



Digital Transformation A Framework for ICT Literacy

**A Report of the International
ICT Literacy Panel**

The *ICT Literacy Assessment* is now called the *iSkills™* assessment. All references to the *ICT Literacy Assessment* in the following document apply to the *iSkills* assessment.

Digital Transformation

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ICT Literacy Panel***

INTERNATIONAL ICT LITERACY PANEL

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Digital Transformation

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I. PREFACE

In January 2001, Educational Testing Service (ETS) convened an international panel to study the growing importance of existing and emerging Information and Communication Technologies (ICT) and their relationship to literacy. The panel was made up of experts from education, government, non-governmental organizations (NGOs), labor, and the private sector. Representatives from Australia, Brazil, Canada, France, and the United States were included in the group. The International ICT Literacy Panel and its subcommittees met five times during the year. In order to maintain a global perspective, two of the meetings took place outside of the United States in Paris and Rio de Janeiro. Presentations by and discussions with local experts introduced the panel to issues unique to these countries and regions. Following each meeting, panel members consulted key clients, constituents and stakeholders for their input.

The panel deliberations had two major themes. First, ETS, along with the panel members, wanted to examine the need for a measure of ICT literacy across countries as well as within specific organizations, such as schools and businesses. ETS's interest in this topic is an extension of its long-standing involvement in large-scale assessment, beginning

with its management of the development and conduct of the National Assessment of Educational Progress (NAEP) since the early 1980's through numerous studies of adult literacy including the first International Adult Literacy Survey (IALS). As a second goal, ETS and the panel wanted to develop a workable ***Framework for ICT Literacy***. This framework would provide a foundation for the design of instruments including large-scale assessments intended to inform public policy and diagnostic measures to test an individual's skills associated with information and communication technology.

Given the enormous and growing importance of technology in people's everyday lives, the panel set out both to frame what we already know about ICT literacy and to define what we don't know. The panel also advances a set of policy recommendations directed to governments, educators, NGOs, labor and industry regarding ICT literacy. It is the panel's hope that this process will lead to assessments and research that will ultimately inform efforts to better understand and address real issues surrounding ICT literacy in its role in contributing to the development of human capital.

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III. OVERVIEW

Over the course of its deliberations, the International ICT Literacy Panel had wide ranging discussions about the nature of information and communication technologies literacy and its growing importance in the well being of societies around the world. A diverse group representing a variety of constituencies, the panel was able to reach consensus on a series of key issues in these areas. Some of those are highlighted here.

- Technology is of increasing importance in people's everyday lives and that presence will most certainly increase in the coming years. No longer relegated to specialized workplace settings, information and communication technologies have become increasingly common in community settings, at school, and at home. Whether looking up a book on a computerized card catalogue at the public library, making a withdrawal from an automated teller machine, or accessing telephone messages, everyday activities have been transformed by ICT. As a result, the notion of a literate populace must be expanded to include the technology-based skills and abilities that will enable citizens to function in an increasingly technological world.
- ICT literacy cannot be defined primarily as the mastery of technical skills. The panel concludes that the concept of ICT literacy should be broadened to include both critical cognitive skills as well as the application of technical skills and knowledge. These cognitive skills include general literacy, such as reading and numeracy, as well as critical thinking and problem solving. Without such skills, the panel believes that true ICT literacy cannot be attained.
- The panel views ICT literacy as a continuum of skills and abilities. Just as we no longer think of general literacy as an either/or proposition in which an individual is either literate or not, ICT literacy ranges from simple uses of technology in everyday life to uses in performing complex tasks.
- The panel reflects a growing consensus that meaningful data from large-scale global assessments, and from smaller diagnostic tests aimed to inform governments, schools, and private sector organizations and consortiums, will be crucial in understanding the breadth and gaps in ICT literacy across the world. Such comparable information is not available today. Furthermore, we believe that these data will be important in analyzing the outcomes and effectiveness of current public policies, education strategies, philanthropic investments, and community initiatives, as well as in identifying potentially new and more effective strategies.
- The panel strongly believes that it is time to expand the notion of the digital divide. The current global public policy focus is on the detrimental impact of limited access to hardware, software and networks such as the Internet. We believe this characterization of the digital divide must be changed to include the impact of limited reading, numeracy, and problem-solving skills. Without these skills, all the hardware and access in the world will not enable people to become ICT literate. A continued focus on building infrastructure should be complimented by an effort to identify those without an ability to manage, integrate, evaluate, and create information in a traditional sense and to provide them with the necessary tools to acquire these critical skills. The panel recognizes and commends the successful partnerships of private sector and public sector in advancing the deployment of the infrastructure. However, it also believes that a single-focused strategy is insufficient and could, in fact, perpetuate a society of haves and have-nots, thus widening the digital divide, severely deteriorating the ability of employers to find skilled and capable workers, and limiting the benefits of technology applications and tools to help people meet fundamental needs, such as quality health care, public safety, and good jobs.

IV. INTRODUCTION

Numerous research studies, associations, and industry groups have examined issues relating to Information Communication Technology (ICT)¹ skills as they affect workforce readiness (see for example Bollier, 2000). Research has examined the global assessment of ICT skills for students in secondary schools (Venezky, 2001). Other work has detailed the necessary skill sets required for the information technology (IT) worker, as well as the skills gap in available workers to meet the workforce needs. These efforts produced models and competencies necessary to meet ICT education and workforce requirements.

The Information Technology Association of America (ITAA) issued two comprehensive studies that explain how information technology has changed the workforce and identified key job categories, requisite skills, and ways for workers to acquire the skills (ITAA, 2000, 2001). Education Development Center in collaboration with ITAA, also issued another report that presents a pathway/pipeline model for integrating technology skills into curricula (EDC, 2000). The Computer Science and Telecommunications Board of the National Research Council proposed a framework for fluency with information technology (Committee on Information Technology Literacy, 1999). Most recently the American Society for Training and Development and the National Governors Association released a report on e-learning and the workforce (Commission on Technology and Adult Learning, 2001).

These efforts provide a solid foundation to examine skills and knowledge levels for the 21st century workforce, as well as for education and

life-long learning. They also provide the basis to link the skill sets to specific curriculum and testing standards, or to tie directly with certification tests for specific ICT job requirements.

However, these studies have only begun to address the requirements for individuals to function successfully in a global ICT society on and off the job, and the assessment criteria necessary to evaluate if individuals have the core competencies to function successfully in an information age society.

Organizations such as Statistics Canada, the National Center for Educational Statistics (NCES) in the United States, and the Organisation for Economic Co-operation and Development (OECD) in Paris have expressed a desire to include these skills along with literacy and numeracy in their international assessments of students and adults. The OECD is planning to include ICT literacy in the domains for assessment in 2006 in the Programme for International Student Assessment (PISA) if a suitable assessment framework and appropriate tests can be developed. To date, however, no one has put forth a framework to assess if an individual has achieved ICT competency to function successfully in a knowledge-based society. It was the task of this panel to begin the process of meeting that goal.

A. Defining ICT Literacy

Reflecting the growing importance and ubiquity of new technologies in work, education, and everyday life, the panel defines ICT literacy in the following way:

ICT literacy is using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society.

The panel's definition reflects the notion of ICT literacy as a continuum, which allows the measurement of various aspects of literacy, from daily life skills to the transformative benefits of ICT proficiency.

¹ The panel has used ICT instead of IT (Information Technology). ICT is being used increasingly by global industry, international media, and academics to reflect the convergence between computer and communication technologies. Thus ICT can be viewed as a set of activities and technologies that fall into the union of IT and telecommunications.

This definition is also important in that it lists five critical components of ICT literacy. The five components represent a set of skills and knowledge presented in a sequence that suggests increasing cognitive complexity. After discussions regarding the kinds of tasks represented by each component, the panel agreed on the following definitions:

- **Access** - knowing about and knowing how to collect and/or retrieve information.
- **Manage** - applying an existing organizational or classification scheme.
- **Integrate** - interpreting and representing information. It involves summarizing, comparing and contrasting.
- **Evaluate** - making judgments about the quality, relevance, usefulness, or efficiency of information.
- **Create** - generating information by adapting, applying, designing, inventing, or authoring information.

B. The Role of an ICT Literacy Framework

While numerous attempts have been made in the recent past to define a framework for measuring ICT literacy, the panel's proposed framework, presented on pages 14-22, is based on a strong view that mastery of technology alone does not define ICT literacy. It is only in the integration of technology skills and cognitive skills, such as traditional literacy, numeracy, and problem solving, that one can adequately define ICT literacy.

The panel envisions its framework as the basis for the design and conduct of large-scale national and international assessments as well as diagnostic tests of individual life skills associated with information and communication technology. The framework provides a well-grounded rationale for defining the skills and knowledge required by students and adults as they complete secondary school, leave higher

education, make career decisions or transitions, or function in everyday life in the 21st century. And finally, the framework makes assumptions about ICT explicit and defines a vocabulary to link existing and new public policies with measurement and data.

C. Technology as a Transformative Tool

While there are many rationales to support the importance of ICT, the panel identified and agreed upon five key assumptions that helped define the framework and its recommendations:

- ICT fundamentally changes the way we live, learn, and work. As a result of these changes, technology tools, and the creative application of technology, have the capacity to increase the quality of people's lives by improving the effectiveness of teaching and learning, the productivity of industry and governments, and the well-being of nations.
- ICT will continue to evolve rapidly.
- Access to technology should not be limited by cultural, economic, gender, geographical, linguistic, or physical barriers.
- A global society and its policy makers have a responsibility to determine the components of *digital knowledge* and to know how to make it equitable and cross-cultural in a digital age.
- An accepted definition that reflects a broader understanding of the critical components of ICT literacy will stimulate a transformation in the skills and knowledge that must be acquired through education and training, thus improving the quality of education for the workforce of the future.

The panel believes strongly that higher levels of ICT literacy have the potential to transform not only the lives of individuals who develop the requisite skills and knowledge, but society as a whole. However, several serious problems exist that

threaten the success and effectiveness of technology as a transformative tool.

- First are the strikingly low levels of general literacy around the world. Even within many OECD countries, there are many young people who fail to develop an adequate level of literacy (OECD, 2001a). As this report argues, limited skills in areas such as reading, numeracy, and problem solving present a fundamental barrier in the attainment of ICT literacy. Increasingly, economists, educators, and policy makers have accepted the role of more traditional literacies in positively influencing the economic fate of individuals and nations around the world. The impact of ICT literacy is no different.
- Second are large inequalities of access to and mastery of new technologies, a notion that has been identified as a “digital divide.”
- Third is a lack of information regarding the distributions of ICT literacy both within and among countries that has created a serious dissonance between how the digital divide is currently perceived and how societies respond to it.
- Finally, the digital divide reflects, and is exacerbated by, a lack of relevant content and technology applications to meet the needs of diverse societies. A lack of resources (along with decisions about allocation issues) in both the NGO community and governmental organizations has limited the development of such content and applications.

