 (page 256), the cognitive load on working memory is higher for the nonintegrated example because the viewer has to look back and forth between the circle chart and the legend. In the integrated example, the load is reduced because the text is inside the chart.

A key strategy for scaffolding learning through visualization is the establishment and use of a set of guidelines that set high standards for the visual quality of student work. Many designers use a minimum of four key standards for design: contrast, repetition, alignment, and proximity (Williams, 2003) in concert with the multimedia principles listed previously. The visual design of digital products can increase or decrease the effectiveness of the communication:

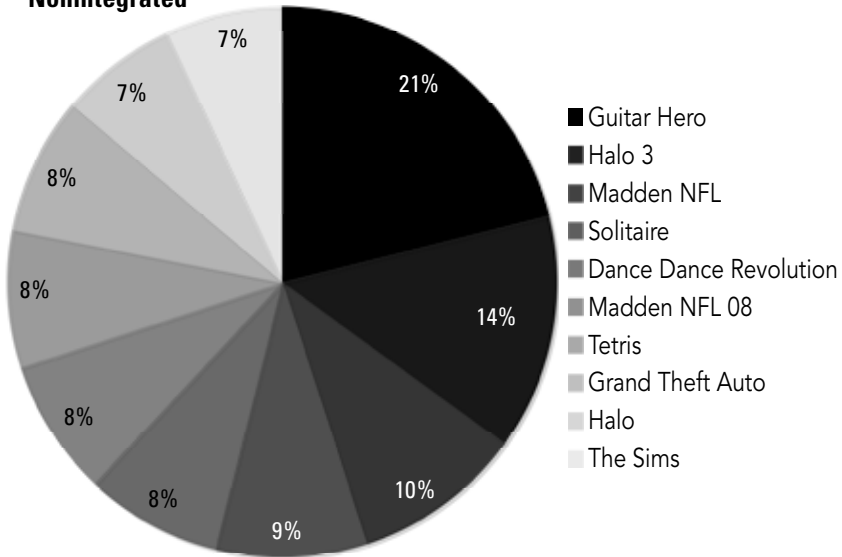
- **Contrast**—The idea behind contrast is to ensure that each element of the visual design is *significantly different* from the others. The eye is attracted to differences; it is the element that attracts the reader to the work. For example, if two or more different sizes of fonts are used, use two that are very different, such as these:

9 point 18 point

Integrated



Nonintegrated



Source: Adapted from Lenhart, Kahne, Middaugh, Macgill, Evans, & Vitak, 2008. Data is from the Gaming and Civic Engagement Survey of Teens and Parents, November 2007–February 2008. Margin of error is $\pm 3\%$.

Figure 11.6: The ten games most frequently played by teens.

- **Repetition**—Repeating elements of the design strengthens the unity of the piece. Repetition can be used with fonts, shapes, colors, thicknesses, spatial relationships, and so on. An example is shown in figure 11.7 (page 258) from the Technology Entertainment Design (TED) webpage (www.ted.com/talks/list), where each entry has the same style heading and format.
- **Alignment**—The way each element is placed on the page directs the order in which the reader's eye will move through the page. Thus, each element should have a visual connection with another element. In the example in figure 11.7, the eye is immediately drawn to the top headline and then drops to the visuals representing the six talks. For each talk, the proximity of the visual and text to its right causes the eye to flow to that text next, following the natural habit (in reading English) to move across the page, left to right. The natural inclination of the eye is to return to the visual but because the eye moves left to right, it returns to the text, and may repeat that eye movement several times. (The design thus creates eye movement that ensures all of the information in the text and visual will be processed.)
- **Proximity**—The eye prefers simple landscapes. Where possible, items that are related should be grouped close enough together to suggest to the eye that they are one visual element. This provides a clean structure, organizes information for the reader, and reduces visual noise. In the case of the Education Commission of the States Web heading in figure 11.8, there are four main elements, as outlined in the gray shading in the bottom portion of the graphic.

Visual literacy is a critical component of what it means to be literate in the 21st century. It can augment and extend students' critical thinking; deepen their understanding in science, math, social studies, and other core subjects; establish strong ties between the arts and sciences; provide a range of opportunities for expressions of what they know and are able to do; and help to ensure that they will be informed consumers of media.

Visual literacy is a critical component of what it means to be literate in the 21st century.

