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DEVELOPING INTERNATIONAL EDUCATION DIGITAL COMMUNICATIONS STANDARDS:

Creating A Domain Model And Recommended Student Assessment Procedures

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Abstract

The paper discusses the background and opportunity for developing international education standards for Digital Communications. Several threads of research suggest advantages for standards. However, the rapid, ongoing change in digital communications means that such standards must remain responsive to new innovations in the tools and technologies for digital communications, with appropriate revisions and updates.

It is essential to keep these goals in mind when developing standards. The International Digital Communications Standards Advisory recognizes the benefits, the limitations, and the time scale needed for setting standards and fully expects that the standard-setting process should encourage, not inhibit, innovation. Clearly, assessments and curriculum need to be designed in tandem so we cannot set standards without also thinking about how and where they will be included in the curriculum.

It is essential that we think about how digital communication standards can be incorporated into existing educational courses so as to make the courses more effective and responsive to advanced Information and Communications Technology (ICT).

Assessments of progress in digital communications require careful attention to the varied use of these resources in different fields. An expert in environment science requires different information and communication knowledge and skills than an expert in medieval literature. The International Digital Communications Standards Advisory recommends that existing curriculum standards and assessments be integrated and infused with these emerging digital communications standards.

To illustrate how standards might be developed and refined based on advances in education and technology, we offer a preliminary domain model. Exemplary student assessment principles, procedures, and resources are presented. Recommended steps in the development of assessment items and tasks are reviewed. Sample items and performance tasks are illustrated. Alternative validation models are presented. Value implications, social consequence and relevance, and use issues are addressed for these Digital Communication Standards. Conclusions and recommendations for future research, development, and evaluation are addressed.

SECTION 1: BACKGROUND AND NEED FOR INTERNATIONAL EDUCATION DIGITAL COMMUNICATION STANDARDS

National Educational Technology Standards for Students (NETS•S)

The International Society for Technology in Education (ISTE), a professional organization with a worldwide membership with educational technology leaders, has developed a set of National Educational Technology Standards (NET•S) (2002) to help educators assess the technology literacy of K-12 students. Other groups have also offered standards to help educators think about how to design instruction (e.g., FITness Report, NAS, 1999). Given the complexity of curriculum design and the overwhelming number of standards already constraining schools, it is essential that standards be designed with usability in mind.

The ISTE standards also include profiles of standards for technology-literate students specifying the types of knowledge and performance skills that should be developed for educational grade groups PK-2, 3-5, 6-8 and 9-12. Table 1 lists the major categories of the ISTE NET•S standards, where phrases relevant to the purpose of this report have been coded in bold red italics. Note the presence of productivity, communication, research, problem-solving and decision-making tools in these educational technology standards.

Table 1: NET·S Standards

NATIONAL EDUCATIONAL TECHNOLOGY STANDARDS FOR STUDENTS (NET·S)
1. Basic (educational technology) operations and concepts
2. Social, ethical and human issues
3. Technology ***productivity tools***
4. Technology ***communication tools***
5. Technology ***research tools***
6. Technology ***problem-solving and decision-making tools*** (Kelly and Haber, p. 13.)

In 2006 ISTE published a set of resources for student assessment of the NET•S skills (Kelly and Haber, 2006). Representative samples of the grade cluster skills from these standards relevant to this paper are presented in Table 2 (numbers that follow the profile or objective statements refer to

the NETS standards in Table 1 above). Phrases relevant to digital communications tools and technologies are coded in bold red italics to highlight the pervasiveness of digital communications in the ISTE grade group profiles for technology-literate students.

Table 2: Sample Profiles for Technology-Literate Students

Grades 3-5

- "Use technology tools (e.g., multimedia authoring, presentation, Web tools, digital cameras, and scanners) for individual and collaborative writing, communication, and publishing activities to create knowledge products inside and outside of the classroom. (3, 4)
- Use telecommunications efficiently and effectively to access remote information, communicate with others in support of direct and independent learning and pursue personal interests. (4)
- Use telecommunications and online resources (e.g., e-mail, online discussions, Web environments) to participate in collaborative problem-solving, activities for the purpose of developing solutions or products for audiences inside and outside the classroom. (4, 5)
- Determine when technology is useful and select the appropriate tool(s) and technology resources to address a variety of tasks and problems. (5, 6)
- Evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information resources. (6)"