The panel hopes that its work will lead to the development and conduct of assessments that will provide a body of evidence from which more effective policies can be made to address the acquisition of ICT literacy and thus help technology fulfill its potential transformative role.

D. Summary of Recommendations

In addition to taking initial steps in defining ICT literacy and laying out a framework, the panel agreed upon a specific set of policy recommendations. The three recommendations, discussed in greater detail on pages 10-13, are summarized as follows:

1. Governments should begin to include large-scale global assessments of ICT literacy, either within existing assessments such as the Adult Literacy and Lifeskills (ALL) survey and the Programme for International Student Assessment (PISA) or in new test vehicles. Governments, education experts, and researchers should conduct new public policy research with the data derived from these assessments. This information can help policy makers, educators and industry as they attempt to broaden people’s access to and fluency with new technologies. Government investments, education curricula, and philanthropy should all be influenced by the data derived from these assessments. Additionally, best practices can be identified when results from specific countries are analyzed.
2. ETS and others should work with governments, educators, industry, and labor to develop specific diagnostic assessments focusing on the measurement of ICT literacy, or on the capacity of individuals to develop it.
3. ICT literacy can best be achieved through experiences that integrate cognitive and technical learning. Single focused, stand-alone curricula, whether academic or technical, will limit the learners’ attainment of ICT literacy. ICT literacy skills need to be integrated appropriately into curricula addressing cognitive skills as well as those addressing IT and technical skills in order to ensure improved ICT literacy.

It is clear that the issue of making ICT literacy a global objective is a complex process. It is exacerbated by many factors, including inequalities in education, income and access to health care, differences in class, gender, and race, access for individuals with disabilities, and geography. No simple solutions leading to the attainment of global ICT literacy are easily forthcoming. However, we hope that both the framework presented in this report and our recommendations will start a discussion that will ultimately lead to a clearer understanding of ICT literacy and ways to improve it.

V. A NEW NOTION OF A DIGITAL DIVIDE

The advent and rapid development of technology has fundamentally changed almost every aspect of life, learning, and work. It will continue to evolve, stimulating further changes that we cannot begin to imagine. Such evolution will occur along the entire technology spectrum, from the simplest life tasks to the most complex innovations. While industry leaders and policy makers have acknowledged this evolution of technology globally, the ability to adopt ICT varies substantially across countries and within communities. Because much of an individual's future success may rely on ICT literacy, the panel believes that access to and opportunities to learn how to use ICT must be made as equitable as possible. The absence of this equity is what has been referred to in the last decade as the *digital divide*.

There is growing international emphasis to drive public and private investment and planning toward knowledge-based economies and information-age societies. New computer and communications technologies are penetrating the home, the workplace, the marketplace, government, and the community. This is changing the fundamental

requirements for the life skills of citizens and, over the last ten years, has created a new political debate on global digital divide issues — issues which challenge world leaders, industry and educators to address a growing gap between societies and individuals with access to technology and those people still isolated from technology and information.

ICT can be a powerful enabler of development goals because its unique characteristics dramatically improve communication and the exchange of information to strengthen and create new economic and social networks. There are striking results around the world in ICT development. Research shows that ICT can play a significant role as part of an overall national strategy for development. In this respect, countries have pursued diverse strategies: some have focused on developing ICT as an economic sector — either to boost exports (Costa Rica and Taiwan) or to build domestic capacity (Brazil, India and Korea). In Gambia, for example, it is being used to achieve better health outcomes. In Chile, it is starting to reap significant results in primary school education. In Bangladesh, it has led to the creation of direct employment for thousands of local women and men, while in parts of India new Internet-enabled centers mean better access to different government services for remote communities. In Indonesia, ICT is allowing local citizens' groups to monitor compliance with environmental standards (Digital Opportunity Initiative, 2001).

However, despite many ICT success stories, the case that there is a digital divide, with inequities caused by geographical, economic, physical, and linguistic barriers has been documented in many studies (de los Santos, de los Santos, & Milliron, 2001; Goslee, 1998; National Telecommunications and Information Association (NTIA), 1995, 1998, 1999, 2000; and OECD, 2000b). As the OECD's report *The Economic and Social Impact of Electronic Commerce: Preliminary Findings and Research Agenda*

(1999) points out, “Visions of a global knowledge-based economy and universal electronic commerce, characterized by the ‘death of distance’ must be tempered by the reality that half the world’s population has never made a telephone call, much less accessed the Internet.”

Economists also point out how technological change is currently the most powerful driver of income inequalities, and thus a part of any examination of a digital divide. One recent study from the Institute for International Economics estimated that technological change was perhaps five times more powerful than trade in widening income inequality in America between 1973 and 1993 (Cline, 1997).

A. The Importance of Cognitive Skills

This panel discussed these issues over the course of a year and has reached consensus that *as technology approaches ubiquity, an increasing importance must now be placed on educating and training citizenry in the ICT skills necessary to function effectively in a global economy increasingly dependent on ICT*. The panel’s overarching belief is that the digital divide should no longer be defined only in terms of limited access to hardware, software, and networks, but rather, one that is also driven by limited literacy levels and a lack of the *cognitive skills* needed to make effective use of these technologies. **Technology skills alone, without corresponding cognitive skills and general literacy, will not decrease the gaps defined by a digital divide.**

The strategies developed over the last decade by governments, educators, and corporations to address this divide have been focused on hardware and access to networks such as the Internet. **These efforts have been instrumental in addressing some of these issues and they need to continue but serious gaps still exist.** This report proposes changes in policy makers’ focus and strategies and begins to define a new notion of the digital divide.

Continued deployment of hardware needs to be complimented by a focus on those without an ability to manage, integrate, and evaluate information in a traditional sense.

As technology becomes more prevalent in our everyday lives, cognitive skills become increasingly critical. Consider a student or employee who is asked to prepare an electronic presentation based on information from the World Wide Web. That person can access vast quantities of information without a lot of understanding. Search engines make accessing information almost trivial. But using the search engines well requires an increased skill level. Evaluating and synthesizing information found in a variety of sources requires even more advanced skills, representing a literacy that is far beyond what is needed in a more constrained environment, such as with textbooks where all the information is contained within one source. In effect, because technology makes the simple tasks easier, it places a greater burden on higher-level skills.

B. The Need for ICT Literacy Measurements

There are numerous ways to measure the digital divide, and data now exist for many of these measures across the wealthier nations of the world. However, these data are invariably reported in one dimension: access, such as telephones and computers per household, Internet connections per household, or measures of telephone industry deregulation. In the education environment, statistics are also dominated by access measures such as computer or Internet connections per student or the existence of computer laboratories. These measures, while important, provide an insufficient view of this issue.

If access and technology skills are indeed only a part of a digital divide, what we need are data to help us understand the digital divide in terms of literacy and effective performance — that is, the

extent to which our students and adults are able to use and successfully integrate technology into their lives and work. The panel believes that developing data to understand this gap will be crucial to identifying and measuring the effectiveness of what we do to lessen the digital divide and prepare students and adults for successful lives in the 21st century.

C. The Case for Education Investment

Although governments and private industry have been quick to grasp the importance of dealing with the digital divide, public policies have lagged behind public pronouncements (Morino Institute, 2001). Since policies to address the digital divide, like any social problem, require policy makers to make difficult decisions about the allocation of finite resources, this historic focus on hardware and access is all the more alarming. In many poor countries, communication deregulation and government spending on infrastructure, hardware, and software is consuming limited resources under the premise that it will lead to economic prosperity and global competitiveness. In many developed countries, proportionately even greater resources are being allocated to investments such as infrastructure, demonstration projects, and the deployment of computers and Internet access in schools, libraries, and community technology centers. In comparison to access, fewer government resources, in both developing and developed countries, are being devoted to creating new training and education curricula and measuring and understanding their effectiveness.

A significant example of hardware and network investment can be found in the United States, where, since the program's inception in 1998, more than \$5 billion has been spent on "E-Rate," a federal funding initiative aimed solely at increasing Internet connectivity in schools and libraries. The

National Association of State Boards of Education (NASBE) in its *Any Time, Any Place, Any Path, Any Pace: Taking the Lead on e-Learning Policy* (2001) report, estimates that the United States is spending \$7 billion annually on education technology.

The Benton Foundation, in a recent review of the E-Rate program, admits the limits to such a program. "Our findings suggest that the E-Rate is working: it has led to dramatic improvements in network infrastructure and Internet access at schools. But while installing hardware and wiring is a necessary step toward ensuring that all students benefit from the new learning opportunities of the information age, it is not sufficient to guarantee success in this endeavor. To sustain public support for this ambitious undertaking, we must set goals carefully, and we must document progress toward achieving them. Moreover, we must provide sustained and creative training opportunities for teachers so that they learn how to use these new tools effectively" (Benton Foundation, 2000).

Another striking challenge to policy makers within developing countries can be found in Brazil, where the government's goal is to provide technology to its citizens. Like most developing countries, Brazil has less than cutting edge technology and low technology penetration. However, the digital divide merely reflects an even greater societal divide. There are 40 million homeless and disenfranchised people in Brazil. A small percent of the population has a large percent of the country's wealth. Despite currently having one of the fastest growth rates in computer sales and Internet use in the world, only 9% of the population owns a computer and just over 5% has access to the Internet. This leaves out close to 160 million people (Hart, 2001). Thus, the government has to address competing social issues such as poverty eradication and universal access to basic education and healthcare at the same time as it addresses investments in technology infrastructure.

For Brazil, and, we believe, all countries, the digital divide is not just about technology: it encompasses economic, racial, and social problems. At the heart of the issue is how countries deal with such competing priorities — which makes the decision on which public policies to pursue so much more crucial. In many developing countries, like Brazil, even basic education still presents huge challenges. Low levels of literacy remain a reality, especially in low-income segments of society and in less developed regions. The challenge, therefore, is two-fold: to overcome long-standing deficiencies and promote the skills required for ICT literacy.

D. ICT Literacy Initiatives

The panel has reviewed successful projects around the world that support the notion that ICT literacy is a primary driver of the digital divide. These projects are, by and large, found within community-driven applications of technology-based education efforts, where a conscious effort is made to integrate the acquisition of technology skills with cognitive skills. They are often funded, at least at the beginning, through corporate and private gifts, and only supported by governments once a successful model is established. A striking example is again in Brazil, where the Committee for Democracy in Information Technology (CDI) has set up, since 1995, 336 schools throughout Brazil. The organization's focus is not primarily centered on technology skill acquisition, but rather using computer skills as a tool for transforming lives and communities (Hart, 2001). Their methodology is based on projects through which students learn to use software. In one such project, students create a community newspaper dealing with local issues — the community's problems and dreams. While they are working, the students learn to use word processing. A similar project maps out the institutions and community organizations that provide services, such as health clinics, schools, and NGOs. The students

then create community maps, thus learning to use data banks and database software. In a recent interview, Rodrigo Baggio, the founder of CDI, described his belief that technology literacy should be a primary driver for economic development. “Research shows that in large urban centers people do not die from lack of food; they die from lack of opportunity. This is what leads them to criminality, violence, and drug trafficking. Information technology provides a tool for breaking the cycle of poverty and misery. Knowing how to use a computer substantially increases chances of competing in the job market.”