TED Ideas worth spreading

TED Conferences TED Community About TED

TEDx Events New TED Blog

TED Prize

TED Fellows

Search

TALKS

Show talks subtitled in: English

Show by event: All Events

Show by length: All lengths

Order talks by:

- Newest releases
- Most languages
- Most emailed this week
- Most comments this week
- Most favorited all-time
- Rated jaw-dropping
- ... persuasive
- ... courageous
- ... ingenious

Showing 1 - 10 of 608

| | | |
|--|--|---|
| <p>TED2007</p> <p>Blaise Aguera y Arcas demos Photosynth</p> <p>07:30 Posted: May 2007</p> <p>Rated: Jaw-dropping Ingenious Fascinating...</p> | <p>TED2006</p> <p>Jeff Han demos his breakthrough touchscreen</p> <p>08:47 Posted: Aug 2006</p> <p>Rated: Jaw-dropping Ingenious Fascinating...</p> | <p>TED2007</p> <p>Hans Rosling's new insights on poverty</p> <p>18:57 Posted: Jun 2007</p> <p>Rated: Jaw-dropping Inspiring Informaliv...</p> |
| <p>TED2007</p> <p>Carolyn Porco files us to Saturn</p> <p>17:09 Posted: Oct 2007</p> <p>Rated: Jaw-dropping Fascinating Beautiful...</p> | <p>TED2007</p> <p>Bill Stone explores the world's deepest caves</p> <p>17:43 Posted: Jun 2007</p> <p>Rated: Jaw-dropping Courageous Fascinating...</p> | <p>TED2004</p> <p>Jennifer Lin improves piano magic</p> <p>24:05 Posted: Aug 2006</p> <p>Rated: Jaw-dropping Beautiful Inspirin...</p> |

Source: Technology Entertainment Design, n.d., www.ted.com. Reprinted with permission.

Figure 11.7: Example of repetition and alignment.



Source: Education Commission of the States, 2010, <http://www.ecs.org>. Reprinted with permission.

Figure 11.8: Example of proximity.

Innovation Two: Democratization of Knowledge

The Internet has opened up a new opportunity for people to learn throughout their lives in both formal and informal environments, individually and in groups. Low-cost access to technology devices connected to high-speed broadband is now available to the majority of the population. Many communities are seeking broadband solutions to ensure equitable access for all members of the community. Despite this rapid growth of broadband in communities and homes, schools continue to play a role in ensuring that all students have robust access—at least within the school day.

The very ecology of learning is evolving. People are informally learning based on personal, professional, family, work, and community needs, interests, or responsibilities. Bridget Barron, a researcher from Stanford, has suggested that adolescent learning should be reconsidered in light of the informal learning opportunities now available to students (Barron, 2006). The diagram in figure 11.9 (page 260), based on Barron’s work, identifies a host of formal and informal learning situations in which preK–12 students may be involved.

The implications for schools are significant. School is just one node among the learning contexts available to students; educators should be actively considering how to extend the formal learning launched in schools into other nodes. In addition, educators should seek to