Grades 6-8

- "Demonstrate knowledge of current changes in information technologies and the effect those changes have on the workplace and society. (2)
- Design, develop, publish, and present products (e.g., Web pages, videotapes) using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (4, 5, 6)
- Collaborate with peer, experts, and others using telecommunication and collaborative tools to investigate curriculum-related problems, issues, and information, and to develop solutions or products for audiences inside and outside the classroom. (4, 5).
- Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems. (5, 6)
- Research and evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources concerning real-world problems. (2, 5, 6)"

Grades 9-12

- "Identify capabilities and limitations of contemporary and emerging technology resources and assess the potential for these systems and services to address personal, lifelong learning and workplace needs. (2)
- Use technology tools and resources for managing and communicating personal/professional information (finances, schedules, addresses, purchases, correspondence). (3, 4)
- Routinely and efficiently use online information resources to meet the needs for collaboration, research, publications, communications, and productivity. (4, 5, 6)
- Select and apply technology tools for research, information analysis, problem solving and decision making in content learning. (4, 5)
- Collaborate with peers, experts, and others to contribute a content-related knowledge base by using technology to compile, synthesize, produce, and disseminate information, models and other creative works. (4, 5, 6)" (Kelly and Haber, pp. 14-15.)

In implementing NET•S, teachers should determine how these standards can best be tailored, applied and localized to the specific content disciplines. New developments in global positioning satellites, digital photography, digital audio, digital video, visualization and modeling, computer programming languages, web information access, and open source operating systems and utilities necessitate that teachers adjust these general standards to dovetail with the specific content area standards.

Fluency in Information Technology

In 1999 the National Research Council (National Academy Press, 1999) convened a panel of experts in information technology and published a set of national intellectual capabilities, information technology concepts, and information technology skills that were seen as being useful for all students.

As noted in the publication,

"Information technology is playing an increasingly important role in the work and personal lives of citizens. Computers, communications, digital information, software--the constituents of the information age--are everywhere.

Between those who search aggressively for opportunities to learn more about information technology and those who choose not to learn anything at all about information technology, there are many who recognize the potential value of information technology for their everyday lives and who realize that a better understanding of information technology will be helpful to them."

This National Academy of Science panel recommended a shift from 'computer literacy' to 'Fluency In Information Technology (FITness).' The report notes, "People fluent with information technology (FIT persons) are able to express themselves creatively, to reformulate knowledge, and to synthesize new information. Fluency with information technology (i.e., what this report calls FITness) entails a process of lifelong learning in which individuals continually apply what they know to adapt to change and acquire more knowledge to be more effective at applying information technology to their work and personal lives." (National Academy Press, executive summary.) The

panel identified three major types of knowledge and skills relevant to FITness and identified the ten most prevalent types of knowledge in each area: contemporary skills, foundational concepts, and intellectual capabilities.

In Table 3 we have coded the knowledge elements most relevant to this paper from the National Academy Press publication using bold red italics. Admittedly, all of these skills, concepts and intellectual capabilities are what successful students need in the digital information age.

Table 3: Fluency in Information Technology
National Academy Press, 1999

Information Technology Skills

1. Setting up a computer
2. Use basic operating systems features
3. Using a word processor to create a text document
4. Use a graphics and/or artwork package to create illustrations, slides, or other image-based ***expressions of ideas***
5. Connecting a computer to a network
6. Using the Internet to ***find information and resources***
7. Using a computer to ***communicate with others***
8. Using a spreadsheet to model simple processes or financial tables
9. Using a database system to set up and ***access useful information***
10. Using instructional materials to learn how to use new applications or features

Information Technology Concepts

1. Computers
2. Information systems
3. Networks
4. ***Digital representation of information***
5. ***Information organization***
6. Modeling and abstraction
7. Algorithmic thinking and programming
8. ***Universality (of digital communication information)***
9. ***Limitations of information technology***
10. ***Societal impact of information and information technology***

Intellectual Capabilities for Information Technology

1. Engage in sustained reasoning
2. Manage complexity
3. Test a solution
4. Manage problems in faulty (or incomplete information) solutions
5. ***Organize and navigate information structures and evaluate information***
6. ***Collaborate***
7. ***Communicate to other audiences***
8. Expect the unexpected
9. ***Anticipate changing technologies***
10. Think about information technology abstractly