The Republic of Chile also has made addressing computer literacy a significant national priority. Like the U.S. E-Rate program, Chile has begun an ambitious effort to invest \$100 million in a computer and social network called Enlaces (a Spanish word meaning “links”), enabling thousands of schools to connect to the Internet. However, Enlaces goes even further beyond ensuring access. The project provides extensive training to help teachers integrate technology into the school curriculum and design collaborative learning projects that involve children all over the world. The project also funds on-line support, current classroom materials, and practical tools for keeping track of attendance and automating other administration functions. Most important, it brings together teachers and students from across the country into a unified — and unifying — learning community, helping teachers and students share their experiences in discussion groups and speeding reforms to some of the most isolated Andean communities. According to early program evaluations, Enlaces has begun to achieve impressive outcomes, including increases in cognitive development, reduction in dropout rates, and enhanced job prospects. “It is clear that Enlaces's widespread impact is a direct, if not inevitable, result of big thinking at a national level” (Morino Institute, 2001).

In the United States, industry has given significant amounts of money, services and in-kind contributions to community organizations and schools in an attempt to bridge the digital divide. While many projects have focused solely on equipment and access, others have gone deeper into communities, focusing on outcomes such as literacy. For instance, the National Urban League, the United States' oldest and largest community-based movement devoted to empowering African Americans to enter the economic and social mainstream, has built 58 "Digital Campuses" with an explicit aim to foster basic and technology literacy. They are focusing on applying technology to achieve the outcomes we seek: real and meaningful improvements in the standard of living of families who struggle to rise from low-income and poorly served communities.

Determining the right investments presents a daunting challenge to policy makers. Basic social needs such as health, housing and food, along with a high percentage of a population below the poverty line, and the need for state-of-the-art equipment and resources are pressures that highly motivate and frustrate governments, policy makers, and philanthropists.

The panel believes, however, that developing countries can do more with less cutting edge technology and that earlier generations of tools may be helpful to close the gap, just as in Brazil and Chile. Though current technology gaps may unfortunately get wider in the short term as strategic uses of resources are prioritized toward education and the development of cognitive skills, a widening of the access gap may be necessary in the short term to accomplish the longer-term goals and benefits of increased ICT literacy. While the gap results from the inequality of opportunities, the ultimate objective is for the larger societal transformation resulting from technology infusion to lessen or even erase this

gap. Thus, as Andrew Blau put it in a highly informative report for the Surdna Foundation, "Money spent on (information technology) without investments in organizational change and training" was largely wasted (Blau, 2001).

A new focus on education and training will also continue to demonstrate that there are new and often more accessible ways to learn that may be fundamentally different in method and place than traditional means (Reinhardt, 1995). For example, the transformation from brick and mortar to virtual university is creating major changes and opportunities in the delivery of higher education. There are different but equally substantial pressures on corporate and higher education to use e-learning and distance education to develop skills. Rationales include increased cost effectiveness, consistency in the delivery of training, quality controls, the expansion of communities served, and the enhancement of teaching and learning activities (Katz, 2001). Distance education has been a particularly successful model in developing countries where affordability and geography have been real barriers to access. The six largest distance-learning universities in the world are located in developing countries: Turkey, Indonesia, China, India, Thailand, and Korea — all of which offer expanding virtual campuses (Digital Opportunity Initiative, 2001). But questions abound.

- Why is there pressure to use distance education or to incorporate ICT (digital technology) in various educational applications?
- Does it work?
- Is it resulting in higher levels of literacy?
- Who is benefiting?
- Does it close or broaden the digital divide?

These are the kinds of questions that need to be addressed as we move the focus of research from access to effective education.

VI. POLICY RECOMMENDATIONS AND DISCUSSION

In addition to the advice presented to ETS on the development of the ICT literacy framework, the panel agreed upon a specific set of policy recommendations. The three recommendations and our discussion follow.

A. Recommendation 1: Large-scale assessments and public policy research

Governments should begin to include large-scale global assessments of ICT literacy, either within existing assessments such as the International Adult Literacy Survey (IALS) and the Programme for International Student Assessment (PISA) or in new test vehicles. Governments, education experts, and researchers should conduct new public policy research with the data derived from these assessments. This information can help policy makers, educators, and industry as they attempt to broaden people's access to and fluency with new technologies. Government investments, education curricula, and philanthropy should all be influenced by the data derived from these assessments. Additionally, best practices can be identified when results from specific countries are analyzed.

The panel strongly endorses the inclusion of ICT literacy measures in large-scale assessments at

both the secondary school and adult level. These measures are needed to provide empirically grounded interpretations that can be used to inform policy decisions in both education and training environments. Assessments should establish a body of evidence from which informed judgments can be made.

The results of these large-scale assessments would be available at a time when the role of general literacy and “human capital” in influencing the fate of individuals and nations is receiving increased attention. It is particularly important because we believe that these literacy proficiencies are strongly associated with social, educational, and economic outcomes in our society. Research indicates that general literacy proficiencies play a critical role in determining educational success, enhancing productivity and innovation, and in improving social cohesion. The recent OECD report entitled *The Well-Being of Nations* (OECD, 2001b), argues that the development of human capital is correlated with better health, lower crime, and political and community participation. Some studies, OECD reports, even suggest that the social impact of acquiring such knowledge and skills could be as large as their impact on economic productivity.

B. Recommendation 2: Diagnostic Assessments

ETS and others should work with governments, educators, industry, and labor to develop specific diagnostic assessments focusing on the measurement of ICT literacy, or on the capacity of individuals to develop it.

ETS and other educational testing and research organizations should work with governments, educators, the private sector, industry consortiums, and labor to evaluate the need for, and the creation and deployment of, new diagnostic assessment tools focused on ICT literacy.

The panel believes that specific assessment tools to measure ICT proficiencies and skills of individuals are sorely needed. Large-scale global assessments will be able to help in the macro analysis of where we are and provide the basis for analyzing existing and new public policies. Instruments for measuring individuals' skills in particular contexts will be valuable for microanalyses, by regions, by schools, and by companies. Teachers and industry currently have no reliable measures to understand the ICT literacy of their students or workers. Such tools will provide data to understand the effectiveness of current teaching strategies and curricula. Without these data and analyses, we have no understanding of what is working and not working.

There is also a significant lack of courseware integrating cognitive and technical education. A clear measure of the necessary skills of ICT literacy will assist educators in the broadest sense, from teachers to industry professionals, from community organizations to job training programs, in creating and implementing such integrated curricula. Specific diagnostic tests will provide a way of finding the nature of local problems, and a means to examine them from a quantitative and qualitative standpoint. If the data are used effectively, societies will be in a stronger position to refocus on the essential integration of technology into cognitive skill development that will take more students and adults to increased levels of ICT literacy.

In addition to education, our recommendations are meant to address ICT literacy in the workplace. Adults participate in labor markets today that have been transformed over the last decade by forces of globalization, technological change, de-regulation, industrial and corporate restructuring, and increased competition and concentration. Additionally, as the rate of change in industry has significantly increased in the last ten years, the need for adaptability in the workforce has similarly changed exponentially. Historically, one business could change technology;

now technology advances themselves are driving industries. Changes in technology, skill requirements, and in the structure of jobs have increased the demand for better-educated and more literate workers with stronger communication and critical thinking skills. The cumulative impacts of these changes in the job market have, on the one hand, increased the economic premiums associated with formal schooling, literacy proficiencies, and technical skills, and, on the other hand, increased the economic costs associated with a lack of these characteristics.

Furthermore, ICT skills necessary for individuals to function in the new economy and in every day life in the 21st century are continuously changing and emerging. The Internet, e-commerce, and other new economy workforce needs will have a large impact on the nature of job skills and life skills. Workers will require new proficiencies, skill sets, and relationships. Employers, training institutions, and higher education are having difficulty keeping pace with the changing job and life skill requirements, and are not currently prepared to assess employees' required skills and knowledge. ICT assessment tools do not exist to balance the conflict between academic institutions' missions to offer broad skills development via degree programs and the specific requirement among employers for on-the-job training. Similarly, effective diagnostic tests for new and existing employees would be an important asset as employers continue to make training investments and recruitment efforts more productive.

There is a severe skills gap in the information technology industry, as well as in other industry sectors and governments, dependent on skilled technology workers. The U.S. Department of Labor reports that of 54 new jobs in the United States, only eight do not require technological literacy (Ellis, 2001). Workers need to master many new skills to adapt to these changes. They need to

develop the vocabulary and fluency required to understand technological concepts and they have to learn to use it. Correspondingly, people will have to adapt the way they work to exploit technology.

The IT industry currently spends significant resources on training and recruitment. According to the American Society of Training and Development's (ASTD) annual benchmarking study on training practices, the IT industry invests more in training, more often, than any other industry. ASTD's information technology companies invest \$1154 per year per employee versus the Bureau of Labor Statistics (BLS) all-industry average of \$300 per employee (American Society of Training and Development, 2000). Much of this investment is obviously crucial to industries where the majority of their revenue derives from new products and services.

However, some private sector training is remedial and many recruitment efforts are thwarted by an inability to assess a worker's existing and potential proficiencies, particularly as they apply to ICT skills. Thus many corporations are frustrated, believing that the traditional educational system is not working. While learning technology skills can be the easy part, a lack of literacy, numeracy, problem solving, and teamwork skills in new and existing workers reflects the gap between technology proficiency and ICT literacy. The Communications Workers of America labor union estimates that it is not uncommon for telecommunications companies to test over 100 candidates to find 2 to 5 potential employees who have the necessary cognitive skills to successfully absorb technical training delivered within a company.

C. Recommendation 3: An Integrated IT Curriculum

ICT literacy can best be achieved through experiences that integrate cognitive and technical learning. Single focused, stand-alone curricula, whether

academic or technical, will limit learners' attainment of ICT literacy. ICT literacy skills need to be integrated appropriately into curricula addressing cognitive skills as well as those addressing IT and technical skills in order to ensure improved ICT literacy.

If ICT literacy is to have a transformative effect on people's lives, it must be understood as a broad set of tools that can be integrated across a range of contexts. Teaching technology applications as isolated competencies, independent of traditional disciplines, does not provide this kind of understanding. Tasks undertaken at school, at work, and in everyday life increasingly require an understanding and application of this integration of cognitive, literacy, and technology skills.