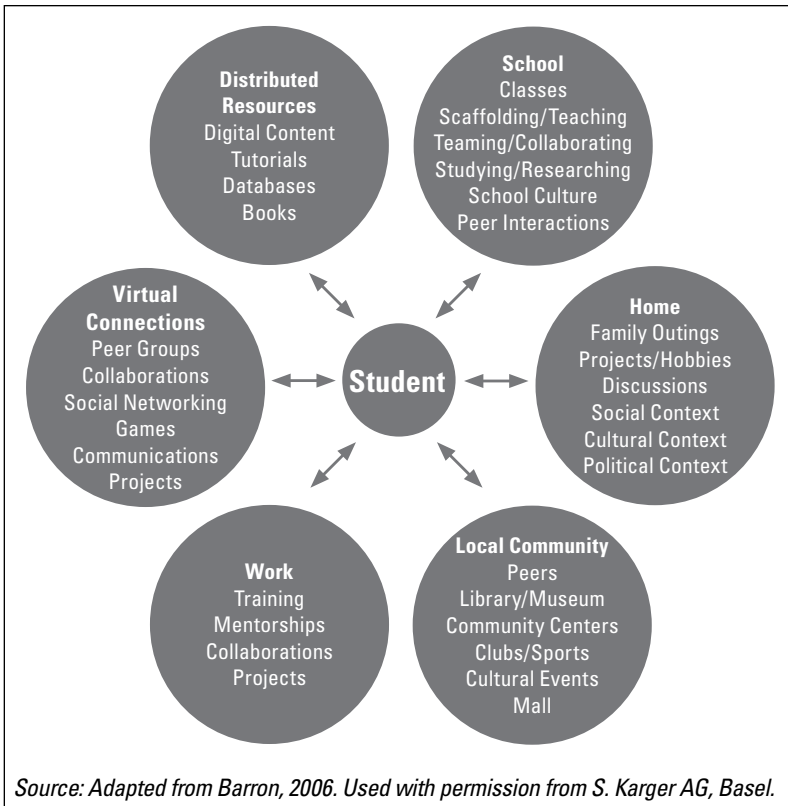


Figure 11.9: Contexts for 21st century learning.

become sufficiently familiar with the informal learning students are actively engaged in outside of school in order to integrate student interests with formal learning experiences. The intent would be to bring added relevancy and student interest to the formal work within the classroom and to integrate, to some degree, students' formal and informal learning. Another responsibility of schools is to ensure that students gain knowledge and expertise in navigating, interacting, and learning within digital environments. The taxonomy that one might consider in thinking about the democratization of knowledge includes:

- **Browsing the Net**—The universal adoption of *google* as a verb says it all. Information is truly at the fingertips of the informed Internet navigator. The key word is *informed*. While information is available, it is critical that schools provide intensive work with students on informed searching, navigating the

visible and invisible Web, critiquing websites to check for reliable sources, and persevering to ensure comprehensive, balanced searches.

- **Learning objects**—A learning object is a self-contained resource, usually digital and/or web-based, that can be used and reused to support learning. Many of the first learning objects were in the form of virtual manipulatives—dynamic objects through which students could explore properties to further their knowledge (Utah State University, 2007). Today, learning objects take the form of YouTube videos, iPod audio and/or video files, interactive websites, scripted slide shows, and so on. That means that twenty-four hours a day, seven days a week, these objects are available to interested learners. Learning objects can be used to supplement face-to-face classrooms, can be embedded in virtual classes, and can easily be accessed by students who are studying, but have not yet mastered the topic. For example, the National Council of Teachers of Mathematics Illuminations website provides many virtual manipulatives, including one that enables students to manipulate the areas that represent each element of the equation $(a + b)^2 = a^2 + 2ab + b^2$ (National Council of Teachers of Mathematics, 2009; visit <http://illuminations.nctm.org/Activity/Detail.aspx?ID=127> to view this manipulative). A second example is a calculator students can use to determine the emissions of their homes. The program enables them to manipulate entries to see the results on carbon emissions (U.S. Environmental Protection Agency, n.d.; visit <http://www.epa.gov/CHP/basic/calculator.html> to view this manipulative).
- **Simulations**—The depth of student learning increases when students are able to experiment with the parameters behind a visual simulation. For example, in a new generation of tools called Yenka, a U.K. firm enables students to learn some rudimentary steps in programming by controlling a dancer's onscreen actions through their creation and running of a flowchart. These resources are available, free of charge, for use by individuals in their homes, and can also be licensed for a fee by schools (Crocodile Clips, 2009; visit www.yenka.com/en/Yenka_Programming/ to view the simulation). A

free-of-charge simulation, SimCalcMathWorlds, enables students to experiment with rate, linear functions, and proportionality through graphing calculators and computers that generate math functions. For example, students are able to determine speed and rate of acceleration of two fish along a linear path while simultaneously watching the functions charted on a grid (see www.kaputcenter.umassd.edu/projects/simcalc/).

- **University courses available to the public**—In the first decade of the 21st century, many universities in the United States have made their courses available online. Currently, MIT Courseware (Massachusetts Institute of Technology, 2009) and Rice Connexions (Rice University, n.d.) have made thousands of courses available. Another digital access point for thousands of free university courses, lectures, and interviews is iTunes University.
- **Online courses for K–12 students and teachers**—According to a meta-analysis on online learning released by the U.S. Department of Education in May of 2009, online learning for both K–12 students and teachers is one of the fastest growing trends in educational technology (Means, Toyama, Murphy, Bakia, & Jones, 2009). The report indicated that the number of K–12 students enrolled in technology-based distance learning courses had increased by 65 percent from the 2002–2003 school year to the 2004–2005 school year. A recent report by the Sloan Consortium (Picciano & Seaman, 2009) estimated that more than one million U.S. K–12 students were engaged in online courses in 2007–2008, which represents a 47 percent increase since 2005–2006. The authors of that study reported a wide range of needs that were fulfilled through online courses, from those seeking advanced placement and college-level courses, to those needing credit recovery or remediation. This access provides a tremendous opportunity for students who are seeking an alternative to the local offerings in terms of courses available, timing of courses, and mode of learning.