The Partnership for 21st Century Skills

The compilation, organization, and definition of a comprehensive set of skills necessary to function in the 21st century society and workforce are still evolving. Many organizations have begun outlining skills they believe are critical to thrive in our time. And leading the way in this discourse has been the Partnership for 21st Century Skills (p. 21). This initiative was formed in 2002 through the efforts of the U.S. Department of Education and eight founding educational and corporate organizations including: America Online Time Warner Foundation, Apple Computer, Inc. Cable in the Classroom, Cisco Systems, Inc., Dell Computer Corporation, Microsoft Corporation, National Educational Association, and SAP. Two individuals, Ken Kay and Diny Goldner-Dardis, were also co-founding members. The Partnership for 21st Century Skills desires to serve as a change agent for teaching, learning and assessment. The Partnership identified a gap between the knowledge and skills that students have now and what they will need to compete successfully in typical 21st century communities and high performance workplaces. To reduce this gap the schools must infuse 21st century skills into the classroom.

In the following bulleted list of skills and knowledge from the Partnership for 21st Century Skills, we have coded the sections relevant to digital communications in bold red italics.

- ***Information and communication skills*** (information and media literacy skills; communication skills)
- ***Thinking and problem-solving*** (critical thinking and systems thinking; problem identification, formulation and solution; creativity and intellectual curiosity)
- ***Interpersonal*** and self-direction ***skills*** (interpersonal and collaborative skills; self-direction; accountability and adaptability; social responsibility)
- Global awareness
- Financial, economic and business literacy, and developing entrepreneurial skills to enhance workplace productivity and career options
- Civic literacy

In the report on *Learning in the 21st Century*, the Partnership notes,

"Today's education system faces irrelevance unless we bridge the gap between how students live and how they learn. Schools are struggling to keep pace with the astonishing rate of change in students' lives outside of school. Students will spend their adult lives in a multitasking, multifaceted, technology-driven world—and they must arrive equipped to do so. We also must commit to ensuring that all students have equal access to this new technological world regardless of their economic background." (Learning in the 21st Century, p. 4.)

The Partnership also identified the following six key elements for 21st century learning:

1. Emphasize core subjects;
2. Emphasize learning skills: ***information and communication skills***, ***thinking and problem solving skills***, and ***interpersonal*** and self-directional skills;
3. Use 21st century tools to develop learning skills;
4. Teach and learn in a 21st century context;
5. Teach and learn 21st century content; and
6. Use 21st century assessments that measure 21st century skills.

The Partnership for 21st Century Skills has also created an online database and summary report of the current status of the assessments for 21st century skills. The complete report and database can be accessed at the following Web link: http://www.21stcenturyskills.org/assess21/ and a summary of their recommended skills are provided below; coded in bold red italics to indicate sections specifically relevant to digital communications.

1. *Information and Communication Skills*:

- Information & Media Literacy: Analyzing, accessing, managing, integrating, evaluating and creating information in a variety of forms and media. Understanding the role of media in society.
- Communication Skills: Understanding, managing and creating effective oral, written and multimedia communication in a variety of forms and contexts.

2. *Thinking and Problem-Solving Skills*:

- Critical Thinking & Problem Solving Skills: Exercising sound reasoning in understanding and making complex choices, understanding the interconnections among systems.
- Problem identification, formulation and solution: Ability to frame, analyze and solve problems.
- Creativity and Innovation Skills: Developing, implementing and communicating new ideas to others, staying open and responsive to new and diverse perspectives.

3. *Interpersonal* and Self-Directional *Skills*

- Interpersonal and collaborative skills: Demonstrating teamwork and leadership: adapting to varied roles and responsibilities; working productively with others; exercising empathy; respecting diverse perspectives.
- Self Direction: Monitoring one's own understanding and learning needs, locating appropriate resources, transferring learning from one domain to another.
- Accountability and Adaptability: Exercising personal responsibility and flexibility in personal, workplace and community contexts; setting and meeting high standards and goals for one's self and others; tolerating ambiguity.
- Social Responsibility: Acting responsibly with the interests of the larger community in mind; demonstrating ethical behavior in personal, workplace and community contexts.

