Partners in Education Transformation

Transforming Education: *Assessing and Teaching 21st Century Skills*

Purpose of this Paper

The structure of global economy today looks very different than it did at the beginning of the 20th century, due in large part to advances in information and communications technologies (ICT). The economy of leading countries is now based more on the manufacture and delivery of information products and services than on the manufacture of material goods. Even many aspects of the manufacturing of material goods are strongly dependent on innovative uses of technologies. The start of the 21st century also has witnessed significant social trends in which people access, use, and create information and knowledge very differently than they did in previous decades, again due in many ways to the ubiquitous availability of ICT.

These trends have significant implications for education. Yet most educational systems operate much as they did at the beginning of the 20th century and ICT use is far from ubiquitous. Significant reform is needed in education, world-wide, to respond to and shape global trends in support of both economic and social development. What is learned, how it is taught, and how schools are organized must be transformed to respond to the social and economic needs of students and society as we face the challenges of the 21st century. Systemic education reform is needed that includes curriculum, pedagogy, teacher training, and school organization.

Reform is particularly needed in education assessment—how it is that education and society more generally measure the competencies and skills that are needed for productive, creative workers and citizens. Accountability is an important component of education reform. But more often than not, accountability efforts have measured what is easiest to measure, rather than what is most important. Existing models of assessment typically fail to measure the skills, knowledge, attitudes and characteristics of self-directed and collaborative learning that are increasingly important for our global economy and fast changing world. New assessments are required that measure these skills and provide information needed by students, teachers, parents, administrators, and policymakers to improve learning and support systemic education reform. To measure these skills and provide the needed information, assessments should engage students in the use of technological tools and digital resources and the application of a deep understanding of subject knowledge to solve complex, real world tasks and create new ideas, content, and knowledge.

Efforts to transform assessments have been hindered by a number of methodological and technological factors and these barriers must be addressed. In issuing this call to action to political, education, and business leaders, Cisco, Intel, and Microsoft argue for an international multi-stakeholder project that will:

- Mobilize the international educational, political, and business communities around the need and opportunity to transform educational assessment—and hence, instructional practice—and make doing so a global priority.
- Specify high-priority skills, competencies, and types of understanding that are needed to be productive and creative workers and citizens of the 21st century and turn these specifications into measurable standards and an assessment framework.
- Examine innovative ICT-enabled, classroom-based learning environments and formative assessments that address 21st century skills and draw implications for ICT-based international and national summative assessments and for reformed classroom practices aligned with assessment reform.
- Identify methodological and technological barriers to ICT-based assessment, support the specification of breakthrough solutions that are needed to measure 21st century skills, and derive implications for the scaling up of ICT-enabled classroom learning environments.
- Support the implementation of these standards and breakthrough methodologies, pilot test them in selected countries, and make recommendations for broader educational assessment reform.

This paper presents the rationale for such a project, reviews the current state of art in the assessment of 21st century skills, and identifies the current barriers and problems in developing transformational 21st century assessments. It also provides an action plan by which multiple stakeholders can work together, identify problems, share knowledge, build on current efforts, and create breakthrough solutions to reform assessment and transform education.

PROJECT RATIONALE

Major Changes in the Economy and Work

Restructured economy. Over the past four decades, there have been dramatic shifts in the global economy. One shift has been from the manufacture of goods to provision of services. Research at the UCLA Anderson School of Management documents this shift (Kamarkar & Apte, 2007; Apte, Kamarkar & Nath, in press). In every country of the world's 25 largest economies, services either account for more than 50% of the GNP or they are the largest sector in the economy. But a more significant shift has been from an economy based on material goods and services to one based on information and knowledge.

For example in the U.S., the production of material goods (such as automobiles, chemicals, and industrial equipment) and delivery of material services (such as transportation, construction, retailing) accounted for nearly 54 % of the country's economic output in 1967. By 1997, the production of information products (such as computers, books, televisions, software) and the provision of information services (financial services, broadcast services, education) accounted for 63% of the country's output. Information services alone grew from 36% to 56% of the economy during that period.