For example, just as reading instruction needs to be considered in the broadest sense as teaching information processing skills and math instruction as a way of communicating using numbers, information technologies must be integrated into a more general curriculum in academic or training environments. It is our belief that such integration will provide reciprocal benefits. Learners will more fully understand information technologies in the process of applying them across the curriculum and their understanding of other curriculum areas will be similarly enriched as they work to apply IT skills in those contexts. Furthermore, there is a need to ensure that people understand the connections between information technologies and the other skills they attain in school, skills they use in work, and in everyday life. The economic development anticipated from ICT investment is unlikely to follow if individuals and institutions fail to make this connection. IT needs to be integrated appropriately into general curricula. It is important for individuals to internalize what they are learning through practice and application.

As technology evolves, becoming simpler and more transparent, one might argue that the need to develop ICT literacy would lessen. We would argue that, in fact, the opposite is true. Simpler interfaces may broaden access to technology, but they cannot make people ICT literate. In order to take full advantage of the opportunities such technology presents, individuals still need critical cognitive and technical skills.

This creates a difficult challenge for investing in training and education. While digital technology, with its immense capacity to present, access, and manage information, is seductive, there must be a balance between the need for cognitive skills, literacy, and knowledge and what the technology can achieve by itself. Further, these new education tools will be that much more difficult to use by those who possess low or mediocre literacy levels.

As an example, consider a minimum wage earning cashier at a retail establishment. That individual must learn the basic operation of the cash register; an action that requires limited knowledge of technology. However, the underlying technology is quite complex. At a simple level, the technology enables a cashier to place an order, deposit the money, and give change. However, the employee who is trained in only the primary technology tool does not necessarily understand that the system behind it contains inventory control software that

continuously monitors orders and the resultant need for replacement of supplies. While not everyone needs to understand all the systems behind a cash register, if education and public policies continue to focus only at the IT and access level, **we will be neither increasing the knowledge level of the worker nor increasing the pipeline for more applicants for skilled IT jobs.** This situation will also lead to a greater divide between the operator of technology and those who design applications and provide content. The former are easily replaceable, low wage earners, while the latter are highly valued workers with higher wages, thus leading to increased economic disparities.

Summary

The panel's new notion of a digital divide, the ICT Framework and the policy recommendations serve as compelling messages for policy makers and other relevant groups engaged in developing a more ICT literate society. These findings will better ensure the inclusion of all segments of society and reduce digital, social, cultural, economic, and technological divides. It is the panel's hope that these recommendations and findings will contribute meaningfully to the development of an inclusive global society in which shrinking technological disparities produce social, cultural, and economic gains for all.

VII. THE ICT LITERACY FRAMEWORK

A. Introduction

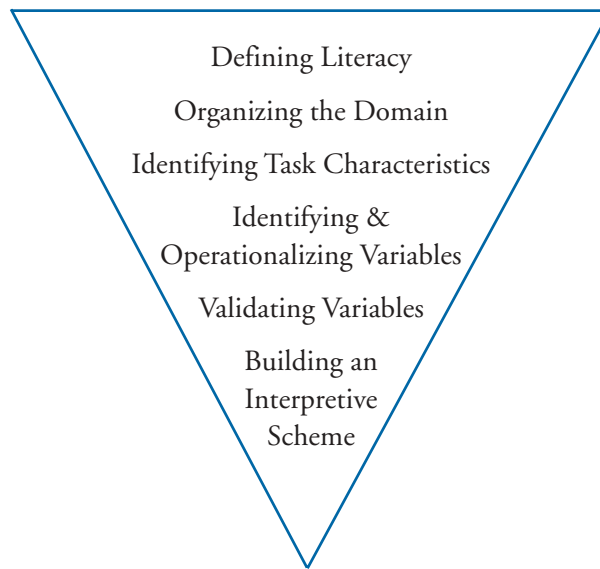
What does it mean to be a literate member of society? The growing acceptance of lifelong learning has expanded the views and demands of literacy. Literacy is no longer seen as a condition that one either has or is lacking. Rather, it is seen as a continuum of knowledge, skills, and strategies that individuals acquire over the course of their lives in various contexts and through interactions with their peers and with the larger communities in which they participate. As historians remind us, literacy in its earliest form consisted of little more than being able to sign one's name on a legal document. It was not until later that fluent oral reading became important and not until the 20th century that reading to gain information was given primary emphasis. As we move into the 21st century, **our conception of literacy is evolving once again**. The prevalence of technology in the everyday lives of the world's citizens has grown at a rate that many would have found hard to imagine 25 or even 10 years ago. Policy makers, business leaders, and educators have come to expand their notion of a literate populace to include the skills and abilities that will enable citizens to function in an increasingly technological world.

B. Developing a Framework

The task of the International ICT Literacy Panel was to develop a framework that would define ICT literacy and provide the foundation for the design and conduct of large-scale assessments and diagnostic tests. While the chief benefit of developing a framework for ICT literacy is improved measurement, a number of other potential benefits are also seen as important. Namely,

- A framework provides a common language and a vehicle for discussing the definition and assumptions surrounding the domain.
- Such a discussion provides a mechanism for building consensus around the framework and measurement goals that grow from it.
- We construct a better understanding of what is being measured through the process of developing the framework and linking it to evidence collected from assessment tasks.
- This understanding and its connection to what we say about learners provides an important link between public policy, assessment, and research which furthers the utility of the data that are collected.

To accomplish this task, the panel chose to adopt the process used to develop frameworks for the International Adult Literacy Survey (OECD & STATCAN 1995; OECD & HRDC 1997; OECD & STATCAN 2000) and for the Reading Literacy Survey conducted as part of PISA, the Programme for International Student Assessment (OECD, 1999). This process consists of six steps, shown in the following diagram and explained more fully below (Kirsch 2001).



1. The first step is to develop a working definition of the domain including the assumptions underlying it. Before the definition is developed, the domain and the skills and abilities it encompasses are wide open. It is the definition that sets the boundaries for what will be measured and what will not.
2. Once the definition is developed, it is important to think about the kinds of tasks that represent the skills and abilities included under that definition. Those tasks must then be categorized, or organized, to inform test design and result in meaningful score reporting. Step 2 allows one to move beyond a laundry list of tasks or skills to a coherent representation of the domain that will permit policy makers and others to summarize and report information in more useful ways.
3. Step 3 involves identifying a set of key characteristics that will be used in constructing tasks for the assessment. This may include characteristics of the stimulus materials to be used as well as characteristics of the tasks presented to examinees.
4. In step 4, the variables associated with each task characteristic are specified.
5. In step 5, research is conducted to show which variables account for large percentages of the variance in the distribution of tasks and thereby contribute most towards understanding task difficulty and predicting performance.
6. Finally in step 6, an interpretative scheme is built that uses the validated variables to explain task difficulty and examinee performance.

The work of this panel involved the first two steps: defining ICT literacy and organizing the domain.

C. Defining ICT Literacy

The International ICT Literacy Panel was comprised of educators, technology experts, scholars and industry and labor representatives from Australia, Brazil, Canada, France, and the United States. Our deliberations resulted in the following definition:

ICT literacy is using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate and create information in order to function in a knowledge society.

This definition carries several assumptions made by the panel and therefore it is important to consider each part of the definition in turn.

“ICT...”

Information Technology (IT) has been used for many years, particularly in the United States, and refers to the electronic display, processing, and storage of information, but not necessarily the transmission of the information. The term carries strong historical associations with enterprise data processing and centralized computer services.

However, Information and Communication Technology (ICT) represents the set of activities and technologies that fall into the union of IT and communication technologies. Global industry, international media, and academics increasingly now use ICT to describe this union. The real benefit of adding “communication” doesn’t derive from including specific technologies, such as routers or servers, but from the dynamism implicit in interconnected social, economic, and information networks. ICT is characterized by unprecedented global flows in information, products, people, capital, and ideas. These flows are enabled by ICT: their sheer scale and pace would not be possible without the ability to connect vast networks of individuals across geographic boundaries at negligible marginal cost.

“...literacy is...”

The panel selected the term literacy over other terms such as competency, ability, or fluency that have been used in earlier frameworks (Committee on Information Technology Literacy, 1999). To some “literacy” connotes functional literacy and implies basic or fundamental skills. To the panel, the term literacy implies a universal need, a condition that must be met to enable full and equitable economic and social participation. We view literacy as a tool that may be applied to simple or more complicated contexts — like a hammer that can be used to build a shelf, or a house. In its broadest sense, literacy is a dynamic tool that allows individuals to continuously learn and grow.

The increasing role of technology in our lives requires us to expand our notion of literacy. It is obvious that to function fully and effectively in society, individuals must be literate in terms of traditional domains such as reading and numeracy. But today it is becoming increasingly clear that ICT literacy joins the ranks of essential and fundamental requirements. Perhaps as important is the panel’s belief that those who fail to acquire this new kind of literacy, like the more traditional literacy skills, will find themselves falling further behind as economies and societies grow and change over the years ahead.

“...using digital technology, communications tools, and/or networks...”

The description of digital technology, communication tools, and/or networks reflects the same thinking that stimulated the panel’s use of information and communication technology (ICT) versus information technology (IT). Digital technology reflects hardware and software products, communication tools reflect those products and services used to transmit information, and networks themselves are the pathways for this

transmission. The words are meant to be as inclusive as possible to reflect the breadth of hardware, software, and infrastructures that makeup ICT.

“...to access, manage, integrate, evaluate and create information...”

Technology is used for an ever-increasing range of purposes to accomplish many different kinds of tasks. This phrase is meant to reflect that range as well as to define five critical components of ICT literacy. The five components represent a continuum of skills and knowledge and are presented in a sequence suggesting increasing cognitive complexity. After discussions regarding the kinds of tasks represented by each component, the panel agreed to the following definitions:

- **Access** - knowing about and knowing how to collect and/or retrieve information.
- **Manage** - applying an existing organizational or classification scheme.
- **Integrate** - interpreting and representing information. It involves summarizing, comparing and contrasting.
- **Evaluate** - making judgments about the quality, relevance, usefulness, or efficiency of information.
- **Create** - generating information by adapting, applying, designing, inventing, or authoring information.

“...in order to function in a knowledge society.”

This phrase reflects the range of contexts in which individuals will be able to apply their ICT literacy — from defined ones such as graduating from school or functioning on a job to those which are less defined and less concrete but which can extend and enrich one’s personal life. The phrase “in order to function” is meant to acknowledge the fact that ICT literacy will provide individuals with a means of contributing to and benefiting from economically developed or developing societies. We believe that ICT literacy skills are becoming increasingly important not only for nations to maintain or improve their standard of living but for the well being of individuals as well. The phrase “in a knowledge society” refers to the changing nature of cultures in the 21st century — an age in which ideas and information are increasingly the drivers of progress. The expanding roles of technology and access to information on a global scale have the potential to change, and hopefully improve, the way we live, learn and work.