The Florida Virtual High School (FVHS) is an example of one of the largest virtual high schools. In the 2007–2008 school

year, FVHS enrolled approximately one hundred thousand students nationally (diplomas are granted by the student's local community school). FVHS announced in the summer of 2009 a new American History, full-credit high school course to be conducted completely within the gaming environment Conspiracy Code (Nagel, 2009).

- **Online course units**—Many school districts and individual teachers are leveraging online learning as a supplement to classroom work. In some cases, teachers are using online units as an integral component of their courses. One example of online units is from the federally funded web-based Inquiry Science site hosted at the University of California, Berkeley (<http://wise.berkeley.edu>). The science inquiry units offered on this site are free of charge to participating schools. Four of the self-contained units are as follows: Airbags: Too Fast, Too Furious? (Grades 11–12); Global Climate Change: Who's to Blame? (Grades 6–9); TELS: Mitosis and Meiosis (Grades 9–12); and Wolf Ecology and Population Management (Grades 7–12). The units are typically four to five days (one class period) in length, are aligned to standards, include lesson plans, and are highly interactive for student teams through the website.

The democratization of knowledge provides the opportunity for lifelong individual and group learning. For students to leverage that opportunity fully requires critical thinking, information literacy, and a measure of self-direction, all of which need to be developed in part by our school systems. The democratization of knowledge also provides tremendous opportunities for educators to begin transforming their schools into physical and virtual places of 21st century learning. One of the critical differences from conventional education is a solid foundation in inquiry learning that is student-centered and authentic. Educators are at a crossroads. They can embrace this democratization of knowledge by authentically connecting their students' formal and informal learning. Or they can ignore it and run the risk of obsolescence, becoming certification mills for the interactive learning that takes place out of school.

The democratization of knowledge provides the opportunity for lifelong individual and group learning. For students to leverage that opportunity fully requires critical thinking, information literacy, and a measure of self-direction, all of which need to be developed in part by our school systems.

Innovation Three: Participatory Learning

Today's schools are focused on individual acquisition of knowledge, student by student, despite the fact that, increasingly, society, community, and work emphasize teaming, collaboration, and participatory learning.

While the Internet of the 1990s gave previously underrepresented groups a public voice, the Web 2.0 tools of the 21st century have given rise to a participatory culture. The advent of Facebook, YouTube, Flickr, Twitter, RSS feeds, GPS tracking, smart mobile devices, and robust international broadband networks have enabled millions to interact in real time twenty-four hours a day, seven days a week. Web 2.0 tools have enabled everyone with sufficiently robust Internet access to post, exchange, and comment on video, audio, and text files; share tagging perspectives through sites such as Delicious.com; interact on social networking sites; participate in live chats; interact and share perspectives within communities of interest/practice; use GPS tracking and texting to connect in real time; participate in interactive, online games and gaming communities; and stay connected and informed through RSS feeds, Flickr, and Twitter.

New social patterns are emerging at unprecedented rates. People now expect to be active participants in these virtual communities, not just passive observers. At the heart of these communities is the evolutionary nature of community norms, content, discourse, and life cycle. Yes, someone establishes the foundational tools, but the community is seldom carefully and strategically planned. Rather, it evolves over time, shaped by dialogue, discussion, shared resources, responses to inquiries, commentary and critique, and levels of participation based on perceived value. An innovative example is the use of Facebook by a teacher to engage students in learning about the periodic table. (Visit go.solution-tree.com/21stcenturyskills for live links and to see full-color versions of the graphics in this chapter.)