The economy of developed countries has shifted from the manufacture of goods to one based on information and knowledge.

Restructured work. The structure of companies and the nature of work have also changed. Organizational structures have become flatter, decision making has become decentralized, information is widely shared, workers form project teams, even across organizations, and work arrangements are flexible. These shifts are often associated with increased productivity and innovativeness. For example, a U.S. Census Bureau study (Black and Lynch, 2003) found significant firm-level productivity increases that were associated with changes in business practices that included reengineering, regular employee meetings, the use of self-managed teams, up-skilling of employees and the use of computers by front-line workers. A U.S. Department of Labor study (Zohgi, Mohr, & & Meyer, 2007) found a strong positive relationship between both information sharing and decentralized decision making and a company's innovativeness. Yet typical instructional practices in schools do not include collaboration, information sharing, or self-management.

Organizational structures have become flatter, decision making has become decentralized, information is widely shared, workers form project teams often across organizations, and work arrangements are flexible.

Enabled by ICT. These changes in organizational structures and practices have been enabled by the application of ICT for communication, information sharing, and simulation of business processes. Recent studies of firms (Pilat, 2004; Gera & Gu, 2004) found significant productivity gains associated with specific ways that technology is being used. The greatest benefits to a firm are realized when ICT investments are accompanied by other organizational changes, such as new strategies, new business processes and practices, and new organizational structures. Yet ICT use in schools is most often incidental and supplements traditional practices and organizational structures rather than new strategies and structures.

Require new skills. These changes in organizational structure and business practices have resulted in corresponding changes in hiring practices of companies and the skills needed by workers. A Massachusetts Institute of Technology study (Autor, Levy, & Murnane, 2003) of labor tasks in the workplace found that commencing in the 1970's, routine cognitive and manual tasks in the U.S. economy declined and non-routine analytic and interactive tasks rose. This finding was particularly pronounced for rapidly computerizing industries. The study found that as ICT is taken up by a firm,

computers ***substitute*** for workers who perform routine physical and cognitive tasks but they ***complement*** workers who perform non-routine problem solving tasks. Because repetitive, predictable tasks are readily automated, computerization of the workplace has raised demand for problem-solving and communications tasks such as responding to discrepancies, improving production processes and coordinating and managing the activities of others. The net effect is that companies in the U.S. and other developed countries (Lisbon Council, 2007) are hiring workers with a higher skill set. In the 21st century economy and society, the memorization of facts and implementation of simple procedures is less important; the ability to respond flexibly to complex problems, to communicate effectively, to manage information, to work in teams, to use technology, and to produce new knowledge is crucial. These capabilities are rarely taught in schools or measured on typical assessments.

The ability to respond flexibly to complex problems, to communicate effectively, to manage information, to work in teams, to use technology, and to produce new knowledge is crucial to economic success.

Major Changes in Society and Everyday Life

Widespread access to ICT. Access to ICT is spreading widely across the world and affecting the everyday lives of people. According to 2005 World Bank figures, a majority of households in most of the world's largest economies have immediate access to television, cell phones, and the internet. Yet ICT availability in most schools is limited and often ICT is kept in closets or dedicated laboratories.

New patterns of information use. The pervasiveness of ICT has changed the way people access information and other people, as well as the way they use information and create new knowledge. People use the internet to find jobs, look for mates, stay in touch with relatives, do their shopping, book flights, run for office, solicit donations, share photos, post videos, and maintain blogs. Studies in North America, Europe, and Asia document that large numbers of people use the internet regularly and do so to conduct online purchases, use online chat or messaging and download music or movies, play games, exchange email, conducting banking transactions, and searching for information. In the U.S., according to the Pew Internet and American Life Project, more than half of all Americans turn to the internet to find answers to common problems about health, taxes, job training, government services (Fallows, 2008). And more and more Americans are using the internet to access multimedia material and to create digital content (Rainie, 2008; Lenhart, Madden, Macgill, & Smith, 2007). In the U.K., 49% of the children between the ages of 8-17 who use computers have an online profile; 59% use social networks to make new friends (Ofcom, 2008). Students come into classrooms with new ICT skills and competencies but they are rarely drawn on in the formal curriculum nor are students able to use these skills to collaboratively solve complex, real world problems.