The Partnership for 21st Century Skills notes that the skills listed above must be represented and presented in a 21st century context. The students should learn their academic content with real-world examples, applications and experiences. This ensures that the education they receive is relevant, meaningful and engaging to their daily lives. In a digital pervasive technology world, students need to learn and effectively use digital tools in their everyday life and in high performance workplace settings. The Partnership identified three new content areas that 21st century students should know: global awareness; financial, economic and business literacy; and civic literacy. The partnership also identified the need for creating 21st century assessments. The principles for creating 21st century assessment are quoted below because of their relevancy to this report.

21st Century Assessments

"The Partnership [for 21st Century Skills] *believes in the following principles with respect to the assessment of 21st century skills:*

- *The movement to embrace 21st century skills will be greatly enhanced by identifying ways to measure these skills and conversely, the lack of such assessments will hinder progress toward widespread adoption of 21st century skills.*
- *Assessment of 21st century skills will improve our ability to evaluate not only individual students but the effectiveness of our educational system as well.*
- *Assessments of 21st century skills must allow us to determine whether students have mastered these skills adequately, and diagnose areas where students require intervention.*
- *Proper assessments of 21st century skills provide students a useful way to validate their skills with potential employers and/or educational institutions.*
- *There is no single assessment tool that will accomplish everything. A diverse menu of assessment tools and models should be available for use in a variety of contexts. It is critical that the most appropriate assessment tool be used in order to evaluate skills or core subject competencies adequately.*
- *Integration of technology into assessment tools is a critical component of assessments that measure 21st century skills.*
- *Current high-stakes assessments alone do not generate the skill sets that the business and education communities believe will ensure success in the 21st century. A more thoughtful approach to assessment tools and models is necessary."*

The Partnership identifies the need for assessment tools that provide for 21st century skills measurement, diagnosis of individual profiles of skills, accountability of schools teaching 21st century skills, and student demonstration of proficiency for schools and employers. No single assessment will cover all of these purposes; therefore there must be a menu of alternative assessments available.

Assessing Information and Communications Technology (ICT) Literacy

Educational and technology leaders of North America (U.S and Canada), Europe, Asia, Australia, and the Pacific Rim realize that ICT literacy must be treated as one of the core academic skill areas just like reading, mathematics, science, and social studies. At the national level countries like the UK, Singapore, Finland, and Israel understand the centrality that ICT literacy must have to prepare students for high performance workplaces of the future.

(Singapore Ministry of Education, 2006, Vision and Mission Statement http://www.moe.gov.sg/corporate/mission_statement.htm; Singapore Ministry of Education Goh Chok Tong, 1997; Malaysia Ministry of Education, 2005, A Vision of the Future of ICT and the Challenges Facing Malaysia Schools, Mala; Partnership for 21st Century Skills, 2005; de Ricjke, 2004; APEC, 2004, Korean Ministry of Education and Human Resource Development, Korea Educational Research and Information Service, 2003).

ICT literacy skills are increasingly seen as having an international scope of influence and use. This gives us an international perspective on the use of advanced communication and technology tools to improve students learning skills in thinking, problem solving, information search, communication skills, interpersonal skills, and self-directional skills.

For example, in a 1997 speech entitled, *Shaping our Future: Thinking Schools, Learning Nation*, Prime Minister of Education for Singapore Goh Chok Tongstated stated Singapore's position regarding the future of education and the need for teaching and learning 21st century skills and new advanced technologies. He said, *"A nation's wealth in the 21st century will depend on the capacity of its people to learn. Their imagination, their ability to seek out new technologies and ideas, and apply them in everything they do will be the key source of economic growth. Their collective capacity to learn will determine the well-being of a nation."*

"We know three things about the future. First, it will be an intensely global future, with diminishing barriers to the flow of goods, services and information. Competition between cities, countries, sub-regions and regions will be intense. No country or region will have permanent advantages. There is no guarantee that it will always retain its competitive edge. Second, knowledge and innovation will be absolutely critical. The recent victory of the computer Deep Blue over chess champion Gary Kasparov was not a triumph of machine over man but the triumph of human innovation, of organized human mastery of technology. Companies and nations which organize themselves to generate, share and apply new technologies and ideas more quickly than others will, like the early bird, catch the worm. The third defining feature of the future is that it will be one of change, and increasingly rapid change. It will be change as a permanent state, not change as a transition to some known, final state. Change will be unpredictable but it will affect everything we do at work, in society and at home."

