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KAMEHAMEHA SCHOOLS

21st Century Skills for Students and Teachers

By Pacific Policy Research Center

Introduction

This literature review synthesizes published works on 21st century learning skills. There has been a significant shift over the last century from manufacturing to emphasizing information and knowledge services. Knowledge itself is growing ever more specialized and expanding exponentially. Information and communication technology is transforming how we learn and the nature of how work is conducted and the meaning of social relationships. Shared decision-making, information sharing, collaboration, innovation, and speed are essential in today's enterprises. No longer can students look forward to middle class success in the conduct of manual labor or use of routine skills – work that can be accomplished by machines or easily out-sourced to less expensive labor markets. Today, much success lies in being able to communicate, share, and use information to solve complex problems, in being able to adapt and innovate in response to new demands and changing circumstances, in being able to command and expand the power of technology to create new knowledge.

Hence, new standards for what students should be able to do are replacing the basic skill competencies and knowledge expectations of the past. To meet this challenge schools must be transformed in ways that will enable students to acquire the creative thinking, flexible problem solving, collaboration and innovative skills they will need to be successful in work and life. Some authors (Carroll, 2007; Burmack, 2002; Riddle, 2009; Frey & Fisher, 2008; Elkins, 2007; Trilling & Fidel, 2009) and organizations (Partnership for 21st Century Learning; National Science Foundation, Educational Testing Services, NCREL, Metiri Group, etc.) argue that 21st Century Learning Skills, the subject of this literature review, are critical for accomplishing the necessary transformation.

The Partnership for 21st Century Skills (www.21stcenturyskills.com) has developed a framework for 21st century learning, which describes the skills that students need to thrive in today's global economy. The North Central Regional Education Laboratory (NCREL) and the Metiri Group have also identified a framework for 21st century skills, which is organized into four categories: digital age literacies, inventive thinking, effective communication, and high productivity.¹ This literature review is organized in line with the framework developed by the Partnership

¹ NCREL & Metiri Group. (2003). enGauge 21st century skills: literacy in the digital age. <http://www.ncrel.org/engauge/skills/skills.htm>

for 21st Century Learning Skills.² The literature review begins by defining 21st century learning skills, and then moves to address “Core Themes and Subjects,” “Learning and Innovation Skills,” “Life and Career Skills,” and “Information, Media, and Technology Skills.” The review concludes with discussions of 21st century support systems.

How are 21st Century Learning Skills Defined?

The Educational Testing Service (ETS) in its publication, *Digital Transformation: A Literacy Framework for ICT Literacy* (2007), defines 21st century learning skills as the ability to a) collect and/or retrieve information, b) organize and manage information, c) evaluate the quality, relevance, and usefulness of information, and d) generate accurate information through the use of existing resources. NCREL identifies broader 21st century skills as achieving 21st century learning through digital age literacy, inventive thinking, effective communication, and high productivity. The Partnership for 21st century skills identifies six key elements for fostering 21st century learning: 1) emphasize core subjects, 2) emphasize learning skills, 3) use 21st century tools to develop learning skills, 4) teach and learn in a 21st century context, 5) teach and learn 21st century content, and 6) use 21st century assessments that measure 21st century skills.

What are 21st Century Learning Skills?

21st Century Core Subjects and Themes

Traditional education models have often focused on learning identified content for subject areas (i.e. math, science, language arts, and social studies), and then assessing this content knowledge with quizzes, and tests at the end of a chapter or learning module. Desired outcomes within 21st century learning frameworks include learning traditional school subject and contemporary content themes in combination with the interdisciplinary 21st century themes. The core subjects and themes that frame 21st century learning include traditional core subjects while emphasizing civic literacy, global awareness, financial literacy, health literacy, and environmental literacy.

Civic literacy

Civic literacy speaks to the need for students to be able to understand and influence civic decision-making. This theme focuses on the importance of staying informed and understanding governmental processes, being able to participate in civic life, and recognizing the local and global implications of civic decisions.

Donald Lazare’s recent text, *Reading and Writing for Civic Literacy: The Critical Citizen’s Guide to Argumentative Rhetoric* (2005) addresses a documented need for students to develop critical reading, writing, and thinking skills for participation in civic society. Lazare provides a number of lesson plans and classroom exercises for teachers to help students understand the ideological positions and the rhetorical patterns that underlie opposing viewpoints in current political debates.

Global awareness

The global awareness theme speaks to the need for students to be able to learn from and work collaboratively with individuals from diverse cultures, religions, ideologies, and lifestyles in an environment of openness and mutual respect. This theme also references the ways in which students utilize 21st century skills to understand and engage with global issues and diverse learning communities.

² The Partnership for 21st Century Skills (P21) is a national organization that advocates for 21st century readiness for every student. P21 advocates for local, state and federal policies that support 21st century learning standards for every school.

A nationwide poll of registered voters conducted in 2007 by the Partnership for 21st Century Skills, found that Americans are deeply concerned that the United States is not preparing young people with the skills they need to compete in the global economy (P21, 2007). Gragert (2001) concurred, arguing that international collaborative problem solving is beneficial for students. In his study, Gragert noted that students who participated in international collaborative e-learning projects showed heightened motivation in class, improved reading and writing skills, and enhanced engagement. Adams & Carfagna (2006) argues that cross-cultural deliberation through Web 2.0 technologies helps to break down stereotypical notions regarding cultures other than one's own.

Financial literacy

Financial literacy speaks to the set of skills individuals need to make informed economic decisions. Research indicates that there is considerable deficiency in financial literacy among students and adults in the United States. Findings from the Jump\$tart Coalition's biennial financial literacy tests of high school seniors in the contiguous United States show that students correctly answered 50 percent of the questions in 2002 (Jump\$tart Coalition, 2002). Similarly, the Institute of Certified Financial Planners, in a survey of Certified Financial Planners (CFP) found that financial literacy is a major problem when it comes to making individual financial decisions. Other studies find that low-income consumers, those with less education, and African Americans and Hispanics also tend to have below-average financial literacy scores.

In recent years, supporters of financial education, defined as knowledge that helps people make sound, informed financial decisions (Hopley, 2003), has been reinforced by the findings of studies that show that financial literacy training has had a positive impact on financial knowledge (Hilgert, Hogarth, & Beverly, 2003; Danes, Huddleston-Casas, & Boyce, 1999; Barrese, Garner, & Thrower, 1998). Braunstein & Welch (2002) argue, however, that an increase in financial knowledge does not necessarily translate into improved financial behavior. Instead, they contend that causality may be reversed since people may gain knowledge as they save and accumulate wealth, or there may be a third influence, namely, family experiences and economic socialization, that affects both knowledge and behavior. Further examination of the relationship between the nature of economic socialization and financial literacy is much needed.