People use the internet to find jobs, look for mates, stay in touch with relatives, do their shopping, book flights, run for office, solicit donations, share photos, post videos, and maintain blogs.

Little Change in Education

Businesses, entire economies, and society generally have made dramatic changes over the past decades, much of it enabled by the wide-spread use of ICT. But education systems have been slow to respond. For the most part, curricula, pedagogy, school organization, and assessment are much like they were at the turn of the 20th century. While people outside of school work flexibly in teams, use a variety of digital tools and resources to solve problems and create new ideas and products, students in schools meet in structured classrooms at specified times; teachers cover the standard content by lecturing in front of the class while students listen; students work individually and reproduce this knowledge on assessments; and their use of ICT is limited. This pattern is global. A recent international survey of teachers in 23 countries in North America, Europe, Asia, Latin America, and Africa (Law, Pelgrum, & Plomp, 2008) found that the three most common pedagogical practices were having students fill out worksheets, work at the same pace and sequence, and answer tests. ICT was rarely used and the applications used most often were general office software, followed by tutorial or drill and practice software.

Around the world, the three most common pedagogical practices were having students fill out worksheets, work at the same pace and sequence, and answer tests. The use of ICT was limited.

At the same time, there are new models of technology-rich learning environments and formative assessments that engage students in collaborative problem solving and the production of creative works. Yet the use of these new models is still rare, in part because traditional assessments are inadequate to measure the outcomes of their application.

The Need to Transform Assessment

Current assessments reflect typical pedagogical and assessment practices found in classrooms but they are also a key determiner of what students learn in classrooms and how that is taught. Consequently, assessment reform is key to the transformation of the educational system as a whole. It is a "determiner" of learning in two senses. Assessment is the means by which society determines what students have learned and what they can do next. These student assessments are often "high stakes"; test scores certify student achievement, permit advancement or graduation, and determine competitive advantage in further study. High stakes assessments include the SAT, ACT, and Advanced Placement exams in the U.S., the O-Level (or GCSE) and A-Level exams in most Commonwealth countries, the Matura in much of Eastern Europe, and the Abitur in Germany, Austria, and Finland.

National assessments are used to determine the effectiveness of teachers, schools, and entire educational systems. These assessments are often also "high stakes"; student performance on tests scores is connected to rewards and punishments for schools and teachers. International assessments are often high stakes for policymakers interested in how their school systems compare with those of other countries.

Whatever the formal curriculum says, whatever teachers are taught to do in class, whatever it is that students want to learn, the paramount determiner of what is taught, how it is taught, and what is learned is what is assessed.

Students, parents, teachers, administrators, and entire schools systems respond accordingly to these high-stakes assessments and it is in this second sense that they have also come to determine what is learned. Whatever the formal curriculum says, whatever teachers are taught to do in their training, whatever it is that students want to learn, the paramount determiner of what is taught, how it is taught, and what is learned is what is assessed, particularly on high-stakes exams. These summative, high-stakes assessments that determine students' futures, establish rewards and punishments for schools and teachers, and shape classroom and instructional practices of classrooms are the focus of this call to action.

Unfortunately, these traditional assessments do not measure all the competencies and skills that are needed by the 21st century workplace and society (Pellegrino, et, al., 2004). There is a significant gap for assessments, and for the rest of the education system, between what happens in schools and what happens outside of schools (as summarized in Box 1). While people contemporary business work with others and use subject knowledge and a variety of technological tools and resources to analyze and solve complex, ill-structured problems or to create products for authentic audiences, students taking traditional exams do so without access to other people or resources and are, in the main, required to recall facts or apply simple procedures to pre-structured problems within a single school subject.

Traditional assessments do not measure the skills that are needed by the 21st century workplace and society.