D. Organizing the Domain

Once we had defined what was meant by ICT literacy and laid out the assumptions underlying that definition, the next step was to develop an organizing framework for ICT literacy. This is an important step because the way in which the domain is organized affects test design and the kinds of tasks that will be developed to provide evidence about the status of ICT literacy in a population of interest. The panel’s task was to define the critical organizing categories for the domain of ICT literacy and how they were related.

In our definition of ICT literacy, we identified five components we view as essential for functioning in a knowledge society: accessing, managing, integrating, evaluating and creating information in a technology context. These components, represented in Figure 1, formed the initial organizational scheme for the domain of tasks that make up ICT literacy.

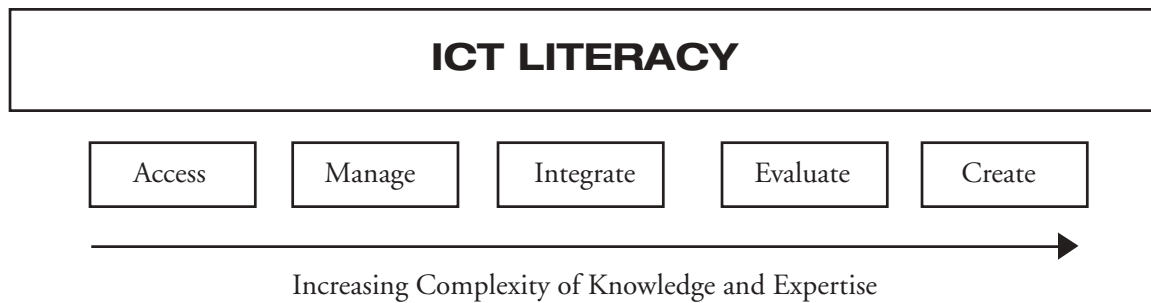


Figure 1.

Upon further consideration, however, we chose to expand this unidimensional model to more fully represent the complexity of ICT literacy. This organizational scheme, shown below in Figure 2, illustrates the foundational set of skills and knowledge that underlie ICT literacy: cognitive and technical proficiency.

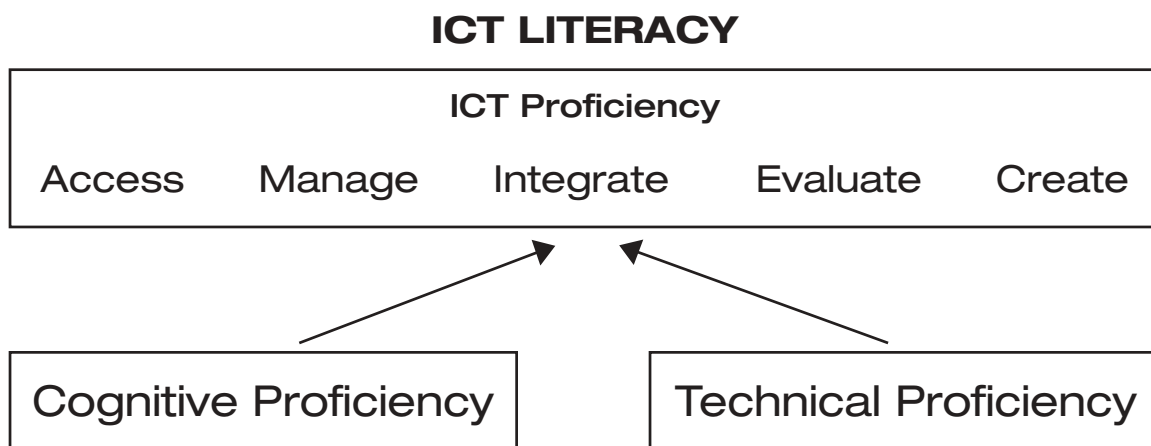


Figure 2.

The three proficiencies are defined as follows.

- **Cognitive Proficiency** — the desired *foundational skills* of everyday life at school, at home, and at work. Literacy, numeracy, problem solving, and spatial/visual literacy demonstrate these proficiencies.
- **Technical Proficiency** — the basic components of digital literacy. It includes a foundational knowledge of hardware, software applications, networks, and elements of digital technology.
- **ICT Proficiency** — the integration and application of cognitive and technical skills. ICT proficiencies are seen as enablers; that is, they allow individuals to maximize the capabilities of technology. At the highest level, ICT proficiencies result in innovation, individual transformation, and societal change.

As conceived in this framework, ICT literacy includes both cognitive and technical proficiency. For example, in order to successfully perform an ICT task such as searching the Internet to find and compare treatment options for a medical condition, an individual must apply reading and problem solving skills

(cognitive) and be able to access information on the Internet using a search engine (technical). While cognitive and technical proficiencies are both necessary components of ICT literacy, each is a distinct domain. Cognitive and technical proficiency each represent independent domains in which the associated knowledge and skills interact to influence ICT literacy. An example is shown below in Figure 3.

	Low Technical Proficiency	High Technical Proficiency
High Cognitive Proficiency	A	B
Low Cognitive Proficiency	C	D

Figure 3.

One would expect that individuals with low cognitive proficiency but high technical proficiency (cell 'D') would be able to perform particular technical tasks in which they had been trained. However, they would probably not possess the kind of generalizable skills or knowledge that could help them work with new applications or perform novel tasks and they would most likely not be able to acquire such skills independently. People with high cognitive proficiency but low technical proficiency (cell 'A') would require technical training (and possibly motivation or practice time) in order to develop ICT proficiency but would be expected to do so and once engaged with ICT would be able to acquire new skills and knowledge quickly and independently.

The representation of ICT literacy shown in Figure 2 provides an organizational scheme for both developing large-scale assessments or individual tests and evaluating existing measures. The framework leaves open the possibility that different constituencies could develop different assessments or individual tests for different purposes by focusing on various parts of the framework itself and by defining the kinds of evidence that might be associated with each. For the purposes of discussion, we present three types of assessments that might be developed using the ICT literacy framework: holistic, component and diagnostic. Each is described in turn below. Additional detail about possible assessment tasks can be found in Appendices A, B and C. These sample tasks are also available in a more interactive form at www.ets.org/research/ictliteracy/index.html.

A holistic assessment would be of most interest to constituencies who wished to focus on how well a test taker completed a given set of tasks rather than on the component skills that make up those tasks. An example would be a task that required test takers to create a flyer for a neighborhood clean-up day. Specific task requirements as well as information such as when and where the event was to be held would be provided and test takers would be scored on how well they completed the final product. (A more detailed illustration of this task can be found in Appendix A.) Such an assessment would allow one to rank order groups or individuals and to make general statements about their ICT knowledge and skills.

Alternatively, one might choose to build an assessment that independently measured the knowledge and skills associated with each of the five components of ICT Proficiency (access, manage, evaluate, integrate and create). This component assessment would result in a measure that could provide general information about the kinds of generative ICT tasks a population, or an individual, could perform. An example of one such task and its associated proficiencies is presented below. (For a more detailed illustration of this task, see Appendix B.)

Scenario: Employees in your company have been asked to provide information about the technology training courses they have taken during the past year. They have sent e-mail messages to their supervisors and each supervisor has forwarded the information to the director of human resources. You've been asked to organize the information, evaluate the extent to which company-based courses are being utilized, and make a recommendation to the human resources department about which courses should be continued next year.

Access	Select and open appropriate e-mails from inbox list.
Manage	Identify and organize the relevant information in each e-mail.
Integrate	Summarize the interest in the courses provided by the company.
Evaluate	Decide which courses should be continued next year, based on last year's attendance.
Create	Write up your recommendation in the form of an e-mail to the vice president of human resources.

But if an individual or a group of individuals performed poorly on this measure, one would be hard pressed to understand or explain why. Were there underlying reading or language problems? Did test takers have sufficient technical knowledge to complete the tasks presented in the ICT measures? To understand what role these other domains contributed one would have to include cognitive and technical tasks in the assessment or test. Alternatively, one might want to focus on particular ICT proficiencies (for example, how well a person can access and manage information) and their underlying cognitive and technical components. This would involve creating tasks that measured these types of skills and knowledge across the three proficiency domains. These measures would provide evidence separating literacy and technology proficiencies from ICT proficiency. Such information would be useful for constituencies such as adult basic education centers interested in diagnosing and remediating problems students are having accessing information on the Internet. A series of tasks that might be appropriate in this context are presented below (and in more detail in Appendix C).

Scenario: Following a stroke, your mother has been diagnosed with an atrial septal defect, or a hole in one section of her heart. While not an emergency, her doctor has recommended open-heart surgery to repair the hole and reduce the risk of additional strokes. You would like to find several reliable sources on the Web that recommend treatment options for this condition.

Access Using a search engine, locate sites that have articles about holes in the heart, or atrial septal defects.

Students having trouble with this basic ICT task could be presented with related cognitive and technical tasks to help diagnose what was causing their difficulty. For example, students might be presented with multiple-choice questions asking them to select the best word or phrase to use when searching for some specified information. Included among the choices might be terms that are overly general or specific. Students having difficulty with this type of task might need practice in defining categories and efficient search strategies. In addition, very basic computer tasks, such as opening a search engine, clicking on sites, and navigating back to the search engine from those sites, might uncover technical skills requiring review or training.

Currently, there are various measures of literacy, numeracy and problem solving being used in large-scale assessments of school age and adult populations. There is also a measure of technical knowledge and understanding that is being used with school-aged populations. These are traditional paper and pencil measures. No attempt has been made, however, to build computer-based tasks to measure the integration of these cognitive and technical domains or to separate out the role each plays in the development of these more generative ICT proficiencies. The panel believes that the measurement of ICT literacy using paper and pencil will limit the ability to assess the full domain of knowledge and skills. Valuable information will be lost if assessment tasks are not embedded in real-world settings incorporating technology. For example, the measurement of an individual's ability to search for and access information would be hindered if the measurement did not provide an opportunity to log onto the Internet or a similar type of environment.

E. Next Steps

As the panel began its deliberations about ICT literacy and how should it be defined and operationalized, we soon recognized that many of our discussions focused around the issue of the digital divide. This divide is commonly defined in terms of connectivity and the inequalities of access that exist both within and across countries. The more important issue the panel recognized was that the true potential of ICT — that is, the ability to transform individuals and societies — came not just from being wired together but also from having the knowledge and skills to use technology and to understand the roles it can play in our lives. As the president of Morris Brown College recently stated, “Merely having access to a box — an information box — does not necessarily mean that you have improved, or that you're more literate, or that you're better able to solve problems in the community” (Young, 2001).

This perspective led the panel to determine what they saw as the important issue facing us as society continues to invest in technologies and as technology continues to alter the way we work and live our lives. Then we wanted to use this storyline as a lead in to the definition of ICT literacy and how it should be operationalized into a framework. This report has taken the initial steps in building a framework by providing a consensus definition of ICT literacy and a model that can be used to further operationalize this construct for a variety of purposes.