At High Tech Middle School in San Diego, students used social networking to personally identify with the elements in the periodic table (see figure 11.10; <http://staff.hthcv.hightechhigh.org/~jmorris/period%20table%20page.html>). Students were asked to list personal characteristics, identify the attributes of elements, and then select which elements' attributes most closely aligned to their personal

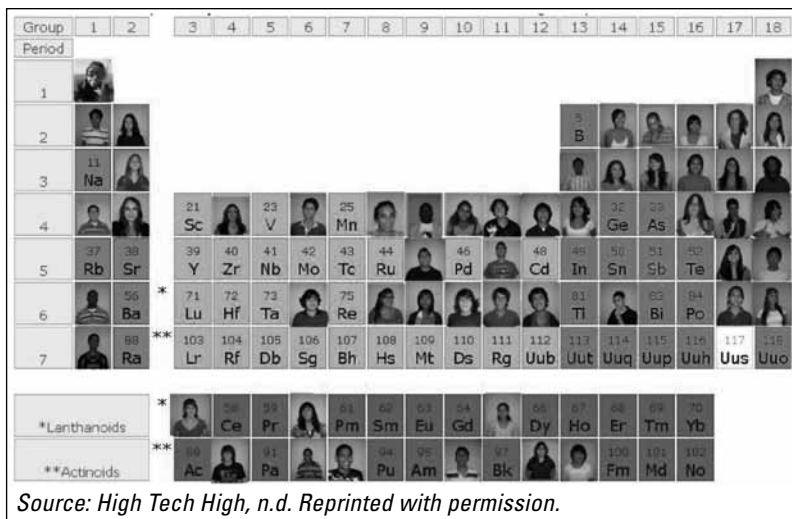


Figure 11.10: The Periodic Table: Students' Facebook pages on the elements.

characteristics. Once their Facebook page was established for their element, they proceeded to “friend” other elements in alignment with their elements’ attributes.

By clicking on the live site, each student’s Facebook page reveals the characteristics of attributes they share with the element they believe aligns most closely to him or her. See figure 11.11 (page 266) for an excerpt.

That participatory culture is reflected in today’s economic globalization. Multinational corporations in particular epitomize this participatory culture, where the success of an individual is directly tied to the success of the teams within which they work. Often the effectiveness of the teams lies in the social and emotional maturity of the members, the diversity of members’ expertise, and members’ leadership and commitment. This is indicative of Web 2.0 participatory cultures where the power lies in the quality, frequency, expertise, backgrounds, and commitment of the participants.

From an educational perspective, it is important to note that participation is not synonymous to collaboration. A participatory culture can range from the harmonious to the acrimonious. The topic of interest that brings a community together may range from social justice to the intellectual, the political, the social, the economic,

Student Entry: What I have in common with Hydrogen.

Gets Along Well With Others: I have an easy-going nature about me and would consider myself to have a go-with-the-flow personality. Just like Hydrogen, I like to be near others and hanging out with friends any chance I get. In this fast-paced world we live in, sometimes it's nice to just spend some time relaxing with friends.

Low Boiling Point (-252.87 C): Generally, I am a calm and collected individual. As is true of anyone, I have my moments of high stress and low patience, but for the most part I am a calm and caring individual. I share my cool nature with Hydrogen.

Just like Hydrogen, I am little but powerful. I have always thought of myself as someone who is small but mighty. I am a strong individual who can take care of herself and others. I am someone you can depend on for strength and dependability. I share this strength and usefulness with Hydrogen.

Source: High Tech High, n.d. Reprinted with permission.

Figure 11.11: Student's Facebook page on Hydrogen.

a community perspective, or simply entertainment and personal interest. The size of the community, its purposes, its longevity, and the norms within those communities vary considerably.

As the three innovations (visualization, democratization of knowledge, and participatory learning) introduced in this chapter ripple through society, people are using their ingenuity to use those innovations for their own purposes. In doing so, they continually influence and redefine the very ecology of the society—hence the ripple effect. This same phenomenon is true of learning. Researcher Kai Hakkarainen and his colleagues discuss how educators think about learning in three distinct ways (Hakkarainen, Palonen, Paavola, & Lehtinen, 2004). The first is an acquisition model, which emphasizes what the individual knows and is individually able to learn. The second model is participation. In this case, the educator goes beyond the acquisition model to acknowledge the social aspect of learning. While students in this model might engage in collaborative work, the measure of success is still largely focused on how much the individual is able to learn, accompanied perhaps by a measure of the student's ability to work within a group, community, network, or culture. The third model is knowledge

creation. In this model, the output of the group or community is a valued asset, complemented by a measure of the individual's contributions to the team and acquisition of knowledge. The reality is that educators should be encompassing all three perspectives on learning.