An emergent body of research suggests that poor job attendance and performance may be linked more closely to financial distress than to demographics (e.g., age, gender, and/or income) (Braunstein & Welch, 2002; Mandell, 1997). Financial education has been shown not only to enhance students' knowledge levels, but also to have a lasting positive impact on their financial behaviors. As schools work to prepare graduates to be effective workers, financial competency (i.e., managing money, understanding banking, using credit wisely, understanding taxes and insurance, understanding investing and homeownership, and understanding the implications of consumer fraud and identity theft) is an important curricular objective to consider.

Health literacy

The emphasis on health literacy addresses the need for individuals to be able to access and use high quality information to make health-related decisions. This includes a working knowledge of ways to access health information and services and a working knowledge of preventative health measures.

Safeer & Keenan (2005) argue that inadequate health literacy can result in "difficulty accessing health care, following instructions from a physician, and taking medication properly. Berkman et. al. (2004) published a report on literacy and health outcomes that

was requested by the American Medical Association and funded by the AHRQ. This report addresses two key questions: Are literacy skills related to: (a) Use of health care services? (b) Health outcomes? (c) Costs of health care? (d) Disparities in health outcomes or health care service use according to race, ethnicity, culture, or age? For individuals with low literacy skills, what are effective interventions to: (a) Improve use of health care services? (b) Improve health outcomes? (c) Affect the costs of health care? (d) Improve health outcomes and/or health care service use among different racial, ethnic, cultural, or age groups? In 2003, the National Center for Education Statistics published *The Health Literacy of America's Adults: Results from the 2003 National Assessment of Adult Literacy*. This represented the first release of the National Assessment of Adult Literacy (NAAL) health literacy results. The results are based on assessment tasks designed specifically to measure the health literacy of adults living in the United States. For the purposes of this study, health literacy was reported using four performance levels: Below Basic, Basic, Intermediate, and Proficient. The majority of adults (53 percent) had Intermediate health literacy. About 22 percent had Basic and 14 percent had Below Basic health literacy. Relationships between health literacy and background variables (such as educational attainment, age, race/ethnicity, where adults get information about health issues, and health insurance coverage) were also examined and reported (NCES, 2003).

The U.S. Department of Health and Human Services Office of Disease Prevention and Health Promotion's *Quick Guide to Health Literacy* provides a basic overview of key health literacy concepts and techniques for improving health literacy through communication, navigation, knowledge-building, and advocacy. It also provides the information for teachers and administrators to become effective advocates for improved health literacy.

Environmental literacy

In January 2003, the National Science Foundation released a report of its Advisory Committee for Environmental Research and Education. The Committee found that “in the coming decades, the public will more frequently be called upon to understand complex environmental issues, assess risk, evaluate proposed environmental plans and understand how individual decisions affect the environment at local and global scales.” The authors argued that environmentally literate individuals at the start of the 21st century will need to be able to understand and discuss both man-made and natural environmental issues and propose or debate alternative solutions to these problems. Two years later, the National Environmental Education & Training Foundation, concluded in a national survey, *Environmental Literacy in America 2005*, that “while the simplest forms of environmental knowledge are widespread, public comprehension of more complex environmental subjects is very limited.”

Environmental literacy, in 2010, for the first time, has been included in the U.S. Department of Education budget. In response to this Obama administration initiative, Senator Jack Reed responded, “This budget takes an important step toward boosting environmental education in the classroom and giving more kids the opportunity to get out and learn about the natural world around them. Environmental education can help raise student achievement in other core subjects like math and science. This is a smart investment in our children's future and the future of our planet.”

David Orr, describes the need for and debate over environmental literacy in his book *Ecological Literacy*:

“The crisis of sustainability and the problems of education are in large measure a crisis of knowledge. But is the problem as is commonly believed, that we do not know enough? Or that we know too much? or that we do not enough about some things and too much about other things? Or is it that our scientific methods are in some ways flawed? Is it that we have forgotten things we need to remember? Or is it that we have forgotten other ways of knowing that lie in the realm of vision, intuition,

revelation, empathy, or even common sense? Such questions are not asked often enough.....” [Orr 155]

Orr cites Garrett Hardin’s definition of ecological literacy as “the ability to ask ‘What then?’” Hardin also cites the ability to read and calculate (literacy and numeracy), ecological literacy (the intimate knowledge of our landscapes, and an affinity for the living world). Orr, states that teachers need to both present the environmental issues in terms of systems and in an interdisciplinary fashion. This approach does not allow for the simplification of problems to a level where their connections to the context (i.e., land, water, environment, sense of place) are lost. Orr faults analytical modes of teaching that abstract problems from the context in the perceived interest of clarity and simplicity. He believes that this clarity is deceptive, because, devoid of context--and hence apparent relevance--the ideas do not stay with the students – they are not made relevant and connected to their daily lived life (Orr, 1992).

Stephen Schneider (1997) argues that we should not expect students to gain a detailed knowledge about the content of all environmentally relevant disciplines. Instead, he proposes that students should be taught how to ask three questions to teachers/experts that include “what can happen,” “what are the odds,” and “how do you know.” He argues that students do not need to know the technical aspects of opposing views, but they should have the skill to evaluate the credibility of processes and arguments. Schneider (1997) defines environmental literacy as the capability for a contextual and detailed understanding of an environmental problem in order to enable analysis, synthesis, evaluation, and ultimately sound and informed decision-making at a citizen’s level. This means that “environmentally literate” students will have the knowledge, tools, and sensitivity to properly address environmental problems, and to conscientiously include the environment as one of the considerations in their work and daily living.

Environmental literacy is about practices, activities, and feelings grounded in familiarity and sound knowledge (Orr, 1992; Schneider, 1997). Just as reading becomes second nature to those who are literate, interpreting and acting for the environment becomes second nature to the environmentally literate citizen. Environmental literacy provides students with the ability to understand and utilize the language of the environment, and respond to its grammar, literature, and rhetoric. It involves understanding the underlying scientific principles, value systems, and the cultural, aesthetic, ethical and emotional responses that the environment invokes.

In the edited work, *Teaching Environmental Literacy: Across Campus and Across the Curriculum* (2009) contributing scientists, policy-makers, artists, and historians, as well as experts in law, economics, and language argue that environmental issues are profoundly entwined with all aspects of society and should not be limited to a few science or science policy classrooms. They argue that environmental literacy needs to be taught across the curriculum (Reynolds, Brondizio, & Robinson, 2009).

In 2008, The National Science Teachers Association published *Resources for Environmental Literacy: Five Teaching Modules for Middle and High School Teachers*. This resource collection focuses on biodiversity, genetically modified foods, earthquakes, volcanoes, tsunamis, and global climate change. The authors state that the resource materials are designed to build skills in critical thinking and analytical reasoning about complex issues. Likewise, Emma Wood Rous, in her 2000 text, *Literature and the Land: Reading and Writing for Environmental Literacy, 7-12*, provides pedagogical techniques and sample interdisciplinary lesson plans that support environmental literacy.