BOX 1

Standardized Student Assessments	Tasks in the Outside World
Assessments are designed primarily to measure knowledge of school subjects and these are divided by disciplinary boundaries.	Subject knowledge is applied within and across disciplinary boundaries along with other skills to solve real world problems, create cultural artifacts, and generate new knowledge.
Students are assessed on their ability to recall facts and apply simple procedures in response to well-defined, pre-structured problems.	People respond to complex, ill-structured problems in the real world contexts.
Students take the exam individually.	People work individually and in groups of others with complementary skills to accomplish a shared goal.

Students take a "closed-book" exam, without access to their notes or to other sources of information, and use only paper and pencil during the assessment.	People use a wide range of technological tools and have access to a vast array of information resources and the challenge is to sort through all of it to find relevant information and use it to analyze problems, formulate solutions, and create products.
Students respond to the needs and requirements of the teacher or school system.	People respond to official standards and requirements and to the needs and requirements of an audience, a customer, or a group of users or collaborators.

This gap between school assessments and the world outside of school fails to prepare students for the demands of the 21st century. As Stanford Professor Linda Darling-Hammond (2005) points out, when high-stakes assessments are emphasized in schools, the use of pedagogical methods focused on the teaching of complex reasoning and problem solving decreases. Teachers report that with such assessments, they have little time to teach anything that is not on the test and that they have to change their teaching methods in ways that are not beneficial to students (Pedulla, et al., 2003). For example, when writing is assessed with paper and pencil, teachers are less likely to use computers when they teach writing (Russell & Abrams, 2004). This is despite the pervasive use of word processors for writing in the real world and the fact that research on the use of word processors consistently shows high levels of impact on the quality of student writing (Bangert-Drowns, 1993; Kulik, 2003).

Traditional assessments also fail to measure all the skills that are believed to be enabled and acquired by the regular use of new, technology-based learning environments. A great deal has been learned about how teachers can integrate the use of ICT into everyday classroom practices and how students can use them to work in teams and to apply their deep understanding of school subjects and ICT tools to solve complex real world problems (Bransford, et al, 2001). For example, international case studies of innovative classrooms (Kozma, 2003) have documented the use of ICT in which students work in groups to specify their own research topics, search the web for related information, use data-loggers to collect science data or web forms to enter survey data, use data bases or spreadsheets to analyze the data, use email to communicate with outside experts, and use word processors, graphics software or presentation software to prepare reports. Video and audio equipment and editing software can be used to create video presentations or performances to be posted on the web and shared with larger audiences. Simulations are used to help students understand complex systems. But traditional assessments do not examine these novel classroom approaches.

A key goal for this project is to examine ICT-enabled, classroom-based learning environments and formative assessments that teach and measure 21st century skills, find ways to scale them, and derive implications for international and national assessments and for classroom practices that support assessment reform.

However, laboratory studies (e.g. see Bransford & Schwartz, 1999; Schwartz, Bransford & Sears, 2005) show that new approaches to assessments reveal the strengths of innovative pedagogical approaches. A key goal for this project is to examine these classroom innovations and find ways to take ICT-based learning environments and assessments out of laboratories and classrooms, scale them up, and derive implications for international and national high-stakes assessments of 21st century skills and for classroom practices that support assessment reform

THE CURRENT STATE OF ASSESSING 21ST CENTURY SKILLS

Current State of 21st Century Skills Development

A number of high-profile efforts have been launched to identify the skills needs to succeed in the 21st century. Table 1 compares these efforts. Paramount among them is the work of the Partnership for 21st Century Skills (www.21stcenturyskills.org). The Partnership brought together the business community, education leaders, and policy makers to create a vision of 21st century learning and to identify a set of 21st century skills. Built around core subjects, the skills include learning and innovation skills; information, media, and technology skills; and life career skills (See Table 1 for a complete list and comparison). These skills have been adopted by a number of states in the U.S., including Maine, North Carolina, West Virginia, and Wisconsin. Similarly, the Lisbon Council (2007) in the European Union crosses knowledge in science, engineering, mathematics, language, and commerce with "enabling skills" that include: technological skills, informational skills, problem solving, adaptability, and team work. Other efforts have focused in on a more-specialized subset of crucial skills, such as ICT literacy or problem solving.