The next steps will involve defining the kinds of evidence that should be gathered with respect to each level of the model — ICT, cognitive and technical proficiencies — and the kinds of activities that would elicit that evidence. This evidence and related activities will vary depending on the purpose of the planned assessment or test.

The framework begun with this paper, along with a prototype of online tasks, will allow ETS to discuss the potential for large-scale assessments or individualized tests with potential sponsors. The major stakeholders who will be interested in this framework and its resulting assessments are international and diverse, and therefore create a unique challenge as well as opportunity. They include government policy makers, corporate leaders, industry associations, unions, workforce groups, educators (K-12, higher education, national educational associations, researchers), consumer and public interest groups, and relevant international associations. The buy-in, cooperation, and support of these groups will be essential in the achievement of global ICT literacy.

ICT has become a permanent part of everyday life. It fundamentally changes how we live, learn, and work. Because ICT is considered an emerging and fundamental literacy, significant attention must be paid to insuring that all citizens have access and opportunity to gain the needed skills to function effectively in a knowledge society.

APPENDIX A

Sample Assessment Task — ICT Proficiency

- Holistic assessment of ICT skills and knowledge
- Scenario presented along with a variety of tools (spreadsheet, word processor, etc.)

In this type of assessment, test takers would be evaluated solely on the end product they created (for example, a database, presentation, or document). Component skills would not be isolated and individually assessed. Instead, a scoring scheme would be developed which defined levels of performance and the criteria for reaching each level. This scheme would represent the collective judgments of experts in the field about what adults should know and be able to do in the ICT domain. Below is an example of what one task in a holistic assessment might look like. A complete assessment would include a number of different tasks that vary in difficulty and require a range of ICT knowledge and skills.

Opening Scenario (Community Context)

You've volunteered to create a flyer for a community clean-up day to be held in your neighborhood. Include the map below along with the following information and create an attractive one-page flyer for the event.

The event will take place on Saturday, May 6th from 1:00 until 4:00. Volunteers are being asked to meet at Lincoln Square Park. Event organizers would like a tear-off registration slip to be included on the flyer where volunteers can print their name, address and phone number. The registration forms should be dropped off at the community center on Race Street by May 1st.

			Race
Lincoln Square Park			Washington
	Lincoln	Walnut	Erie
			South

To complete this task, test takers would need to use a word processing program to create a flyer. The final product would be scored on the accuracy and completeness of the information it contained (e.g., did the flyer include all the relevant information about dates and times, the map and the tear-off registration form?). Additional scoring points might include evaluating the layout and inclusion of graphic elements (borders, lines, etc.).

APPENDIX B

Sample Assessment Task – ICT Components

- Focus on the components of ICT proficiency: access, manage, integrate, evaluate, and create
- Present a scenario followed by tasks addressing each of the five components

Below is an example of what one task in this type of assessment might look like. A complete assessment would include a number of different tasks that vary in difficulty and require a range of knowledge and skills in technical, cognitive, and problem-solving domains.

Opening Scenario (Workplace Context)

Employees in your company have been asked to provide information about the technology training courses that they have taken during the past year. They have sent e-mail messages to their supervisors and each supervisor has forwarded the information to the director of human resources. You've been asked to organize the information, evaluate the extent to which company-based courses are being utilized and make a recommendation to the human resources department about which courses should be continued next year.

The Five Components

Based on this scenario, test takers would be presented with a series of tasks. Each task would be designed to measure one of the five components, as summarized in the chart below. While the sequence in which individual test takers undertake these tasks might vary, each component could be scored discretely in order to better understand its relative contribution to an individual's overall ICT proficiency.

Access	Select and open appropriate e-mails from inbox list.
Manage	Identify and organize the relevant information in each e-mail.
Integrate	Summarize the interest in the courses provided by the company.
Evaluate	Decide which courses should be continued next year, based on last year's attendance.
Create	Write up your recommendation in the form of an e-mail to the vice president of human resources.

Test takers might work from a screen that presents all of the task components and allows them to select the order in which they complete those tasks. An alternate approach would be have test takers work through a structured series of tasks with the first component presented, followed by the second component and so on.

A more detailed description of the component tasks is presented below.

Access and Manage Task

Task Description: *Seven supervisors have sent information about training courses to Ann Simpson, Director of Human Resources, and she has forwarded them to you. Find and open each of those e-mails in your inbox. Select the text from each e-mail that provides information about training course attendance and copy it all into a single file.*

Test takers would be presented with a simulated inbox, similar to the sample shown below. Some might chose to open all the e-mails and then select the relevant information. Others might open one e-mail, select the critical information and then move on to the next. Whatever the sequence, to complete the task correctly test takers would be expected to open each of the correct e-mail messages and paste all the relevant information into a file.

Sample In-Box:

FROM	SUBJECT	RECEIVED	SIZE
Simpson, Ann	FW: Training	12/17/01 10:32 AM	3 KB
Simpson, Ann	FW: Course Information	12/17/01 10:44 AM	2 KB
Davidson, Denise	RE: Lunch	12/17/01 10:57 AM	7 KB
Simpson, Ann	Work Objectives	12/17/01 11:11 AM	5 KB
Simpson, Ann	FW: Classes Taken	12/17/01 11:27 AM	3 KB
Corporate Communique	Virus Alert	12/17/01 12:01 PM	4 KB
Simpson, Ann	FW: Courses This Year	12/17/01 12:15 PM	4 KB
Simpson, Ann	FW: Training Classes	12/17/01 12:49 PM	2 KB
Gonzalez, Frank	Team meeting	12/17/01 1:08 PM	8 KB
Simpson, Ann	FW: Thursday Staff Meeting	12/17/01 1:11 PM	3 KB
Simpson, Ann	FW: Training Courses	12/17/01 1:59 PM	2 KB
Salverston, Amy	RE: Phone Billing	12/17/01 2:14 PM	6 KB
Mirano, Leslie	Training Class Question	12/17/01 2:48 PM	5 KB
Jenkins, Ralph	Update	12/17/01 3:19 PM	3 KB
Simpson, Ann	Memo for Davidson	12/17/01 3:21 PM	4 KB
Ellis, Edward	Re: Phone Conference	12/17/01 3:56 PM	2 KB
Simpson, Ann	FW: Staff Training Courses	12/17/01 4:17 PM	2 KB
Rogers, Charlie	FW: Memo Format	12/17/01 4:45 PM	3 KB

Sample e-mail with relevant sentences highlighted:

Ann – Jason and I met yesterday and have a schedule for the next team meetings. We will send that information out to everyone later today. Here is the information you requested about training courses. In my area, 25 people took one or more training classes this year. 15 people took Learning Excel, Level 1 (March 27 and 28), 20 took Introduction to Outlook (June 3 and 4) and 5 took Flash, Level 2 (October 19 and 20). The first two courses were given on site and the last was at the community college. We have gotten particularly positive feedback about the Outlook course. Let me know if you need any additional information.

- E. O'Brien

Integrate

Task Description: *You want to look at all the information the supervisors have provided so that you can see which of the courses taught at the company were most popular. Represent that information in a way that will help you make the recommendation about which courses to continue next year.*

Test takers would need to decide the best way to integrate and compare the information they have selected in the previous task. They might present the information in a list or series of lists, in a table, etc. In the sample response shown below, the information from the seven e-mail messages has been used to create a table that allows one to quickly compare course location and attendance across courses.

Sample response:

LOCATION	NAME OF COURSE	NUMBER OF EMPLOYEES
On site	Learning Excel	31
On site	Introduction to Outlook	50
On site	Visual Basic	5
On site	HTML	25
On site	Networking Essentials	2
Advantex Computer Training	C++	5
Community college	Flash, Level 2	5
Community college	Windows NT	17

Evaluate and Create

Task Description: Using last year's attendance figures for courses offered by the company, decide which courses should be offered next year. Write an e-mail to Ann Simpson with your recommendation, including as attachments any tables or charts that support your position.

Test takers would need to identify the on-site courses with the best attendance based on the supervisor's reports. They would then to write up their recommendation and attach supporting documentation. Scoring models would be created to focus on the skills and knowledge deemed most relevant to assess for a particular population. For example, one might be interested in the extent to which test takers were able to support their recommendation with evidence from the original supervisor's e-mails, the sophistication of supporting documentation, or the test taker's ability to use software to create tables or graphs.

APPENDIX C

Sample Assessment Task — Diagnostic Assessment

This type of assessment would allow one to investigate the cognitive and technical proficiencies underlying particular ICT components. On the surface, the Diagnostic Assessment would look exactly like the assessment of ICT Components. Only if and when test takers had difficulty with a component task would they see new types of tasks designed to assess underlying cognitive and technical skills.

The results of this kind of assessment could be used in a variety of ways:

- The assessment could provide an overall score of a person's ICT, cognitive and technical proficiency.
- A more detailed score reporting system might be developed that profiled specific strengths and weaknesses that an individual demonstrated.
- Links to existing or specially developed instructional materials could be provided to help teachers in education or training settings.
- Based on a person's performance, targeted instructional goals and suggestions on how best to reach those goals could be made available.

Just like in the ICT Component assessment, a number of scenarios in different contexts would be presented. One sample scenario, developed in a health context, is shown below.

Opening Scenario (Health Context)

Following a stroke, your mother has been diagnosed with an atrial septal defect, or a hole in one section of her heart. While not an emergency, her doctor has recommended open-heart surgery to repair the hole and reduce the risk of additional strokes. You would like to find several reliable sources on the Web that recommend treatment options for this condition.

The Five Components

Based on this scenario, test takers would be presented with a series of tasks organized around the five components, as summarized in the chart on the following page.

Access	Using a search engine, locate sites that have articles about holes in the heart, or atrial septal defects.
Evaluate	Evaluate the sites and identify three that you would expect to provide reliable medical information.
Manage	Identify the treatment information in each article.
Integrate	Compare and contrast the treatment options suggested in the articles.
Create	Develop a Word document with treatments listed (citing sources) to share with physician.

As each task was completed it would be automatically scored. If a test taker did not complete a task correctly, related cognitive and technical tasks would be presented to try and determine if one or both of those areas were contributing to the individual's difficulty.

An example of how the Access task might be broken down follows.

Access Task

Task Description: *Use the search engine provided to find three sites with information about your mother's medical condition as described in the opening scenario.*

Assessing Underlying Technical Skills

If a test taker did not complete the task correctly, one question would be whether he or she had the requisite technical skills. Technically, this access task requires test takers to open up a browser, type a word or phrase into the text entry box, and click on the Search button. They might additionally need to open a site and then navigate back to search engine. As an individual test taker completed this task, the computer would record clicks, typing and other actions. Based on the test taker's responses, additional discrete computer-based tasks might be presented (e.g., "Type the phrase 'Movie Listings' into the search box" or "Click on the button that will take you back to the search page") to assess the technical skills underlying this basic Access task.