Visual literacy

The graphic user interface of the internet and the convergence of voice, video, and data into a common digital format have increased the use of visual imagery dramatically. Advances such

as smart phones, digital cameras, graphics packages, streaming video, and common imagery standards, allow for the use of visual imagery to communicate ideas.

There is conflicting evidence regarding whether younger and non-traditional learners prefer image-based over textual content for learning. Many authors (Burmark, 2002; Riddle, 2009; Frey & Fisher, 2008; Elkins, 2007) argue that students need good visualization skills to be able to decipher, interpret, detect patterns, and communicate using imagery. In *Visual Literacy: Learn to See, See to Learn*, author Lynell Burmark claims that teaching visual literacy can enhance student learning in K-12 classrooms and also improve students' options in the workplace. Burmark argues that with access to print materials and internet sites, an image-rich curriculum can reach more students and teach them more quickly and meaningfully than traditional written student reports and text-based, verbal instruction (Burmark, 2002). Some authors have cited a demand for textual content, but after further investigation, the preference for textual content reflected low levels of access to web-based content (Riddle, 2009).

21st Century Critical Learning and Innovation Skills

Communication and collaboration

Learning is a fundamentally social activity—whether in schools, workplaces, or other environments. The communication and collaboration skill sets refer to the ability of individuals to communicate clearly, using oral, written, and non-verbal languages, and collaborate effectively and responsibly with diverse populations. In the area of communication skills, Eisenkraft (2009) argues that the growing diversity of the U.S. student population poses new communication challenges. Eisenkraft provides the example of the ways in which earth science and physics textbooks often refer to ice on glaciers or waves on a beach, yet many students across the country have never actually been to a mountain or to the beach. Similarly, chemistry books, when discussing the concept of balancing a chemical equation, often suggest that it is similar to baking bread, in which one combines certain amounts of various ingredients. Most students today purchase bread and are unfamiliar with baking, Eisenkraft said. The world of people adding and mixing measured ingredients to make bread, he said, “is not the America we live in,” yet textbook authors assume it is when they try to communicate with students. Although communication and problem-solving skills have always been important, Eisenkraft argues, that society now demands that everyone to have these skills, not just an educated elite.

While education has focused on the fundamentals of good communication – speech, writing, and reading- the demands of social relations and global economy call for a much more diverse set of communication and collaboration skills. Trilling & Fadel (2009) argue that today's student should be able to:

Communicate Clearly

- Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions
- Use communication for a variety of purposes [e.g., to inform, instruct, motivate and persuade]
- Utilize multiple media and technologies, and know how to judge their effectiveness a priori as well as assess their impact
- Communicate effectively in diverse environments [including multi-lingual]

Collaborate with Others

- Demonstrate the ability to work effectively and respectfully with diverse teams
- Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal
- Assume shared responsibility for collaborative work, and value individual contributions made by each team member (Trilling & Fadel, 2009)

These communication and collaboration skills can be learned through a variety of methods (e.g., project-based learning, problem-based learning, and design-based learning). Research on teaching communication and collaboration skills encourages direct and mediated communication, working with others on team projects, and performance-based learning and assessment (Partnership for 21st Century Learning, 2009).

Critical thinking and problem solving

Critical thinking and problem solving skills include the ability of individuals to a) reason effectively, b) ask pointed questions and solve problems, c) analyze and evaluate alternative points of view, and d) reflect critically on decisions and processes. The P21 initiative specifically focuses on the ability of learners to: a) reason effectively, b) use systems thinking, c) make judgments and decisions, and solve problems.³ Trilling & Fadel (2009) define critical thinking as the ability to analyze, interpret, evaluate, summarize, and synthesize information. What gives these, perhaps traditional, critical thinking skills a twist in the 21st Century is the availability of advanced technologies for accessing, manipulating, creating, analyzing, managing, storing, and communicating information.

Creativity and innovation

Just as business and industry must constantly adapt to the rapid shifts in this 21st Century, so must education. This calls for a culture of innovation informed by data, research, and critical and creative thinking. This skill set promotes creative thinking and the ability to work creatively with others.

Creativity is often described as an essential skill that can and should be fostered (Wegerif & Dawes, 2004). In a review of the interconnection between technology, learning and creativity, Loveless (2002) shows how technology allows individuals to produce high quality work in a range of media that provide opportunities for creativity.

Lack of attention to developing creativity and innovation skills is often based on a common misperception that creativity is only for artistic-types and geniuses – that creativity is something one is born with or without (Trilling & Fadel, 2009). Creativity can, Triling & Fadel argue, be nurtured by teachers and learning environments that encourage questioning, openness to new ideas, and learning from mistakes and failures. Creativity and innovation skills can be developed, like other skills, with practice and over time (Wegerif & Dawes, 2004). Though it is difficult to assess creativity, there are multiple instruments and assessments that have been designed to measure creativity in specific fields such as problem solving and design.

21st Century Life and Career Skills

The 21st century life and career skills focus on the ability of individuals to work effectively with diverse teams, be open-minded to varying ideas and values, set and meet goals, manage projects effectively, being accountable for results, demonstrate ethical practices, and be responsible to both one's self and the larger community.

³ See: Partnership for 21st Century Skills, www.21stcenturyskills.com

Leadership and responsibility

Leadership and responsibility skills include the ability of individuals to work with the interest of the larger community in mind, to inspire others by example, and to capitalize on the strengths of others to achieve a common goal.

Productivity and accountability

Skills that fall into the “productivity and accountability” category include: setting and meeting goals, prioritizing needs, managing time, working ethically, and collaborating and cooperating with colleagues and clients. The Partnership for 21st Century Skills (2009) maintains that students should be able to manage projects; set and meet goals; prioritize, plan, and manage work; produce results; multitask; work positively and ethically; be accountable for results; and collaborate and cooperate effectively with teams.

Social and cross-cultural skills

21st century social and cross-cultural skills reference the ability to work well with colleagues, present oneself professionally, and respect and embrace social and cultural differences. This ability is an essential 21st century life skill. Understanding and embracing cultural and social differences and using those differences to develop new ideas and new solutions to problems are increasingly important in social spheres as well as in the workplace (Partnership for 21st Century Skills, 2009). NCREL (2003) and the Partnership for 21st Century Skills both argue that students should be able to interact effectively with others, conduct themselves in a respectful and professional manner, work effectively in diverse teams, respond open-mindedly to different ideas and values, and be able to work effectively with people from a range of social and cultural backgrounds.