Some organizations define ICT literacy in very narrow terms as the skills needed to operate hardware and software applications. But others define it more broadly. Prominent among them is the International Society for Technology in Education (ISTE; www.iste.org/), which has defined a set of standards that include technology operations and concepts. They position technology skills in the context of school subjects and a broader set of skills that include creativity and innovation, communication and collaboration, research and information fluency, critical thinking, digital citizenship, and technology operations and concepts. These standards have been adopted by a number of countries and U.S. states. The Educational Testing Service (ETS) iSkills project (www.ets.org/iskills/; Katz, 2007) defines ICT skills as the ability to solve problems and think critically about information by using technology and communication tools and information skills that include defining, accessing, evaluating, managing, integrating, and communicating information and creating new knowledge.

In 2003, a special assessment study of the Programme on International Student Assessment (PISA), a program of the Organization for Economic Cooperation and Development (OECD), defined a skill set related to problem solving skills that included understanding the problem, characterizing the problem, representing the problem, solving the problem, reflecting on the solution, and communicating it to others. ETS designed an assessment of problem solving skills for the U.S. National Assessment of Educational Progress (NAEP) that defined problem solving in terms of the scientific inquiry skills of exploration and synthesis, as well as computer skills.

Table 1

Skills	21st Century Partnership	Lisbon Commission	ISTE NETS	ETS iSkills	PISA Problem Solving	NAEP Problem Solving
Creativity, innovation	X		X	X		
Critical thinking	X		X	X		
Problem solving	X	X	X	X	X	X
Decision making	X		X			
Communication	X		X	X	X	
Collaboration	X	X	X			
Information literacy	X	X	X	X		
Research & inquiry			X			X
Media literacy	X					
Digital citizenship			X			
ICT operations & concepts	X	X	X	X		X
Flexibility & adaptability	X	X				
Initiative & self-direction	X					
Productivity	X					
Leadership & responsibility	X					
Integrated with school subjects	X	X	X			

Table 1 shows the range of skills identified by these efforts. While there are some differences between them, there is significant commonality among them. Based on the examination of this commonality, we propose an initial set of core 21st century skills:

- **Creativity and innovation**
- **Critical thinking**
- **Problem solving**
- **Communication**
- **Collaboration**
- **Information fluency**
- **Technological literacy**
- **Embedded in school subjects**

Listing of these skills is relatively easy; operationalizing them is much more difficult. For assessment purposes, skills must be defined precisely and in measurable terms so that assessment tasks can be designed and scoring rubrics can be specified. A key goal of this project is to work with multiple stakeholders to specify these 21st century skills in measurable ways that are relevant to real world work and everyday situations. This will be particularly challenging for skills such as innovation, critical thinking, and collaboration. Specifically, the project will build on previous work in this area to refine the definition of these skills and develop a coherent assessment framework and set of measureable standards for each of the skills.

Another key goal of this project is to work with multiple stakeholders to specify 21st century skills in measureable ways that are relevant to real world work and everyday situations.

Current State of Assessment

Many countries have a national assessment of student achievement. Some, such as the Graduate Certificate of Secondary Education (GCSE) and the A-level examinations in the United Kingdom, are taken by all or nearly all students as they progress through their studies. Others, such as the National Assessment of Educational Progress (NAEP) in the United States, test a sample of students for the purpose of measuring the effectiveness of the education system. The major international assessments are PISA, of the OECD, and the Trends in Mathematics and Science Study (TIMSS), of the International Association for the Evaluation of Educational Achievement (IEA). These two assessments differ in that PISA tests 15 year olds and assesses the knowledge in reading, mathematics and science needed to meet the challenges of everyday life of young adults. On the other hand, TIMSS assesses 4th and 8th graders on mathematics and science knowledge that is common to the curricula of participating countries. All of these large scale assessments are focused on the measurement of school subject knowledge, rather than the skills listed above. None currently incorporate the use of ICT tools that are pervasive in the workplace and everyday life.