"Education and training are central to how nations will fare in this future. Strong nations and strong communities will distinguish themselves from the rest by how well their people learn and adapt to change. Learning will not end in the school or even in the university. Much of the knowledge learnt by the young will be obsolete some years after they complete their formal education. In some professions, like Information Technology, obsolescence occurs even faster. The task of education must therefore be to provide the young with the core knowledge and core skills, and the habits of learning, that enable them to learn continuously throughout their lives. We have to equip them for a future that we cannot really predict."

In 2005, Malaysian Minister of Education Sri Hishammuddin Tun Hussein spoke on the *Vision of the Future of ICT and the Challenges Facing Malaysia Schools*, where he stated, *"It is now clear that we are at the start of a revolution in the way we store, process, retrieve, manipulate and communicate information; a revolution on a scale with few, if any, parallels in human history. If the straightforward and slow-moving information technology of the printing press spurred such vast social and political changes it is hard to imagine where we are headed today, with a rapidly growing, quickly converging set of information and communications technologies. ICT is growing not just in capacity but in accessibility, availability and popularity. It has become smaller, cheaper and faster at a geometric rate for the last quarter century and is set to continue doing so. We should bear in mind that any kind of growing technology is a force for creative destruction. Old ways of communicating information and making things are destroyed or altered. New ones come into being. With each of these changes come changes in the patterns and distribution of social and economic activity."*

"Our children will come of age in a world even more transformed by ICT. Ministries of Education the world over should have come to the same conclusion. ICT-enablement and ICT-integration is not optional to Education. Nor is it just an essential add-on. It is far more than an augmenter of

present ways of doing things because technologies of Information and Communication help structure what we can and cannot achieve in and beyond the classroom. If learning had to be organized in certain ways because of the technical possibilities and limitations of blackboard and chalk, paper and pencil, a very different set of possibilities and constraints holds when you have a laptop with a wireless broadband connection to the World Wide Web."

"We are fully committed to the reshaping of our economy into a knowledge economy and will thus need a workforce skilled in ICT. However we also see that in the near future ICT literacy will be as important as print literacy is today for the achievement of the rights and powers of democratic citizenship. An increasing number of benefits and rights that are now conveyed via old media will be transmitted via new, interactive and personalized media. An increasing number of essential services such as healthcare and yes, education, will be transmitted via ICT. Nobody is to be left behind. "

"More positively, we believe that the new technologies offer great promise for eradicating poverty, developing our communities and integrating them into the global economy, not merely of products and services but also of knowledge. In all sorts of ways, by integrating different types of media, increasing the speed of communication while lowering its cost, by facilitating dialogue, by bridging the enormous divide in information and access to healthcare between rural and urban communities, ICT can bring our poorest schools and thus our poorest communities into the growth orbit of our rural areas."

In 2004 at the 3rd Asia Pacific Economic Cooperation (APEC) Education Ministerial Meeting, the ministers of education met from April 29–30 in Santiago, Chile. Under the theme of *Skills for the Coming Challenges*, the education ministers recommended the following initiatives:

- *Study use of foreign language e-language learning, Web sites and distance education programs to compensate for limited number of teachers and resources;*
- *Assess communication skills, especially in large classes, and the possibility of collaborative assessment tools, along with associated impact studies; and*
- *Develop a collaborative for foreign language teachers, standards assessment and accreditation programs, and associated impact studies.*

Using ICT for Teaching and Learning

The APEC group also identified the following cooperative areas for using ICT for improving teaching and learning:

- Establish communities of practice, both on line and on site to *share knowledge among students, teachers, researchers, parents, policy makers* and other stakeholders among APEC communities;
- *Collaborate* on research and development (APEC economies *can share and collaborate with one another on how technology tools can yield high pedagogical impact* with low investment, and how such tools can be widely accessible and widely adopted, especially in regions where the digital divide in schools is an issue); and
- Adopt a holistic approach in *assimilating ICT into all aspects of teaching and learning to promote ICT literacy*.

In 2003, the Korea Ministry of Education and Human Resource Development authored a report by the Korea Educational Research and Information Service (KERIS) entitled *2003: Adapting Education to the Information Age, A White Paper*. In the forward to the report the following statement was made by Deok-hong Yoon, the Deputy Prime Minister serving as the Minister of Education and Human Resources Development:

"The Korea Education and Research Information Service (KERIS) has been a driving force in pushing through education reforms by promoting the use of ICT among elementary and secondary education and university research. This year we have witnessed Korea become the top nation in ICT infrastructure in a survey conducted by the World Economic Forum. The world-class ICT has been continuously adapted into education and research across the nation."