21st Century Information, Media, and Technology Skills

Media literacy

The literature on 21st century media skills argues that it is essential for individuals to be able access, understand, and analyze media and media messages. This skill set includes the ability to understand media bias and the ways in which media influences beliefs and behaviors. A media literate individual will be able to understand ethical issues surrounding the production of and use of various media forms and critique the inclusion or exclusion of opinions or factual information in media reports. 21st century media skills also refer to the ability of individuals to effectively create and deliver media products. Learners need skills in critically evaluating and creatively producing representations in a variety of media.

Information literacy

Information literacy forms the basis for lifelong learning. It is common to all disciplines, to all learning environments, and to all levels of education. It enables learners to master content and extend their investigations, become more self-directed, and assume greater control over their own learning.⁴

In order to thrive in a digital economy, students will need digital age proficiencies. It is important for the educational system to make parallel changes in order to fulfill its mission in society, namely the preparation of students for the world beyond the classroom.⁵

Information literacy is “the ability to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information” (LearnHigher, 2006). Information literacy skills include: accessing information efficiently, evaluating information

⁴ <http://www.ala.org/ala/mgrps/divs/acrl/standards/informationliteracycompetency.cfm>

⁵ 21st Century Workforce Commission National Alliance of Business

critically, and using information accurately and creatively. These literacies form the basis for lifelong learning (Andretta, 2005). They are common to all disciplines and to all learning environments. Information literate individuals are able to:

- Determine the extent of information needed
- Access the needed information effectively and efficiently
- Evaluate information and its sources critically
- Incorporate selected information into one's knowledge base
- Use information effectively to accomplish a specific purpose
- Understand the economic, legal, and social issues surrounding the use of information, and access and use information ethically and legally

Due to the increasing volume of information available, teachers, students, and other stakeholders are faced with diverse, abundant information choices. Additionally, evermore so, information comes to individuals in unfiltered formats, raising questions about its authenticity, validity, and reliability. The uncertain quality and expanding quantity of information pose large challenges for the effectual application of relevant information. The mere abundance of information will not in itself create a more informed citizenry without a related set of abilities necessary to use information effectively (LearnHigher, 2006).

Big6, an approach to teaching information and technology skills, defines information literacy as the ability to 1) define information problems and identify information needed, 2) understand information seeking strategies, 3) locate sources and find information within sources, 4) use information, 5) synthesize information, and 6) evaluate or judge information and/or processes.

The American Library Association (ALA) Presidential Committee on Information Literacy, Final Report (1989) states, "To be information literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information." In 1992, the Colorado Study (Lance, K., Welborn, L. & Hamilton-Pennell, C. (1993) found significant links between student success and school library programs. In school library programs where a School Library Media Specialist (SLMS) teaches information literacy skills and information problem solving to both teachers and students, student achievement has been bolstered, resulting in a 10 to 20% boost in reading scores, improved performance on state and local assessments (compared with performance in library impoverished schools) (Lance, K., Rodney, R., & Hamilton-Pennell, C., 2000). The findings of this study indicate that collaboration between school librarians and teachers are instrumental for student success because they foster student engagement, utilize active learning models, and employ strategies for information problem solving.

In 1998, AASL published *Information Power: Building Partnerships for Learning*, a guide for school library media specialists in helping students develop information literacy skills and thrive in a learning community not limited by time, place, age, occupation or disciplinary borders. The guidelines of *Information Power* also emphasized the importance of collaboration -- joining teachers and school librarians to identify student information needs, develop curricular content, teach to state and national education standards, and compile a variety of print and non-print resources for standards-based instruction and research (AASL, 1998).

The Best Practices Initiative Institute for Information Literacy, Association of College and Research Libraries published *Characteristics of programs of information literacy that illustrate best practices: A guideline* (2003). This text offers a presentation of characteristics that represent

a metaset of elements of exemplary undergraduate information literacy programs and philosophies. Bordonaro, K. & Richardson, G. (2004) have developed and disseminated a multistep process to integrate library instruction and information literacy skills training into an undergraduate education. Their research found that scaffolding is important to support the research process and reflection is important to shape the process.

To measure information literacy, DeMars, et. al. (2003) discusses the reliability and validity of a computer-based test – the Information Seeking Skills Test (ISST) to measure students’ ability to find and evaluate information. The Educational Testing Service (ETS) has also introduced the ICT Literacy Assessment, designed to measure students’ abilities to find, use, manage, evaluate, and convey information efficiently and effectively.

Grassian (2004) argues that incorporating information literacy goals, standards, and benchmarks throughout the curriculum is the best approach to help students learn how to find, evaluate, make efficient use of, and cite electronic materials responsibly. Schools and school libraries with highly trained staff can act as a catalyst for the incorporation of information literacy standards and increased student achievement and lifelong learning. Effective school librarians, in collaboration with the classroom teacher, can positively impact the ability of all students the ability to identify information needs, seek out resources to meet those needs, and then analyze, synthesize, evaluate, and communicate the resulting knowledge (Lance, K., Rodney, R., & Hamilton-Pennell, C., 2000, Association of College and Research Libraries, 2000, Andretta, 2005).

Technological literacy

The use of social media – from blogging to on-line social networking to creation of all kinds of digital material is central to many teenagers; lives.⁶

21st century learning initiatives, informed by emergent research on how people best learn, leverage emerging technologies (e.g., computers, smart phones, and Web 2.0 tools) and embraces the collaborative, participatory learning made possible through Web 2.0.

Web 2.0 technology enables users to produce and share content in new ways and in real-time: user-generated content creation and ‘remixing’ (Caruso, J.B. & Kvavik, R.B., 2005; Lessig, 2008) become creative and engaging practices that challenge the traditional relationships between teachers and students in providing information and content for learning.

E-learning, defined by (Lamb & Callison, 2005) is the accessing of information, instruction, and/or interaction through the Internet or Intranet using instructional materials and tools such as web-based resources, e-mail, discussion boards, blogs, chat or video. In 2008, the State of Hawai‘i’s House of Representatives passed legislation mandating that the Hawai‘i Department of Education increase e-learning opportunities for students by furthering the development of online programs (State of Hawai‘i House of Representatives, 2008).

Downes (2005), Anderson (2007) and Walton et. al. (2007) argue that learners’ familiarity with web 2.0 technologies opens up a new space for and style of learning. This new style of learning focuses on collaborative knowledge building, shared assets, problem solving, and the breakdown of distinctions between knowledge and communication (e.g., the production and utilization of podcasts, blogs, videos, and interactive tutorials).

Watson, Gemin, & Ryan (2008) argue that e-learning will transform all forms of education and learning in the 21st century. Ellis (2005) argues that a commitment to teaching 21st century skills will enable educational leaders to a) improve teaching an course quality, b) move to performance and competence based modes of learning, c) ensure that every student is college or work ready, and d) enable educators to be more flexible and creative in the ways

⁶ Pew Internet & American Life Project, “Teens and Social Media” December 19, 2007.

they assist and engage students with learning disabilities and students that are needing a more challenging curriculum.