However some initial efforts have begun to use ICT in the assessment of school subjects. In 2006, 13 countries participated in an optional pilot to test the efficiency and equivalency of delivering science assessment using computers. And in 2009, NAEP will have some computer-based tasks in its science assessment. PISA has the goal of introducing the wider use of ICT in 2009 with the assessment of the reading of electronic texts. PISA is considering the incorporation of ICT in the assessment of mathematics in 2012.

Several projects have begun to explore the use of ICT for the assessment of 21st century skills. In 2003, OECD and ETS conducted a feasibility study that looked at the prospects and difficulties in using ICT to measure ICT literacy skills. ICT literacy was defined as "the ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate, and evaluate information, construct new knowledge, and communicate with others" (Lennon, et al., 2003, p. 8). The two-and-a-half-hour assessment was delivered with ICT and consisted of a multiple choice questionnaire, multiple choice simulated tasks for email, web searching, and database applications, and extended performance tasks involving web search and simulation applications. The assessment was used with a total of 118 students in three participating countries: Australia, Japan, and the U.S. This feasibility study resulted in the development of the ETS iSkills, an assessment of ICT literacy, as well as national ICT Literacy assessment projects in Australia (Ministerial Council on Education, Employment, Training, and Youth Affairs, 2007) and Hong Kong (Law, Yeun, Lee, & Shum, 2007). In Australia, 7,400 students in grades 8 and 10 took an assessment that included the use of both simulated ICT tasks and live applications. In Hong Kong, 2,600 primary and secondary students were assessed on their ICT skills as they used ICT tools in Chinese language, mathematics, and science tasks. In all these assessments, ICT proficiency standards and scoring rubrics were developed and validated. In the U.S., NAEP will assess technology literacy in 2012.

In 2003, ETS conducted a field investigation for the National Assessment of Educational Progress with an ICT-delivered assessment of problem solving in technology-rich environments (Bennett, et al., 2007). The study used two extended scenarios, a search scenario and a simulation scenario, to measure problem solving skills, defined in the context of scientific investigation, and ICT skills. The assessment was given to a nationally representative sample of 2000 8th grade students.

PISA is considering ICT-based assessment of ICT skills in 2012. The IEA is also considering such an assessment of ICT literacy for 2012 or 2014. And in 2012, NAEP is planning to measure technological literacy with an entirely computer-based assessment. A goal of this project is to encourage and support the development of national and international assessments that incorporate the use of ICT.

Beyond problem solving and ICT literacy, SRI's Center for Technology in Learning developed and pilot tested three ICT-based performance assessments of students' ability to use various technology tools to access and organize information and relevant data; represent and transform data and information; analyze and interpret information and data; critically evaluate the relevance, credibility and

appropriateness of information, data, and conclusions; communicate ideas, findings, and arguments; design products within constraints; and collaborate to solve complex problems and manage information (Quellmalz & Kozma, 2003).

However, due to a variety of methodological and technological barriers, there have been no large-scale implementations of ICT-based assessments of the 21st century skills other than ICT literacy and problem solving. Another goal of this project is to work with multiple stakeholders to promote and support the development of ICT-based assessments for the full range of 21st century skills within the context of school subjects and real world problems. Specifically, this context includes the foundational ideas that organize the factual knowledge of school disciplines and the key questions that make this knowledge relevant to real world situations. The project will use the 21st century skills framework and standards to collect or produce, if necessary, and share examples of ICT-based assessment tasks for each skill and catalog or develop, if necessary, scoring rubrics for skills measured by each task.

Another goal of this project is to work with multiple stakeholders to promote and support the development of ICT-based assessments of 21st century skills embedded in school subjects and within the context of real world work and everyday situations.