Today's schools are out of sync with society—they are still operating on the acquisition model. They do register some forays into the participation model through collaborative learning, but they neither regularly establish structures that measure and value the group or community's collective knowledge construction, nor document the contributions of the student to that work. This translates into a need to restructure learning, teaching, and assessment to increasingly emphasize and value the participation in groups and the group's knowledge creation, in addition to the individual's acquisition of knowledge. This is necessary if schools are to graduate students who are ready to thrive in this new participatory culture.

Implications of the Three Innovations

Students who are learning in schools influenced by the innovations of visualization, democratization of knowledge, and participatory cultures need different skills than prior generations. Tremendously important to these students are the skills discussed throughout this book, including critical and creative thinking, self-direction, collaboration, multimodal learning, and adaptability. The ecology of learning will itself evolve over time, with students taking stronger, more active roles in shaping their learning trajectories, often blending informal and formal learning in face-to-face, virtual, and hybrid learning never before possible. One of the immediate ways in which schools can immerse students in such learning is through authentic learning. Such learning is defined by Fred Newmann as learning that has three key elements: (1) deep inquiry (Higher Education Academy, 2009) into the subject matter (as opposed to surface learning), (2) relevancy beyond the school day (students are working with teams outside of the school on projects that matter), and (3) knowledge construction (students are producing

Students who are learning in schools influenced by the innovations of visualization, democratization of knowledge, and participatory cultures need different skills than prior generations.

and constructing actual products to contribute to the community of interest as they demonstrate what their team now understands and what they individually understand).

Getting There From Here

To ensure U.S. students are ready to thrive in today's global, knowledge-based society, our schools need to embrace the innovations of visualization, democratization of knowledge, and participatory cultures for learning. This begins through leadership's creation of a culture of openness, risk taking, and adaptability within schools, where learners, teachers, and their communities can investigate how these innovations will change, grow, and adapt learning inside and outside of school. A first step is to gauge your school's readiness for 21st century learning. Metiri Group's Dimensions of 21st Century Learning (D21) provide a framework for gauging such readiness (Metiri Group, 2008):

- **Vision**—Does your school system have a forward-thinking, common vision for 21st century learning that represents societal innovations to serve as a unifying and energizing force of change?
- **Systems thinking/leadership**—Are all educators and staff thinking and acting systemically to embrace innovation in ways that advance the vision?
- **21st century skills/learning**—Has your school system adopted 21st century skills in the context of research-informed learning strategies?
- **21st century learning environments**—Is the vision of 21st century learning coming to life in your schools?
- **Professional competencies**—Are your teachers, administrators, and other staff ready to facilitate, lead, and assess 21st century learning among students, the community, and parents?
- **Access and infrastructure**—Is the access to technology devices and the infrastructure sufficiently robust to support 21st century learning?

- **Accountability**—Are learners, educators, and the system held accountable for making progress, while also provided with the data and support for achieving results?

For educators, this framework translates into a need for leadership that (1) establishes a culture of openness to new ideas in and outside of education, (2) encourages calculated risk taking, and (3) is sufficiently insightful to establish a process that accelerates the spread of powerful, creative ideas that have the potential to “tip and ripple.” Authors from the *Harvard Business Review* suggest such leaders should be strategists, those who generate organization change in highly collaborative ways that, at times, challenge and change current assumptions (Rooke & Torbert, 2005).

It is time to challenge assumptions in today’s preK–12 school systems and embrace the ripple effects of these three innovations: visualization, democratization of knowledge, and participatory learning.

References

- Associated Press. (2006, October 10). Google buys YouTube for \$1.65 billion. *MSNBC online*. Accessed at www.msnbc.msn.com/id/15196982 on July 1, 2009.
- Barron, B. (2006). Interest and self-sustained learning as catalysts of development: A learning ecology perspective. *Human Development*, 49(4), 193–224.
- Chan, M. S., & Black, J. B. (2006, April). *Learning Newtonian mechanics with an animation game: The role of presentation format on mental model acquisition*. Paper presented at the American Education Research Association Annual Conference, San Francisco.
- Corum, J., & Hossain, F. (2007, December 15). Naming names. *The New York Times*. Accessed at www.nytimes.com/interactive/2007/12/15/us/politics/DEBATE.html on October 10, 2008.
- Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York: Harper and Row.
- Crocodile Clips. (2009). *Yenka programming*. Accessed at www.yenka.com/en/Yenka_Programming/ on July 7, 2009.
- Education Week and the Editorial Projects in Education (EPE) Research Center. (2009a, June 11). *Diplomas count 2009: Broader horizons: The challenge of college readiness for all students*. Bethesda, MD: Authors.
- Education Week and the Editorial Projects in Education (EPE) Research Center. (2009b). *National technology report: Breaking away from tradition*. Bethesda, MD: Authors.