Assessing Underlying Cognitive Skills

Cognitively, this access task requires a test taker to select or invent a search term that would yield the requested information. Some of the words or phrases in the task description and scenario would be more likely than others to provide the information needed. For example, typing in the phrase "hole in the heart" in one browser would yield the results shown below, none of which would be likely to include the information needed.

Web Images Groups Directory
Searched the web for **hole in the heart** Results 1 - 10 of about 918,000. Search took 0.20 seconds.

Category: [Health > Conditions and Diseases > ... > Heart Disease > Congenital](#)

Healing the Hole in a Heart
... just what the doctor ordered". Nancy Mac Isaac authored Healing the **Hole** in A **Heart**, One Birthmother's Journey Into the Adoption Triangle 1998 to help others ...
www.adoptshop.com/healholinhea.html - 37k - [Cached](#) - [Similar pages](#)

Hole in my Heart
since 29.Feb.2000. *** **Hole** in my **Heart** *** 202.Dec.2001 ?
refresh! open! <????????????? ...
www.edit.ne.jp/~moro/ - 6k - [Cached](#) - [Similar pages](#)

Korean War Vet Has Hole in Heart (washingtonpost.com)
News Home Page News Digest ... Korean War Vet Has **Hole** in **Heart**, ... The Associated Press Friday, November ...
www.washingtonpost.com/wp-dyn/articles/A38948-2001Nov30.html - [Similar pages](#)

ERTV : Episode Guide
... A **Hole** In The **Heart**. Ross follows Weaver as she rushes baby Josh up to the pediatric intensive care ...
www2.warnerbros.com/web/ertv/episode_guide.jsp?season=4 - 27k - 10 Feb 2002 - [Cached](#) - [Similar pages](#)

I a cat-shaped hole in my heart
... a common love for cats, Projekt presents this unique compilation, a cat-shaped **hole** in my **heart**. Each band contributed a song about their own cat and donated ...
www.projekt.com/cat/thecd.html - 4k - [Cached](#) - [Similar pages](#)

Typing in the more general term, “heart,” would result in the following types of sites.

Web Images Groups Directory
Searched the web for **heart** Results 1 - 10 of about 23,300,000. Search took 0.04 seconds.

Category: [Health > Conditions and Diseases > ... > Heart Disease > Resources](#)

American Heart Association
... American **Heart** Association . This February, Be an American Heartsaver! February is American ...
Description: Information and education about **heart** and stroke disease.
Category: [Health > Conditions and Diseases > ... > Heart Disease > Organizations](#)
www.americanheart.org/ - 31k - 10 Feb 2002 - [Cached](#) - [Similar pages](#)

The Heart: An Online Exploration
... The **Heart**: An Online Exploration. ... Our Table of Contents will help you find your way through the exhibit. Visit The **Heart** - Save \$10.00 on Museum Membership! ...
Description: An online exploration of the **heart** for kids.
Category: [Kids and Teens > Health](#)
sln.fi.edu/biosci/heart.html - 7k - 10 Feb 2002 - [Cached](#) - [Similar pages](#)

Preview The Heart
... A text version of the above image map is available. Visit The **Heart** - Save \$10.00 on Museum Membership! ... GO: Begin Your Tour of The **Heart**.
Description: All about the **heart**, how to keep a healthy **heart**, **heart** disease, blood vessels, pulmonary system,...
Category: [Health > Conditions and Diseases > ... > Heart Disease > Resources](#)
sln.fi.edu/biosci/preview/heartpreview.html - 5k - [Cached](#) - [Similar pages](#)
[[More results from sln.fi.edu](#)]

National Heart, Lung, and Blood Institute (NHLBI)
Go to text only home page. Special Web Pages and Interactive Applications.
Act in Time to **Heart** Attack Signs. ...
Description: Information for professionals and the general public about **heart** and vascular diseases, lung diseases,...
Category: [Health > Medicine > Surgery > Cardiothoracic > Hospital Departments](#)
www.nhlbi.nih.gov/ - 13k - [Cached](#) - [Similar pages](#)

The word or phrase test takers used for their query would provide the basis for scoring this task (with a more precise phrase such as “atrial septal defect treatment” resulting in a higher score than “treating heart”). The program might also track if test takers refined their search based on the results each search yielded. If a test taker did not perform well on this task, other less open-ended tasks might be presented. These might include multiple-choice questions that asked test takers to select from the choices provided the best term to search for specified information. Questions that focused on general versus specific categories might provide additional diagnostic information. Another possibility would be to present a similar search task that was not computer based, such as locating specified information in the Yellow Pages and seeing if the test taker could successfully complete that task. The goal of any of these or additional follow-up tasks would be to try and identify underlying areas of difficulty that might be contributing to poor performance on the computer search task.

APPENDIX D: PANEL MEMBERS

Barbara O'Connor, Ph.D. — Chair
Sacramento, California, USA

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Dr. O'Connor is a tenured Professor of Communications & Media at California State University, Sacramento. She also directs the University's Center for the Study of Politics and Media. As Chair of both the California Educational Technology Committee and the California Technology CEO Task Force, she worked closely with government and industry leaders to develop the master plan for technology for the California Department of Education. The report *Connect, Compute and Compete* is recognized in educational technology as groundbreaking on many of the access, cost, and implementation issues.

Dr. O'Connor is also a founder and Former Chair of National Alliance for Public Technology, a national advocacy group focused on universal access and telecommunications reform — a key player in the national telecommunications reform policy signed by President Clinton in 1996. She has served on advisory initiatives for technology leaders, such as ATT, Pacific Bell, SBC Communications, and VERIZON, and is considered an international spokesperson on educational technology, communications and media policy and issues.

Paul A. Anderson
Washington, DC, USA

e-mail: panderson@att.net

Mr. Anderson served as the Director of Apprenticeship, Benefits, and Employment for the Communications Workers of America (CWA). CWA represents more than 730,000 workers in the fast-growing telecommunications, broadcasting, media, information technology, and cable service industries. CWA's membership also includes about 90,000 workers employed in the public sector.

His assignments included directing and serving as a resource for the Joint Apprenticeship, Certification Programs, H1B technical training initiatives, Military to Work Program, Employment Centers, and Benefits Administration initiatives.

After serving in the U. S. Navy, Mr. Anderson worked as a telephone technician for 18 years with Wisconsin Telephone and AT&T where he became a union activist. He served as a local union officer for 14 years before accepting a full-time position with CWA in 1982. He was transferred to CWA's Washington, DC headquarters in 1985 to head up various administrative functions. While in Washington, Anderson completed his undergraduate degree and earned an MBA from George Washington University in 1994.

Marjorie Bynum

Arlington, Virginia, USA

e-mail: mbynum@itaa.org

Ms. Bynum is Vice President of Workforce Development at the Information Technology Association of America (ITAA) in Arlington, VA. In her role as Vice President, Marjorie oversees all of ITAA's numerous workforce and education initiatives that address the critical shortage of skilled information technology (IT) workers in American industry. She was responsible for leading the recent industry effort that released the report, *Bridging the Gap- Information Technology Skills for a New Millennium*. Her responsibilities also include initiating and developing new partnerships among industry, academia, and government; coordinating an annual Workforce Convocation event for stakeholders on this issue; raising awareness about the career opportunities in IT; and lobbying on legislative issues dealing with IT training and education.

Prior to joining ITAA, Marjorie worked at the American Association of Community Colleges (AACC) in Washington, DC, where she managed a number of major workforce initiatives and planned a major Workforce Development Institute conference. She also served as an adjunct professor of English at Montgomery Community College in Rockville, MD for three years. Marjorie holds an undergraduate degree from North Carolina State University and an MA in English from the University of Maryland at College Park.

Patrick Gaston

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Mr. Gaston is Executive Director of Verizon Strategic Alliances/Government Relations and is responsible for outreach and relationship building with a wide variety of external constituents including state and local government, ethnic minority advocacy, consumer, disability, seniors, think tanks, trade associations and education organizations. Prior to his current position, Mr. Gaston was an Assistant Vice President for Bell Atlantic Communications Inc., a provider of long distance service. Before joining the Bell Atlantic Corporation, Mr. Gaston worked in the health care, travel and journalism industries in Canada, France and the United States.

Mr. Gaston holds a Masters in Business Administration in International Management/Business from Northeastern University. He earned an International Certificate in Business from L'Ecole Supérieure de Commerce in Reims, France and is a fellow at the Aspen Institute. He received his undergraduate degree from the University of Massachusetts.

Mr. Gaston is a member present and past of several boards including: National Children's Latino Institute, World Institute on Disability, National Foundation for Women Legislators, American Cancer Society's William B. Price Unit, Generations United and the NAACP. He is also chair of Generations United's Public Policy committee. He is a Corporate Fellow of the National Governors Association and is on the Executive Committee of the Council of State Governments Eastern Regional Conference and is a member of the ETS Communications and Technology panel on E-Literacy.

Mr. Gaston is a frequent speaker on telecommunications policy and the digital divide. He has also made television and radio appearances in his attempt to bring national and international attention to these issues.

Maria Helena Guimaraes de Castro
Brasilia, Brazil

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Since 1995, Ms. Guimaraes de Castro has served as the President of the National Institute for Educational Studies and Research in Brazil. She has extensive international experience in the area of testing and evaluation. Among many other appointments, her credits include serving as Representative for Latin America and the Caribbean on the Governing Board of UNESCO's International Institute for Statistics, as Coordinator for Brazil of the EFA 2000 Assessment, as Brazilian Representative on the World Education Indicators Project — WEI, for OECD and UNESCO, and as Coordinator for Line of Action for Educational Evaluation and Indicators for the SUMMIT OF THE AMERICAS. She also represents Brazil in the Board of Participating Countries of PISA.

Ms. Guimaraes de Castro holds a Master's Degree in Political Science, and is a Doctoral Student in Political Science at the University of Sao Paulo, Brazil.

Joyce Malyn-Smith, Ed.D.
Newton, Massachusetts, USA

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Dr. Malyn-Smith is a Senior Project Director in the Center for Education, Employment, and Community at Education Development Center, Inc. in Newton, Massachusetts. Dr. Malyn-Smith plays a key role in three national IT projects. She is Principal Investigator for the NSF funded IT Applications Across Career Clusters, developing a common language and framework for IT applications across industry sectors. She is Project Director for the Office of Vocational and Adult Education's Information Technology Career Cluster Initiative (ITCCI) that is developing a national career cluster model and curriculum framework for careers leading to the design, development, management and support of hardware, software, multi-media and systems integration services. Dr. Malyn-Smith is EDC's Project lead for the Techforce Initiative funded by the National School-to-Work Office to highlight and expand participation of IT employers in school-to-work nationally.