TECHNOLOGICAL AND METHODOLOGICAL CHALLENGES

Technological Advantages, Challenges, and Preconditions

While not all assessment reforms require the use of ICT, technology provides some significant advantages when introduced into assessment. The incorporation of ICT into large-scale assessments promises a number of significant advantages. These include:

- Reduced costs of data entry, collection, aggregation, verification, and analysis.
- The ability to adapt tests to individual students, so that the level of difficulty can be adjusted as the student progresses through the assessment and a more-refined profile of skill can be obtained for each student.
- The ability to efficiently collect and score responses, including the collection and automated or semi-automated scoring of more-sophisticated responses, such as extended, open-ended text responses.
- The ability to collect data on students' intermediate products, strategies and indicators of thought processes during an assessment task, in addition to the student's final answer.
- The ability to take advantage of ICT tools that are now integral to the practice and understanding of subject domains, such as the use of idea organizers for writing, data analysis tools in social science, and visualization and modeling tools in natural science.
- The ability to provide curriculum developers, researchers, teachers, and even students with detailed information that can be used to improve future learning.

The use of ICT in assessments looks something like this:

> *Students are given a problem scenario in which they are rangers for a national park experiencing a dramatic increase in the population of hares that threatens the ecology of the park. They are asked to decide whether or not to introduce more lynx into the system and, if so, how many. Students receive, respond to, and initiate simulated communications with other rangers who are working on the project and have specialized knowledge of the situation. They search the World Wide Web to find out pertinent information on both hares and lynxes. They organize and analyze this information and evaluate its quality. They make predictions based on their analyses, test their predictions with modeling software, and analyze the results, as represented in graphs, tables, and charts. They integrate these findings with information from other sources and create a multimedia presentation in which they make and defend their recommendations and communicate these to others.*
> (Example courtesy of Edys Quellmalz.)

A key goal of this project is to identify and address the barriers to the assessment of 21st century skills embedded in subject domains and work with partners to develop and implement breakthrough methodologies and technologies.

Such assessments correspond to the situations in the outside world. In the implementation of these assessments, there may be certain local technological barriers that must be overcome related to operating system, hard ware, software, and networking and bandwidth. A goal of this project would be to specify the range of preconditions that might be required of schools to use ICT-enabled learning environments and participate in ICT-based assessments. Among the technological challenges that might inhibit the use of ICT-based assessments are:

- Significant start-up costs for assessment systems that have previously implemented only paper and pencil assessments. These costs would include hardware, software, and network purchases; software development related to localization; and technical support and maintenance.
- The need to chose between the use of “native” applications that would not allow for standardization but would allow students use the applications with which they are most familiar, the use of standardized off-the-shelf applications that would provide standardization but may disadvantage some students that regularly use a different application, or the use of specially developed “generic” applications that provide standardization but disadvantage everyone equally.
- The need to integrate applications and systems so that standardized information can be collected and aggregated.
- The need to choose between stand-alone implementation versus internet-based implementation. If stand-alone, the costs of assuring standardization and reliable operation, as

well as the costs of aggregating data. If internet-based, the need to choose between running applications locally or having everything browser-based.

- If the assessment is internet-based, issues of scale need to be addressed, such as the potentially disabling congestion for both local networks and back-end servers as large numbers of students take the assessment simultaneously.
- Issues of security are also significant with internet-based assessments.
- The need to handle a wide variety of languages, orthographies, and symbol systems for both the delivery of the task material and for collection and scoring of open-ended responses.
- The need to keep up with rapidly changing technologies and maintaining comparability of results, over time.
- The need for tools to make the design of assessment tasks easy and efficient.
- The lack of knowledge of technological innovators about assessment, and the corresponding paucity of examples of educational software that incorporates with high-quality assessments.

Methodological Challenges

Significant methodological challenges include:

- The need to determine the extent to which ICT-based items that measure subject knowledge should be equivalent to legacy paper and pencil-based results.
- The need to detail the wider range of skills that can only be assessed with ICT.
- The need to determine the age-level appropriateness of various 21st century skills.
- The need to design complex, compound tasks in a way such that failure on one task component does not cascade through the remaining components of the task or result in student termination.
- The need to integrate foundational ideas of subject knowledge along with 21st century skills in the assessments. At the same time, there is a need to determine the extent to which subject knowledge should be distinguished from 21st century skills in assessment results.
- The need to incorporate qualities of high-level professional judgments about student performances into ICT assessments, as well as support the efficiency and reliability of these judgments.
- The need to develop new theories and models of scoring the students' processes and strategies during assessments, as well as outcomes.
- The need to establish the predictive ability of these judgments on the quality of subsequent performance in advanced study and work.
- The need to distinguish individual contributions and skills on tasks that are done collaboratively.