The Outcomes of Adapting ICT in Education

International education and technology leaders each face the need to create assessments that address higher-order thinking, reasoning, communication and problem solving skills and to use of technology appropriately to deliver these assessments.

Key sections of the KERIS report are presented below in Table 4 with relevant digital communications standards emphasized in red bold italics.

Table 4: KERIS and ICT Adoption Outcomes

Developing Human Resources that Will Lead the Knowledge-based Society
"Unlike the agrarian and industrial societies of the past, today we have a knowledge-based society. In a knowledge-based society, advanced Information and Communications Technology (ICT) supports the exchange of information without time or location constraints. Because new information is created and dispersed quickly in this new era, the ability to use knowledge to increase productivity is a vital skill."
"To make the human resource development process more efficient, education should build on a person's natural skill and encourage people to look towards the future. A nation's future depends on how well it can prepare its human resources for the information age, and whether the potential of each individual in society can be reached."
National Human Resource Development Basic Framework
"As a result of the socioeconomic changes that have occurred throughout the nation, the Korean government announced the Basic Framework for National Human Resource Development (2001). Its purpose is to put forth the nation's goal of attaining a level of national competitiveness on a par with developed nations through the development of highly-skilled workers."
"The Basic Framework for National Human Resource Development includes national strategies and policy designed to facilitate human resource development in a knowledge-based society. This framework is a comprehensive government policy on knowledge and people, and it will set the direction for education, training, research, employment, industry, and other areas. It focuses on the following four policy areas: ▪ *Improving the basic abilities of citizens,* ▪ *Developing individual development for personal growth,*

- *Advancing the harness and management of national human resources, and*
- *Building a national human resources infrastructure."*

Public Policy

"With the election of President Roh Moo-Hyun, government policy regarding the development of national human resources has reached a major turning point. One of the top 12 policy goals of the Roh administration is 'Educational Reform and the creation of a Knowledge- and Culture-based Society,' a policy that has been created to maximize the development of human resources in a knowledge-based society and to help Korea realize its full potential as a knowledge-based society. This policy also outlines the specific tasks that must be accomplished to develop human resources in a knowledge-based society."

"The human resource development policy under the Roh administration is based on the nation's governing principles and seeks to maximize the skills of each individual by changing society and culture so that people can reach their full potential in developing their capabilities. In addition, in the execution of centralized policy, the Ministry of Education & Human Resources Development (MOE & HRD) should allocate resources to Municipal and Provincial Offices of Education, local offices of education, and schools efficiently, and in a way that promotes the autonomous development of each institution. The success of the national policy for human resource development will narrow the gap between Korean society and the societies of developed nations, while helping the nation achieve an average national income of 20,000 US dollars. This is one of the goals of the Roh administration. Accomplishing these goals will elevate Korea's standing in the international community."

Educational Reforms

"In order to effectively develop human resources for a knowledge-based society, reforms must be carried out through the entire educational system. As natural resources are scarce in Korea, human resource development through education is an important part of the national agenda. The educational reforms that will facilitate the development of a knowledge-based society include teaching students effective learning strategies that allow them to acquire knowledge."

"Students need to possess the ability to absorb new knowledge in an active way and learn how to link together disparate pieces of information to solve problems. It is also important that creative thinking and problem-solving skills be developed by students."

"Students must develop the communication skills and enthusiasm for challenge that will allow them to handle changing situations, and find innovative solutions to problems."

"Students must also be able to succeed in an international environment…. Koreans need to keep abreast of international affairs and have in-depth knowledge of foreign cultures."

"Finally, Korea must improve its support for education by emphasizing science education, moderating regulations that prevent the creation of an efficient and effective education system, and eradicating elitism and favoritism among university graduates. New policy frameworks and continuous improvements to the current laws and regulations are necessary to overhaul the education system. To achieve a sophisticated knowledge-based society, it is essential to create an educational information infrastructure and a cyber education system."