- Drucker, P. F. (2002, August). The discipline of innovation. *Harvard Business Review*, 80(8), 95–103.
- Foray, D., & Lundvall, B. D. (1998). *The knowledge-based economy: From the economics of knowledge to the learning economy*. In D. Need, G. Siesfeld, & J. Cefola, *The economic impact of knowledge* (pp. 115–122). New York: Butterworth-Heinemann.
- Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74(1), 59–109.
- Gapminder Foundation. (2009). *Gapminder: Unveiling the beauty of statistics for a fact based world view*. Accessed at www.gapminder.org on June 5, 2009.
- Ginns, P. (2005). Meta-analysis of the modality effect. *Learning and Instruction*, 15(4), 313–331.
- Gladwell, M. (2000). *The tipping point: How little things can make a big difference*. Boston: Little, Brown.
- Global System for Mobile Communication. (2009, February 11). *Mobile world celebrates four billion connections*. GSM Association press release. Accessed at www.gsmworld.com/newsroom/press-releases/2009/2521.htm on June 20, 2009.
- Hakkarainen, K., Palonen, T., Paavola, S., & Lehtinen, E. (2004). *Communities of networked expertise: Professional and educational perspectives*. Amsterdam: Elsevier Science.
- High Tech High. (n.d.). *We are the periodic table of elements*. Accessed at <http://staff.hthcv.hightechhigh.org/~jmorris/period%20table%20page.html> on January 28, 2010.
- The Higher Education Academy. (2009). *Deep and surface approaches to learning*. Accessed at www.engsc.ac.uk/er/theory/learning.asp on October 1, 2008.
- Jenkins, H. (2007, December 5). *Reconsidering digital immigrants*. *Confessions of an aca-fan: The official weblog of Henry Jenkins*. Accessed at www.henryjenkins.org/2007/12/reconsidering_digital_immigran.html on June 8, 2009.
- Jeong-hyun, L. (n.d.). In *Wikipedia, the free encyclopedia*. Accessed at http://en.wikipedia.org/wiki/Jeong-Hyun_Lim on July 5, 2009.
- KCTS Television. (2004). *Don't buy it: Get media smart*. Accessed at http://pbskids.org/dontbuyit/entertainment/covermodel_1.html on May 20, 2009.
- Lemke, C. (2008). *Multimodal learning through media: What the research says*. Accessed at www.cisco.com/web/strategy/docs/education/Multimodal-Learning-Through-Media.pdf on June 6, 2008.
- Lemke, C., & Coughlin, E. (2008). *Student engagement*. Culver City, CA: Metiri Group.
- Lemke, C., Coughlin, E., Garcia, L., Reifsneider, D., & Baas, J. (2009, March). *Leadership for Web 2.0 in education: Promise and reality*. Culver City, CA: Metiri Group.