Collaborative, computer-based learning environments can work to stimulate student learning and the process of inquiry (Wasson et al., 2003; Laurillard, 2009). McFarlane (2001) notes, “It seems that use of ICT can impact favorably on a range of attributes considered desirable in an effective learner: problem-solving capability; critical thinking skill; information-handling ability” (p. 230).

In supporting digital and learning literacies, support staff and faculty should work to: design flexible learning opportunities, situate those learning opportunities, where possible and appropriate, in authentic contexts, continually review how technologies are integrated into the curriculum, support students to use their own technologies and to develop effective strategies for learning with technology, use assessment and feedback to encourage innovation in learners’ approaches to study, reward exploration as a process, empowering students to navigate increasingly complex learning landscapes, and support student self-assessment and review.

Game-Based Learning

Research shows that learning content through virtual environments enhances student learning. Simulation games in online “virtual” environments can be influential learning tools. Such games give students a chance to take on new identities and sink, virtually, into situations in which they can apply knowledge in ways not possible in most students’ real lives. The choices a player makes within a virtual simulation game transform the virtual environment, which give students something rare: a world in which their personal actions dramatically alter events (Metri Group 2006).

Simulation environment and modern video games are often difficult to master. They require students/players to be skilled at pattern recognition, sense-making of unfamiliar environments, and multitasking (Metiri Group, 2006; Carroll, 2007). They also often require the user to be a risk-taker. In game play, players immerse themselves in complex, information rich, dynamic realms where they must sense, infer, decide and act quickly. When they fail, they must repeat the task, learning from that failure and working towards mastery (Carroll, 2007).

McFarlane (2001) argues that the gaming generation is bottom-line oriented. He states that students often want metrics and want their performance measured – if the form of measurement is meaningful to them. Game designers at top gaming companies work to design good (engaging) learning environments; environments that are create new challenges for players that are neither too difficult nor too simple. As the players improve, the gamers expect the challenges to become more demanding--but at just the right pace. The skills needed for gaming reflect many of the 21st century skill sets discussed in this review. Translating this into classroom pedagogy is critical for reaching students who learn well in this type of environment.

Support Systems

The vision, mission, and values of educational agencies are crucial for framing an agenda for 21st century learning work. Once these statements or goals have been developed, education leaders can then align them with their strategic plans, strategies, and accountability systems. This section of the review discusses two support systems for 21st century learning skills: *learning environments* and *professional development*.

21st Century Learning Environments

The Partnership for 21st Century Skills (P21) defines 21st century learning environments as “the support systems that organize the condition in which humans learn best – systems that

accommodate the unique learning needs of every learner and support the positive human relationships needed for effective learning” (p.3). Thus, 21st century learning environments are the physical spaces, tools, and learning communities that encourage and enable students and educators to attain the skill-sets that the 21st century requires. This includes a number of important elements such as the physical environment, a school’s daily operations – including scheduling, courses and available activities, technology infrastructure, school culture, community involvements, and school leadership. P21 states that 21st century learning environments are *system of systems* that:

1. “Creates learning practices, human support and physical environments that will support the teaching and learning of 21st century skill outcomes
2. Supports professional learning communities that enable educators to collaborate, share best practices, and integrate 21st century skills into classroom practice
3. Enables students to learn in relevant, real world 21st century contexts (e.g., through project-based or other applied work)
4. Allows equitable access to quality learning tools, technologies, and resources
5. Provides 21st century architectural and interior designs for group, team, and individual learning.
6. Supports expanded community and international involvement in learning, both face-to-face and online.”⁷

Cornell (2002) argues that 21st century learning needs to take place in contexts that “promote interaction and a sense of community [that] enable formal and informal learning.” Similarly, Sack-Man, the author of *Building the Perfect School* (2007) and Susan Black, author of *Achievement by Design* (2007) both argue that the qualities of *where* we learn affect the quality of *how* we learn. Sack-Min (2009) encouraged school districts and planners to “design for flexibility.” At learning styles continue to change, learning spaces will need to be able to adapt. To achieve this flexibility, architects are designing classrooms with moveable furniture and walls that can easily be reconfigured.

Konings (2007) surveyed tenth-grade students and teachers about their desired learning environments. In his findings, he noted that educator’s perceptions of what learning environments should be like were vastly different from students’ preferences (Konings, 2007). He concluded that when students had input into the design of their environments, they felt more successful and invested in their learning. Similarly, when a first-year high school teacher asked students to list factors that would make them more successful in learning, the students did not ask for more time to complete assignments and similar supports. Students stated that their learning would be best furthered in an environment that they designed and in which they could pursue their personal interests in addition to their schoolwork (Mitsoni 2006; Brown, C., Murphy, T.J., Nanny, M., 2003).

Best Practices for Implementing 21st Century Skills

How do we best prepare our students for a future of work that does not yet exist, careers that have not yet been created, and an economy that prizes creativity and innovation? Emerging research encourages teachers and other educational stakeholders to a) focus on real-world problems and processes, b) support inquiry-based learning experiences, c) provide opportunities for collaborative project approaches to learning, d) and focus on teaching students how to learn (above “what” to learn). Linda Darling-Hammond, in her recent work, *Powerful Learning – What we Know about Teaching for Learning*, provides a meta-review of accumulated research on project-based learning, problem-based learning, and design-based learning.

⁷ Partnership for 21st Century Learning, http://www.p21.org/documents/le_white_paper-1.pdf (p. 5)

Project-Based Learning

The research on project-based learning has illustrated significant benefits for students who work collaboratively on learning activities in contrast with students who work alone. An additional research finding was that students who have difficulties with traditional classroom/textbook/lecture learning benefit significantly from a project-based learning experience which more closely aligns with their learning style and preference (Darling-Hammond et. al., 2008). Best practices for project-based learning (Thomas, 2007) include a) tying project outcomes to curriculum and goals, b) employing questions or posing questions to introduce students to central concepts and principles, c) student responsibility for designing and managing much of their learning, and d) basing projects on authentic, real-world problems and questions that students care about (Thomas, 2007).

Problem-Based Learning

Problem-based learning, a form of project-based learning, allows teachers to develop, and students to focus, on complex, real-world problems using a case study approach. When students work in small groups to research and pose solutions to problems, both a collaborative and multifaceted environment is created. Within this environment, students can explore multiple solutions and best practices for tackling projects. Studies and meta-studies of research that has focuses on problem-based learning have found that for factual learning, problem-based learning has similar impacts to traditional learning methods, but that problem-based learning does exceed traditional learning methods when skills such as critical thinking, communications, collaboration, and applying knowledge to real world situations are measured (Darling-Hammond et. al., 2008).