Assessment of ICT Literacy in the United Kingdom

The United Kingdom has implemented an innovative approach to assessing ICT literacy skills and has attracted the attention of many other ministries of education who plan on adapting assessments and assessment approaches similar to those developed by the UK. One of these assessment initiatives, the Key 3 ICT Literacy Assessment (ages 12-13), is receiving much international attention (Leong, Erstad, Lawand, and Ripley, 2004).

The Key 3 ICT online assessment measures higher order thinking and ICT use. The assessment addresses ICT skills and corresponding ability to solve complex problems using research, communication, and information management and presentation skills. As an example task, students are to write and publish a journal article addressing the ethnic diversity of a police force and educational system. Students must collect and analyze ethnic group employment information from each work group, e-mail messages regarding permission to publish information, graphic displays, and charts and then summarize the information in both written and graphic form. The technologies used involve search engines, Web based repositories, and exchange e-mail messages and employ office tools with spreadsheets, graphic displays, word processors and presentation applications. The innovative Key 3 ICT assessment provides an overall score as well as a formative profile of strengths and areas for improvement (Ripley, 2004). "The use of ICT in assessment is the most powerful lever available to embed the government's e-learning and ICT initiatives in the classroom, as assessment defines the goals for both learners and teachers," notes Martin Ripley (Honey, Pasnik and Fasca, 2006).

Assessments of ICT Skills

The International Society for Technology (ISTE) and Microsoft have jointly developed an eighth grade NETS Online Technology Assessment (http://www.iste.org/resources/asmt/msiste/).This assessment measures the NETS standards and the capability to show analytic, presentation, and communication skills using a variety of office applications.

The *Assessment of 21st Century Skills: The Current Landscape* (2005) report notes, *"As more of our economic competitors move to foster 21st century skills development and assessment within their educational systems, the United States faces a critical challenge to keep pace in preparing our students to meet the demands of global community and tomorrow's workforce.*

If we are to improve the status of assessments in the U.S. educational system and to ensure that we are measuring the kinds of content and skills that are necessary to succeed in the 21st century, we must recognize not just the power of assessments as levers to effect change but also as tools to foster the application of higher-order thinking skills and to provide critical feedback to inform instruction and student learning…the movement to embrace 21st century skills will be greatly enhanced by identifying ways to measure these skills. Conversely, the lack of such assessments will hinder progress toward widespread adoption of 21st century skills."

Jud Hersh, senior fellow with the Council for Aid to Education, notes that, *"Trust in schools has greatly eroded over the past quarter century in part because we have not used assessment to focus on student learning, especially the 'higher' order outcomes of education—critical thinking, analytic reasoning, and the ability to write and communicate well. Nor have we constructively used assessment to give appropriate and timely feedback to students and teachers to help them improve their learning and teaching."*

In assessing 21st century skills, Horney, Pasnik and Fasca (2006) state, *"Measuring the kinds of critical reasoning and communication skills now prized in the workplace and our increasingly global communities demands a shift in our assessment strategies. We must move from primarily measuring discrete knowledge and skills to measuring students' ability to think critically, examine problems, gather information, and make informed, reasoned decisions while using technology…we must begin measuring students' ability to apply knowledge, whether existing or newly acquired to complex, real-world tasks."*

Internet and Computing Core Certification (IC3)

First launched in 2002, Certiport's Internet and Computing Core Certification (IC3) has defined the Internet and Computing standards for students for basic computing and Internet literacy worldwide. The IC3 program is well suited for academic institutions, workforce development programs, and organizations needing a reliable means of ensuring individual computing literacy in an increasingly digital world. IC3 certification verifies that individuals possess the accepted global standard level of digital literacy, making them more efficient and professionally marketable.

The objectives for the IC3 Certification address areas of computing fundamentals: knowledge of computer hardware, computer software, and use of an operating system; key software applications: common program functions, word processing, spreadsheets, and presentation software; and living online: networks and the Internet, electronic mail, using the Internet and Web browsing, and the impact of computing and the Internet on society.

The skills and knowledge measured by the IC3 exams were derived from studies of national and international programs that clearly defined essential competencies in the objectives indicated; through analysis of training programs from courseware, computer-based testing, training vendors and book publishers covering these topics; and with a survey that validated and provided input to the final list and weighting of the objectives.