Since 1992 she has been involved in the development and implementation of voluntary industry skill standards and has co-authored skill standards implementation guides, including *Making Skill Standards Work* (NSSB/DOL). She has worked with the states and national groups of educators in developing strategic plans to integrate skill and academic standards; and is developing standards-based scenario assessments.

Prior to joining EDC, Dr. Malyn-Smith served for more than 20 years on the staff of the Boston Public Schools. An author and speaker, Dr. Malyn-Smith holds an undergraduate degree from Universidad Interamericana in Puerto Rico, a Masters in Education from Boston State Teacher's College and a Doctorate from Boston University.

Barry McGaw, Ph.D.

Paris, France

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Barry McGaw is Deputy Director for Education in the Directorate for Education, Employment, Labour and Social Affairs of the Organisation for Economic Co-operation and Development (OECD) based in Paris. In this role, he is responsible for the work on education within OECD. Prior to taking up this appointment in September 1998, Dr. McGaw had been Professor of Education at Murdoch University in Perth, Western Australia from 1976 to 1984. From 1985 to 1998, he served as Executive Director of the Australian Council for Educational Research, an independent, not-for-profit company, based in Melbourne, with an international research and development program.

In 1970, while a Ph.D. student at the University of Illinois, he spent the two months at ETS as part of the summer program for doctoral students.

Richard Methia, Ed.D

Fairfax Station, Virginia, USA

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Dick Methia is a nationally known consultant in education technology policy and leadership training. President of his own consulting firm, Methia currently serves as president of the National Coalition for Technology in Education and Training (NCTET), a Washington, D.C.-based leadership coalition of technology stakeholders representing national education associations and many of the Nation's foremost technology companies. He is a member of the Board of Directors of LinkAmericas, a California non-profit that cultivates technology-based strategic alliances between academic and private sector partners in the United States and Central America.

In June 1985 Methia, a 20-year veteran of the classroom, was chosen from 11,000 applicants worldwide to be one of the ten National Finalists in NASA's Teacher-In-Space Program for the seat aboard Challenger eventually filled by his colleague Christa McAuliffe. Methia was stationed at NASA Headquarters, Washington, D.C., where he served as liaison to national education organizations and conducted an international speaking tour. For his efforts in 1988 NASA bestowed on him its prestigious Public Service Award.

In further recognition of his contributions to education, the Air Force Association named Methia a General Jimmy Doolittle Fellow, an award he received from the (late) General Doolittle himself.

Methia is also an accomplished public speaker. He was the first U.S. educator invited to Beijing, China to deliver the keynote address in the Great Hall of the People at the American-Chinese Youth Science Exchange.

Leslie Ann Taylor
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Leslie Taylor joined DynCorp in 1997 as Director of Employment. She was responsible for identifying and recruiting top tier IT talent into the international technology company, and assisting executive management in the development and implementation of strategic e-recruiting and retention methods. Prior to joining DynCorp, Leslie worked at Computer Sciences Corporation recruiting and staffing senior level IT talent. She recently left DynCorp and is now an independent HR Consultant.

Leslie is a graduate of Leadership Fairfax- Class of 2000. Leadership Fairfax, Inc. is a membership organization that brings together the best and brightest representatives of industry, government, education, and the community who make up Fairfax County.

Leslie is currently pursuing a doctorate degree in Human Resources at Virginia Tech University. She holds a Masters Degree in Human Resources Management & Development. She received her Bachelor's Degree in Business Administration from Howard University. Additionally, she is a member of SHRM (Society of Human Resource Management & Development), Women in Technology, Project SAVE, the Washington Board of Trade - Workforce Group, and ITAA. Leslie also participates in several workforce initiatives and programs.

Participating Organizations

Vivian Guilfooy
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Vivian Guilfooy is a vice president of Education Development Center, Inc. (EDC) and Director of its Center for Education, Employment, and Community. She offers more than 30 years experience in designing, managing, evaluating, and disseminating model programs in workforce development, education reform, and community development. Her special interest is facilitating partnerships and strengthening systems that help all learners achieve to high standards, especially those who face multiple obstacles in school or work. Many projects focus on the use of information and communications technologies as a tool for success.

Examples include America Connects Consortium, a national effort to build the capacity of community technology centers and educational organizations providing technology access to people in poor communities; Building Linkages, a national consortium for designing and implementing new pathways to careers in information technology; Techforce, a national initiative to increase employer participation in school-to-career programs in ICT arenas; Neighborhood Networks, providing technical support to more than 400 HUD community technology learning centers that promote self-reliant neighborhoods for low-income families; the Gender and Diversities Institute and WEEA Equity Center, promoting high achievement for girls and women around the world; Rompiendo Barreras...Breaking Barriers, a community empowerment model that serves Latino women and their families; and Young Leaders, bringing 13-17 year-olds together to design local

initiatives, develop their own websites, and conduct online panel discussions for service providers and other youth around the world. She also served as a Principal Investigator for Community Technology Centers Network (CTCNet), helping build CTCNet from a group of 50 centers to an independent, self-governing nonprofit organization with over 550 affiliate members. Ms. Guilfooy received her BS in Social Sciences from the University of Pennsylvania and her MA in Educational Research from the University of Pittsburgh.

Scott Murray

Ottawa, Ontario, Canada

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Scott Murray was recently appointed to the post of Director General, Social and Institutional Statistics after spending roughly 23 years in the Special Surveys Division at Statistics Canada. Mr. Murray specialized in the design and conduct of large-scale ad hoc surveys to meet emerging public policy issues. His own work has included studies of volunteer international comparative work, childcare usage, longitudinal labor market activity and the assessment of adult skill. Mr. Murray holds an Honors BA in Business Administration from the University of Western Ontario.

Eugene Owen

Washington, DC, USA

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Eugene Owen is Director of the International Activities Program at the National Center for Education Statistics of the U.S. Department of Education. Dr. Owen has worked within the Department and with foreign governments and agencies to develop and improve international indicators of education. He represents the United States to international organizations, such as the Organization for Economic Cooperation and Development, and is chair of several international committees charged with developing international education indicators. Dr. Owen holds a Doctorate in Rural Sociology from the University of Maryland.

Educational Testing Service (ETS) Staff

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Irwin Kirsch

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Irwin Kirsch is a Senior Research Director and the Director of the Center for Global Assessment at ETS. Since joining ETS in 1984, he has directed a number of large-scale assessments including the first International Adult Literacy Survey. Other large-scale assessments include the National Adult Literacy Survey, the U.S. Department of Labor Workplace Literacy Assessment, and the NAEP Young Adult Literacy Survey. In 1987, he received the ETS Research Scientist Award for his work in this area and was recently named as an ETS Distinguished Presidential Appointee.

Mr. Kirsch's research interests include the psychology of literacy, issues of comparability and interpretability in large-scale assessments, and using technology to link learning and assessment.

Marylou Lennone-mail: mlennon@ets.org

Marylou Lennon is a consultant to the Center for Global Assessment. Prior to her consulting position, she worked as an ETS staff member on a variety of literacy projects including large-scale assessments, individualized tests and a multimedia instructional system for teaching functional literacy skills. She also co-developed a series of on-line tutorials to familiarize examinees with computer-based tests, including the Test of English as a Foreign Language (TOEFL). As a member of ETS's Technology Research Group, Ms. Lennon worked on research and development projects to design the interface for new computer-based tests. Her research interests focused on the effects of presentation variations, such as screen resolution and font size, on test performance.

Ellen B. Mandinache-mail: emandinach@ets.org

Ellen Mandinach is a Senior Research Scientist in the Center for Higher Education at ETS. She received her Ph.D. in educational psychology from Stanford University in 1984. She joined ETS in 1985 following postdoctoral work at the University of California, at Berkeley, and the Far West Laboratory for Educational Research and Development, in San Francisco.

Ms. Mandinach's research has focused on the implementation and impact of computer environments on learning and the measurement of individual differences in cognitive and affective processes.

Pamela Smithe-mail: phsmith@ets.org

Ms. Smith is a science and math program developer in the National Assessment for Educational Progress at ETS. She has recently joined ETS, bringing with her a rich background in education, biological sciences and computer sciences. Ms. Smith carries degrees in education as well as biochemistry with an M.S. degree in Computer Science. She is currently finishing her Ph.D. in Computer Science. Prior to joining ETS, Ms. Smith served as Vice President in the Architecture and Infrastructure Technology group for the past six years at a major Wall Street firm.

She is currently serving as President on the board of directors for the Professional Association for SQL Server serving more than 15,000 users. Ms. Smith was also appointed to the Executive Advisory Board, MIT Media Lab 1998-99, Executive Operating Committee, MIT/Merrill Lynch partnership 1998-99 and the Enterprise Developer Advisory Board, Microsoft Corporation 1999-2000.

Project Advice and Counsel**Brenda Kempster**e-mail: brenda@kempstergroup.com

Palm Desert, California, USA

Brenda Kempster is President and founder of Kempster Group a consulting firm focused on the education technology market development and strategic alliances. She founded Kempster Group in 1993, after serving

as Executive Director of the Education Business Unit at Pacific Bell. She is a nationally known advocate of educational technology and telecommunications, and has served on many national and international committees and panels.

She has been honored for achievements in telecommunications, public relations, and government relations, and served as Chair of the National Coalition for Technology in Education and Training — a role in which she assisted the White House in developing policy and strategic alliances for the national information infrastructure.

She is a former member of the California Commission for Planning and Technology, and served as principal consultant to California Department of Education on the Task Force that recommended the master plan for technology in its report *Connect, Compute, Compete*.

Brenda was named as one of 100 most influential in telecommunications by *Federal ComputerWeek Magazine*, and received the prestigious Federal 100 Award. She is also the recipient of the International Association of Business Communicators' (IABC) Gold Quill Award in Government Relations.

She has a BA in Spanish and History from California State University, Long Beach, and an MA in Public Administration from the University of San Francisco.

John Schweizer
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Mr. Schweizer retired after 25 years from Pacific Bell in 1999, where he was Director, External Affairs. He directed the company's response to controversial public policy issues by building public interest coalitions and working closely with consumer advocates, academics, regulators, and legislators. He shaped the corporate reputation through product deployment strategies, technology demonstration projects, consumer education, and philanthropy. He also developed public policies for privacy, service quality, disability issues, the digital divide, and fraud.

Mr. Schweizer was also Chief of Staff for State Senator Jackie Speier (San Francisco / San Mateo) during 1999-2000.

He is a former board member of the American Civil Liberties Union, the Alliance for Technology Access and the Center for Accessible Technology. He also served on the advisory boards of the World Institute on Disability, Accessible Software for All People, The University of San Diego's Center for Public Interest Law: Privacy Rights Clearinghouse, Berkeley High School — Computer Academy, CompuMentor, Horizons Foundation and Consumer Action's National Consumer Resource Center.

Mr. Schweizer received a BA in history from Pomona College. He is now a consultant in France.

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