Design-Based Learning

Design-based learning has been shown to have the most impact in the areas of math and science (Darling-Hammond et. al., 2008). Popular design-based learning activities include robotics competitions wherein student teams design, build and then pilot their robots in a series of competitive challenges. Research has found that students who participate in learning by design projects have a more systematic understanding of a system's parts and functions that control groups (Hmelo, Holton, & Kolodner, 2000).

Obstacles to collaborative and inquiry-based learning include a) the ability of teachers to choose activities and/or topics that benefit from differing viewpoints and lived-experiences of students, b) the need to strategically select students who will work well together and set ground rules so that all students may have the opportunity to participate, and c) encouraging multiple strategies to encourage deeper discussion and better learning for all group/team members.

How might we best prepare our teachers to support student acquisition of 21st century skills?

Teachers of 21st century skills will need to be experts and have expertise in teaching the same 21st century skills that they are encouraging their students to excel in. Teachers will have to take conscious efforts to communicate and collaborate with each other and with students; become flexible with managing new classroom dynamics; be able to support and enable independent student learning, and be willing to adapt their teaching styles to accommodate new pedagogical approaches to learning. For the above to occur, teachers will need professional development opportunities and strong support systems.

The professional development of our nation's workforce must be a top priority and teachers will need to become 21st century learners themselves. Developing successful 21st century teacher education programs and initiatives requires flexible and coordinated leadership. All of those involved in education need to be able to reflect and learn from each other's experiences as new methods and processes are piloted and implemented.

21st Century Assessment

Assessment of student skills and knowledge is essential to guide learning and provide feedback to students, teachers, and parents on how well students are achieving set standards. In moving to design assessments to measure 21st century skills, the NEA states that a comprehensive approach to assessment, involving measurements that assess 21st century skills, is necessary to ensure accountability of schools in the 21st century. The P21 initiative recommends:

- Assessment systems be based on multiple measures of students' abilities that include 21st century skills.
- Assessment of 21st century skills should be listed as an integral part of the academic assessments in math, reading and science.
- Reporting requirements should be expanded to include information on whether the student is achieving 21st century skills.
- Funds should be made available for pilot projects that examine the use of assessments that measure 21st century skill competencies in high school students.
- Funds should be allocated for an international benchmarking project that allows U.S. high school students to be compared to their international peers in terms of competencies in 21st century skills.⁸

Learning.com's 21st Century Skills Assessment instrument measures and is aligned to the ISTE NETS-S 2007 standards. The assessment is aligned to all 24 standards in six strands: creativity and innovation, communication and collaboration, research and information literacy, critical thinking, problem solving and decision-making, and technology operations.

Elena Silva (2009), an advocate for the meaningful assessment of 21st century learning states that school systems should be investing in curriculum and professional development, but not forgetting to invest in rethinking traditional forms of student assessment. Silvia argues that the potential exists today to produce assessments that measure thinking skills and are also reliable, valid and comparable between students and schools—elements integral to efforts to ensure the accountability and equity mandated both locally and federally. Silvia states that efforts to assess these 21st century skills are still in their early years and that school districts will have difficulties in developing the ability to deliver these assessments at scale.

According to Silva, a central challenge is the cost of assessment design and development. Although higher-level skills like critical thinking and analysis can be assessed with well-designed multiple-choice tests, a 21st century assessment instrument would need to move past multiple-choice testing and include measures that support greater creativity, show how students arrived at answers, and even allow for collaboration. Such measures, however, cost more money than state and federal policymakers have traditionally been willing to commit to assessment design and delivery. Silva argues that to move from traditional forms of assessment, we would need a coordinated public and private strategy (including intensive research and development) for assessment systems to change.

Cramer (2009) in his article, "Digital Portfolios: Documenting Student Growth" discusses the digital portfolio process as a 21st century form of assessment. Prior to beginning the portfolio process, students are trained in basic web design to build and maintain digital portfolios. Cramer argues that this process is not only useful for classroom instruction, but that these skills equip students with tools they will most likely use in college and the professional world. Cramer sees the digital portfolio development as an opportunity to provide students the skills necessary to be independent and use their own knowledge to present themselves and

⁸ See: www.21stcenturyskills.com

their work to others. Cramer claims that the digital portfolio process provides the students with two sets of skills: self-presentation and technology know-how. “Through creating and maintaining digital portfolios, students are engaged in a process of synthesizing and presenting their academic work and growth in an increasingly professional manner. These skills associated with web design competence are an important way we give the students the technological and professional resources that they will draw upon throughout their lives.”

Cramer states that digital portfolios have had a positive impact on student achievement across the curriculum. He believes that the public aspect of high stakes of the digital portfolios is a powerful motivator. Teachers, parents, as well as members of the community are able to access students’ work and students are able to share their work with possible employers or internship providers.

21st Century Professional Development

Students may not master 21st century skills without the support of teachers who are well trained and supported in this type of instruction. 21st century professional development opportunities prepare educators to integrate 21st century skills into learning standards and classroom instruction. The P21 initiative recommends that:

- Funds be allocated for professional development of 21st century skills and establishment of 21st Century Skills Teaching Academies.
- Higher education institutions be supported in identifying and disseminating the best practices for teaching and assessing 21st century skills.
- Higher education institutions be encouraged to ensure that all pre-service teachers graduate prepared to employ 21st century teaching and assessment strategies in their classrooms.⁹

Trilling & Fadel (2009) argue that successful professional development programs tend to be:

- Experimental, engaging teachers in the concrete tasks of designing, implementing, managing, and assessing learning activities and projects, and observing other teachers methods and skills
- Grounded in teachers’ own questions, problems, and issues as well as what evidence-based research has to offer
- Collaborative, building upon the collective experiences and expertise of other teachers and the wider community of educators
- Connected to a teacher’s own work with students and the teacher’s curriculum
- Sustained and intensive, with ongoing support by modeling, coaching, mentoring, and collaborative problem solving with other teachers
- Integrated with other aspects of school reform and transformation.

Bybee & Starkweather (2006) argue that teacher and support staff professional development used to focus mainly on how to use technology, and that today, the focus now is on instructional strategies and needs. The authors state that technology education professional development needs to focus on how to use technology to improve student achievement and how to teach a standards-based lesson infused with technology. The P21 initiative states that, “all professional development efforts should exist as part of an aligned system of teaching and learning that includes 21st century skills standards, curriculum, instruction, and

⁹ See: www.21stcenturyskills.com

assessments” (p.2). Bybee & Starkweather, in the same vein as Cradler et. al. (2002), encourage administrators and education stakeholders to recognize the technology-related professional development to be ongoing. The author’s encourage school systems to move away from short-term learning experiences and towards on-going support systems.