A key goal of this project is to identify, elaborate on, and address the barriers to ICT-based assessment of 21st century skills and work with partners to develop and implement breakthrough methodologies and technologies.

AN ACTION PLAN

In response to the urgent and crucial need for assessment reform to advance educational transformation, Intel, Microsoft, and Cisco have set up a structure and a series of actions to address this need. We are currently identifying a team of international experts that will lead this effort and, with this call to action, invite other interested partners from government ministries, assessment organizations, universities and educational research institutions, foundations, and businesses to join in achieving the challenging goals of this Project.

There are many international and national assessment programs, assessment organizations, NGOs, businesses, research centers, and individual researchers working on the specification of 21st century skills and development of ICT-based formative and summative assessments. The Project will leverage these existing efforts and add value to them for the purpose of transforming educational assessment for the 21st century. Specifically, the Project will add value by catalyzing this international community to identify the problems, issues, and barriers that:

- are common to all,
- that are of the highest priority, and
- cannot be addressed by any individual project alone.

Furthermore, the Project will provide a structure by which this international community can draw on and share existing knowledge and create effective solutions to address the problems, issues, and barriers associated with the identified skills and foster wide-scale adoption of assessment reforms.

Five working groups form the core of an international expert-led project

The goals of the Project will be accomplished by the Executive Director, Dr. Barry McGaw of the University of Melbourne, and a Management Team that is organized into five Working Groups:

1. The 21st Century Skills Working Group, led by Ms. Senta Raizen of WestEd. This group will specify high priority 21st century skills in measurable form.
2. The Classroom Learning Environments and Formative Evaluation Working Group, headed by Dr. John Bransford of the University of Washington. This group will review classroom-based, ICT-enabled learning environments that emphasize interactive, formative assessments and provide opportunities for students to reach important criteria at their own rates, and derive implications from these environments for summative assessments and for classroom practices aligned with assessment reform.
3. The Methodological Issues Working Group, led by Dr. Mark Wilson of the University of California, Berkeley. This group will identify methodological problems and specify solutions for development of assessments of 21st century skills.

4. The Technological Issues Working Group, led by Dr. Beno Csapo of the University of Szeged. This group will identify technological problems and specify solutions for scalable ICT-based assessments of 21st century skills.
5. The Country Deployment Working Group. This group will ensure there is coordination and knowledge-sharing by multiple stakeholders, both within and across partner countries, as well as between countries and the other working groups and between participating countries and the partner companies.

The work of the Project will be organized around a series of annual working conferences, online-interactions, and a knowledge sharing web portal. A public, knowledge-sharing portal will collect and share examples of the measurement specifications of various 21st century skills and assessment frameworks, tasks, and scoring rubrics. The portal will also post the finished works of the Project.

How you can get involved

In the context of the Project's goals, structure, and activities, we are looking for:

- Assessment experts, researchers, business leaders, policymakers, and non-governmental organizations—especially those who have been working in this area—to help identify and specify 21st century skills in measurable ways.
- Assessment experts, researchers, educators, software developers, and ministry officials to develop, collect, and share exemplary ICT-based assessment tasks and scoring rubrics.
- Assessment experts, researchers, and software and network engineers—especially those who have been the leaders in experimenting with ICT-based assessment—to share their experience and expertise, identify and address the barriers to ICT-based assessment, and develop breakthrough technologies and analytic methodologies.
- Policymakers and ministry officials who are interested in having their countries help shape and refine the efforts of the Project and participate in the implementation and pilot testing of the new assessments.
- Businesses, foundations, and government agencies to co-fund these important efforts in private-public partnership.

The project began in January 2009 and will run for approximately three years. Those interested in participating in this effort should contact the Project Executive Director, Dr. Barry McGaw at bmcgaw@unimelb.edu.au.

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