- Lenhart, A., Kahne, J., Middaugh, E., Macgill, A. R., Evans, C., & Vitak, J. (2008). *Teens, video games, and civics*. Washington, DC: Pew Internet & American Life Project.
- Massachusetts Institute of Technology. (2009). *MIT OpenCourseWare*. Accessed at <http://ocw.mit.edu> on June 9, 2009.
- Mayer, R. (2001). *Multi-media learning*. Cambridge, UK: Cambridge University Press.
- Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. In R. Bruning, C. A. Horn, & L. M. PytlikZillig (Eds.), *Web-based learning: What do we know? Where do we go?* (pp. 23–44). Greenwich, CT: Information Age Publishing.
- Moreno, R., & Mayer, R. E. (2005). *A learner-centered approach to multimedia explanations: Deriving instructional design principles from cognitive theory*. Accessed at <http://imej.wfu.edu/articles/2000/2/05/index.asp> on October 8, 2008.
- Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2009, May). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies* (Report No. ED-04-CO-0040 Task 0006). Washington, DC: U.S. Department of Education. Accessed at www.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.doc on June 30, 2009.
- Metiri Group. (2008). *Dimensions of 21st century learning*. Accessed at <http://D21.metiri.com> on July 7, 2009.
- Nagel, D. (2009, June 2). Virtual school begins rolling out game-based courses. *THE Journal*. Accessed at <http://thejournal.com/Articles/2009/06/02/Virtual-School-Begins-Rolling-Out-GameBased-Courses.aspx> on June 8, 2009.
- National Council of Teachers of Mathematics. (2009). *A geometric investigation of $(a + b)^2$* . Illuminations. Accessed at <http://illuminations.nctm.org/ActivityDetail.aspx?ID=127> on July 7, 2009.
- National School Board Association. (2007). *Creating and connecting: Research and guidelines on online social—and educational—networking*. Alexandria, VA: Author.
- Nielsen Company. (2009). *How teens use media: A Nielsen report on the myths and realities of teen media trends*. New York: Author. Accessed at http://blog.nielsen.com/nielsenwire/reports/nielsen_howteensusemedia_june09.pdf on July 6, 2009.
- Official Google Blog. (2008, July 25). *We knew the Web was big*. Accessed at <http://googleblog.blogspot.com/2008/07/we-knew-web-was-big.html> on June 20, 2009.
- Picciano, A. G., & Seaman, J. (2009). *K-12 online learning: A 2008 follow-up of the survey of U.S. school district administrators*. Newburyport, MA: The Sloan Consortium. Accessed at www.sloanconsortium.org/publications/survey/pdf/k-12_online_learning_2008.pdf on April 4, 2009.

- Quealy, K., Roth, G., & Schneiderman, R. M. (2009, January 26). How the government dealt with past recessions. *The New York Times*. Accessed at www.nytimes.com/interactive/2009/01/26/business/economy/20090126-recessions-graphic.html on May 10, 2009.
- Reed, N. (2008). *GigaTweet*. Accessed at <http://popacular.com/gigatweet> on July 7, 2009.
- Rice University. (n.d.). *Connexions*. Accessed at <http://cnx.org/> on June 6, 2009.
- Rooke, D., & Torbert, W. R. (2005, April). Seven transformations of leadership. *Harvard Business Review*, 83(4), 67–76.
- Schlechty, P. C. (2002). *Working on the work: An action plan for teachers, principals, and superintendents*. San Francisco: Jossey-Bass.
- Schwartz, D. L., Bransford, J. D., & Sears, D. (2006). Innovation and efficiency in learning and transfer. In J. P. Mestre (Ed.), *Transfer of Learning from a Modern Multidisciplinary Perspective* (pp. 40–59).
- Shah, J. A. (2005, December 20). *Guitar* [YouTube video]. Accessed at www.youtube.com/watch?v=QjA5faZF1A8 on July 5, 2009.
- Singer, A. (2009, January 12). Social media, Web 2.0 and Internet stats. *The Future Buzz*. Accessed at <http://thefuturebuzz.com/2009/01/12/social-media-web-20-internet-numbers-stats> on July 2, 2009.
- Technology Entertainment Design. (n.d.). *TED: Ideas worth spreading—Talks page*. Accessed at www.ted.com/talks/list on February 18, 2010.
- U.S. Department of Education. (2009, June 8). *Robust data gives us the roadmap to reform*. [Speech Secretary Arne Duncan gave at the Fourth Annual IES Research Conference]. Accessed at www.ed.gov/news/speeches/2009/06/06082009.html on June 19, 2009.
- U.S. Department of Education. (2009, June 26). *U.S. Department of Education study finds that good teaching can be enhanced with new technology*. U.S. Department of Education Press Release. Accessed at www.ed.gov/news/pressreleases/2009/06/06262009.html on May 10, 2009.
- U.S. Environmental Protection Agency. (n.d.). *Household emissions calculator*. Accessed at http://epa.gov/climatechange/emissions/ind_calculator2.html#c=transportation&p=reduceOnTheRoad&m=calc_WYCD on July 7, 2009.
- Utah State University. (2007). *National Library of Virtual Manipulatives*. Accessed at http://nlvm.usu.edu/en/nav/grade_g_2.html on May 20, 2009.
- Williams, R. (2003). *The non-designers design book*. Berkeley, CA: Peachpit Press.