Research has shown that professional development sessions must be followed up with regular classroom visits or professional development workshops to provide support and mentoring (Guskey, 2002; Cradler et. al, 2002). The authors contend that classroom visits help teachers translate what they learn in professional development sessions into actual classroom practice. Guskey claims that this is the piece that is usually missing in most professional development programs. Another key element of sustained professional development is collaboration. In the Summer 2003 issue of the *Journal of Staff Development*, Stephanie Hirsh states, “To meet [the NSDC goal of having all teachers experience high-quality professional learning], every teacher must be a part of a learning team—a team of teachers who meet almost every day about practical ways to improve teaching and learning.”

In working to build professional development learning communities, P21 recommends working with the most capable and energetic people first. Build their capacities and provide opportunities for these teachers to model both their teaching and curriculum. P21 then recommends having the early group of teachers who have began the professional development be placed within already existing learning communities. Technology (including online learning and mentoring) can be an important tool to help with collegiality and sustained learning (Burns, 2002). P21 cites the My eCoach model, developed by Barbara Bray. This resource is based on a “coach the mentors” approach, in which teachers collaborate online to develop inquiry-based units and curriculum tools supported by virtual coaches who are being mentored by the My eCoach team.

The above discussion directed attention to the need to reshape teacher practice through developing 21st century skills literacies. While recognizing the importance of 21st century professional development, some researchers remind us that this potential, or need, is often unrealized due to the reality that educators are often not prepared or able to harness 21st century technologies and the possibilities they enable (Burns, 2002). Guskey (2002) argues that to teach 21st century skills, teachers need to be provided with on-going professional development that is supportive and allows teachers to question, practice, and explore emerging technologies. Guskey states that before a teacher can effectively teach and encourage 21st century learning, they must have the interest, motivation, and support to do so.

Failure to implement 21st century pedagogy and effective technology integrations is often attributed to educators being unprepared for the changes demanded by and formed by “technology infusion (Charp, 2000; Rakes & Casey, 2002). Barnett (2003) states that too often, teachers are eager to infuse Web 2.0 technologies, but lack the skills and technological and pedagogical knowledge to effectively introduce these technologies into the classroom. Rakes & Casey (2002) caution that if educators are pushed into adopting Web 2.0 and other multimedia technologies without support and clear understanding of purpose, then transformation of both teaching practice and student learning will be unlikely. The focus of these authors reiterates the above insistence of the importance of focusing on on-going educator support and development (Charp 2000; Rakes & Casey, 2002, Burns, 2002). Thus teachers can begin with supplemental use of 21st century skills and move to full integration.

The P21 research brief on 21st century professional development provides both “guiding recommendations” and “promising directions.” The eleven guiding recommendations are 1) develop intensive teacher professional development programs that focus intentionally on 21st century skills instruction, 2) integrate 21st century skills into teacher preparation and certification, 3) build capacity, 4) develop district leadership teams to infuse 21st century skills throughout the school district, 5) invest in information communications technologies

(ICT), 6) develop professional learning communities around specific 21st century skills, 7) train administrators around how to lead 21st century skills initiatives, 8) offer professional development to state departments of education staff, 9) engage colleges of education for 21st century skills leadership, 10) integrate 21st century skills into teaching standards, and 11) leverage the reach of the Web to distribute resources.¹⁰ For each of the guiding recommendations, the P21 group provides corresponding models and/or best practices.

Conclusion

This review of the literature about 21st century skills suggests that educational decision makers need to acknowledge that the academics of yesterday are not sufficient for today (NCREL, 2003). The current state of research on the impact of 21st century skill acquisition of student achievement is steadily expanding, with current research seeking to document the longitudinal effects of the acquisition of 21st century skills on student success and workforce development.

Demand for 21st Century Skills

A survey of manufacturers conducted by Deloitte Development (2005) found that 80 percent reported shortages of skilled employees across all occupations in their firms. In terms of the kinds of skills needed, the respondents most frequently cited basic employability skills, including attendance, timeliness, and work ethic; problem-solving skills; ability to collaborate; and reading, writing, and communication skills. These skills are quite similar to the central 21st century skills identified above. A 2009 study by Andrew, DeRocco, & Taylor found that manufacturers view innovation as integral to company growth, competitiveness, and shareholder value. Deloitte Development survey respondents indicated that the education and skills of the workforce are the single most critical element of successful innovation, while also reporting a lack of skilled workers. Andrew, DeRocco & Taylor argue that companies whose workforces lack 21st century skills are at a disadvantage to compete globally and have difficulty in dealing with such challenges as the convergence of technology and manufacturing and the need to quickly move new products and services to market. The authors conclude that it is imperative to better educate the workforce not only in science, but also in 21st century skills.

In 2006, Caser Lotto & Barrington conducted a survey of 400 business executives and managers, asking respondents to rank the relative importance of 20 skills and fields of knowledge to the job success of new workforce entrants at three education levels: high school, two-year college or technical school, and four-year college. The respondents ranked three skills among the top five most important skills and fields of knowledge for all three groups of new entrants: (1) professionalism/work ethic, (2) teamwork/collaboration, and (3) oral communication. In comparison, science knowledge was ranked 17th in importance in the list of 20 skills and fields of knowledge for high school graduates and 16th in importance for two- and four-year college graduates. When asked which skills and knowledge fields would become even more important over the following five years, critical thinking/problem solving, information technology application, teamwork/collaboration, and creativity/innovation were at the top of the list, and science knowledge was ranked 16th in growing importance.

Emerging Trends

Given the economic and political challenges of our times, students will need plenty of practice developing and fine-tuning their 21st century skills to become better problem solvers and more creative innovators. Current research on 21st century skills and skill acquisition is focusing on social and cross-cultural interaction, developing and piloting programs and curriculum for students to develop leadership and responsibility skills, and the development of a body of research that can support the preliminary research that illustrates the impact of 21st century learning skills on student achievement and workforce development.

¹⁰ See: www.p21.org/documents/p21-stateimp_professional_development.pdf

Guiding Recommendations

The Partnership for 21st Century Skills (2009) argues that all 21st century initiatives must focus on both core academic subject mastery and 21st century skills outcomes. In providing recommendations for the implementation of 21st century initiatives, both the Partnership and NCREL strongly suggest a) developing teacher professional development programs and workshops that focus specifically on 21st century skills instruction, b) integrating 21st century skills training into teacher preparation and certification programs, c) developing on-line professional learning communities to provide support for teachers, d) invest in a ICT and provide professional development opportunities for both ICT staff and teachers, e) develop professional development opportunities for the faculty of colleges of education that address 21st century skills, and f) integrate 21st century skills into both student and teacher standards.

In conclusion, there is much work to be done to incorporate 21st century learning standards and implement curriculum designed to teach to such standards. To adequately prepare – to become college and work ready – students and teachers must learn and share content within the context of 21st century skills. To do this, they will need the support of education policy makers, business, community and family.

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Online Resources:

ACRL Information Literacy

<http://www.ala.org/ala/acrl/acrlissues/acrlinfolit/informationliteracy.cfm>

Apple Learning Interchange

<http://ali.apple.com>

Big 6: An Information Problem-Solving Process

<http://www.big6.com/>

Campaign for Environmental Literacy:

<http://www.fundee.org>

Center for Digital Story Telling

<http://www.storycenter.org>

Classroom 2.0 (a social network)

<http://classroom20.ning.com>

Educational Podcasting Network

<http://www.epnweb.org>

Educational Wikis (a collection of educational wikis)

<http://educationalwikis.wikispaces.com>

Environmental Literacy Council:

<http://www.enviroliteracy.org>

JakesOnline! - Digital Storytelling

<http://www.jakesonline.org/storytelling.htm>

NCREL & Metiri Group. (2003). enGauge 21st century skills: literacy in the digital age.

<http://www.ncrel.org/engauge/skills/skills.htm>

Partnership for 21st Century Skills

<http://www.21stcenturyskills.org/>

Rubistar (for creating rubrics)

<http://rubistar.4teachers.org/>

Support Blogging (a collection of educational blogs)

<http://supportblogging.com/Links+to+School+Bloggers>

A comprehensive list of references is available at www.21stcenturyskills.org.

Appendix A. Central Themes/Theories and Corresponding Authors

Theme or Theory	Author(s)
<u>Twenty-First Century Standards</u>	Partnership for 21 st Century Skills, 2009; NCREL, 2003
<u>Core academic subject mastery:</u> All 21st century skills can and should be taught in the context of core academic subjects.	Partnership for 21 st Century Skills, 2009; NCREL, 2003. Sawchuck, 2009
<u>Economy/workforce development:</u> emerging research suggests that a set of broad “21st century skills”—such as adaptability, complex communication skills, and the ability to solve non-routine problems—are valuable across a wide range of jobs in the national economy. These authors conduct research on the association between a 21st Century education system and economic success	Levy & Murnane, 2004; Partnership for 21 st Century Skills, 2009; Sawchuk, 2009; U.S. Department of Labor, 2000.
<u>Multimodality</u>	Kress, 2006; Silva, 2008
<u>Professional learning communities</u> can support teachers, administrators and policy-makers in teaching and supporting the instruction of 21 st century skills.	Partnership for 21 st Century Skills, 2009; Sawchuk, 2009
<u>Project-based learning</u> supports the teaching of 21st Century skills and may positively impact student learning.	Partnership for 21 st Century Skills, 2009; Pearlman, 2006; Sawchuk, 2009; Wenglinsky, 2004
<u>Standards and assessment:</u> New approaches/methods are needed to effectively teach and assess 21 st Century skills. How to assess 21 st Century skills?	Silva, 2008; Walser, 2008
<u>Student academic performance:</u> Research indicates that students who are taught 21st Century skills perform better.	Sawchuk, 2009; Wenglinsky, 2004
<u>Student academic performance.</u> Some authors argue that by focusing on 21 st Century Skills, attention is detracted from learning core content knowledge.	Mathews, 2009; Ravitch, 2009; Rotherham, 2008
21 st century skills should be integrated into <u>teacher learning standards</u> to ensure that teachers are able to teach and assess critical thinking and problem solving skills.	NCREL, 2003, Partnership for 21 st Century Skills, 2009; Trilling & Fadesl, 2009.
<u>Teacher professional development:</u> Research indicates that many teachers do not use technology or do not use it effectively. Graduates of teacher education programs frequently possess basic technology skills, but may not understand how to apply or integrate technology into classroom practice in meaningful ways.	Charp, 2003; Cuban, 2001; Partnership for 21 st Century Skills, 2009; Rakes, Fields & Cox, 2006
The use of <u>Web 2.0 technology</u> in K-12 education supports a pedagogical shift in education towards a constructivist paradigm by providing students with tools/supports for collaboration, easier access to information, and the development of higher-order thinking.	Kent & McNergney, 1999; Waxman, H. C., Connell, M. L., & Gray, J. 2002; Greenhow, C., Robelia, B., & Hughes, J., 2009.
<u>Use of mobile technologies</u> may enhance children’s learning; mobile technology can be used to keep students involved and motivated	Carly Shuler, Ed.M., The Joan Ganz Cooney Center at Sesame Workshop (2009); Ramasubbu & Wilcox (2008); Hartnell-Young, 2005; Kharif, 2008; Partnership for 21 st Century Skills, 2009

Appendix B. Best Practices and Outcomes

Best Practice	Obstacles	Support Systems	Outcomes
Supporting collaborative inquiry	<ul style="list-style-type: none"> • Lack of commitment by from teachers and administrators • Need for teacher training 	Curriculum and Instruction Professional Development Learning Environments	Learning and Innovation Skills: Learning to Create Together <ul style="list-style-type: none"> • Learning to Learn and Innovate • Critical Thinking and Problem Solving • Communication and Collaboration • Creativity and Innovation Career and Life Skills: Work-Ready, Prepared for Life <ul style="list-style-type: none"> • Flexibility and Adaptability • Initiative and Self-Direction • Social and Cross-Cultural Interaction • Productivity and Accountability • Leadership and Responsibility Info-Savvy, Media-Fluent, Tech-Tuned <ul style="list-style-type: none"> • Information Literacy • Media Literacy • ICT Literacy New Learning Environments Cross-cultural understanding
Enabling student creativity; teaching to student creativity	<ul style="list-style-type: none"> • Lack of commitment by from teachers and administrators • Need for teacher training • Need for instructional time 	Standards and Assessments Dedicated Funding	
Teaching problem solving by (1) providing reflection time; (2) promoting listening; (3) letting students teach one another digital skills; (4) using interactive white boards; (5) building emotional literacy; (6) teaching mindfulness; and (7) telling stories.	<ul style="list-style-type: none"> • Classroom time • Need for teacher training • Cost of new technologies 		
Supporting project-based learning	<ul style="list-style-type: none"> • Need for curricular development • Need for teacher training • Need to develop new modes of assessment 		
Integrating technology into the classroom; development of digital literacy skills	<ul style="list-style-type: none"> • Need for and cost of teacher professional development • Cost of technology 		
Designing new learning environments	<ul style="list-style-type: none"> • Cost • Commitment of state educational agencies 		
Supporting the acquisition of foreign language skills through immersion. Developing an understanding of the culture the target language comes from—and some ease interacting in that culture.	<ul style="list-style-type: none"> • Difficult to fund and encourage immersion. • In classroom technologies such as digital technologies—like Skype, wikis, and asynchronous online conversation tools—allow students to connect with native speakers in other countries 		