The three IC3 exams use various test question methods. For example, testing a student's ability to use specific product functions, such as file and system management, is achieved with performance-based items that require the student to perform specific 'real world' tasks in a simulation of the software environment. Performance-based testing has proven to have a high degree of statistical reliability as well as user satisfaction. (For more on performance-based testing see Section 3). Testing of other knowledge is achieved with traditional selected response item types. An appropriate combination of performance-based and selected response items ensures a high degree of validity and reliability for the program participants.

Digital Natives

"It is amazing to me how in all the hoopla and debate these days about the decline of education in the US we ignore the most fundamental of its causes. Our students have changed radically. Today's students are no longer the people our educational system was designed to teach," notes Marc Prensky (2001).

"A really big discontinuity has taken place. One might even call it a 'singularity' – an event which changes things so fundamentally that there is absolutely no going back. This so-called 'singularity' is the arrival and rapid dissemination of digital technology in the last decades of the 20th century."

"Today's students – K through college – represent the first generations to grow up with this new technology. They have spent their entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age. Today's average college grads have spent less than 5,000 hours of their lives reading, but over 10,000 hours playing video games (not to mention 20,000 hours watching TV). Computer games, e-mail, the Internet, cell phones and instant messaging are integral parts of their lives…"

"What should we call these 'new' students of today? Some refer to them as the N-[for Net]*-gen or* D-[for digital]*-gen. But the most useful designation I have found for them is Digital Natives. Our students today are all 'native speakers' of the digital language of computers, video games and the Internet."*

In part II of his article, Marc Prensky discusses and defines characteristics of digital natives.

"Our children today are being socialized in a way that is vastly different from their parents. The numbers are overwhelming: over 10,000 hours playing videogames, over 200,000 e-mails and instant messages sent and received; over 10,000 hours talking on digital cell phones; over 20,000 hours watching TV (a high percentage fast speed MTV), over 500,000 commercials seen—all before the kids leave college. And, maybe, at the very most, 5,000 hours of book reading. These are today's 'Digital Native' students."

"One of the most interesting challenges and opportunities in teaching Digital Natives is to figure out and invent ways to include reflection and critical thinking in the learning (either built into the instruction or through a process of instructor-led debriefing) but still do it in the Digital Native language. We can and must do more in this area."

"Digital Natives accustomed to the twitch-speed, multitasking, random-access, graphics-first, active, connected, fun, fantasy, quick-payoff world of their video games, MTV, and Internet are bored by most of today's education, well meaning as it may be. But worse, the many skills that new technologies have actually enhanced (e.g., parallel processing, graphics awareness, and random access)—which have profound implications for their learning—are almost totally ignored by educators."

"The cognitive differences of the Digital Natives cry out for new approaches to education with a better 'fit.' And, interestingly enough, it turns out that one of the few structures capable of meeting the Digital Natives' changing learning needs and requirements is the very video and computer games they so enjoy. This is why 'Digital Game-Based Learning' is beginning to emerge and thrive."

In Marc Prensky's (2004a) presentation entitled, *Give us 21st Century Tools*, for the U.S. Department of Education No Child Left Behind e-learning summit, he identifies eighteen differences between digital natives' behavior and that of their parents and teachers as digital immigrants. These differences are detailed in Table 5 below and can be found in Prensky's online paper entitled *The Emergent Online Life of the Digital Native* (2004b) and additional characteristics are presented in brackets after each difference.

Table 5: Characteristics of Digital Natives

Digital Natives are Communicating differently (e-mail, IM, chat, text messaging)
Digital Natives are Sharing differently (Blogs, Webcams, camera phones)
Digital Natives are Buying and Selling differently (eBay, schoolwork)
Digital Natives are Exchanging differently (music, movies, humor)
Digital Natives are Creating differently (Web sites, avatars, mods)
Digital Natives are Meeting differently (3D chat rooms, dating, Wiki, net meetings)
Digital Natives are Collecting differently (mp3, video, sensor data, P2P)
Digital Natives are Coordinating differently (Projects, workgroups, MMORPGs)
Digital Natives are Evaluating differently (reputation systems–Amazon, Slashdot)
Digital Natives are Gaming differently ('versus,' small & large groups)
Digital Natives are Learning differently (about stuff that interests them)
Digital Natives are Searching differently (Info, connections, people)
Digital Natives are Analyzing differently (SETI, drug molecules)
Digital Natives are Reporting differently (Moblogs, digital photos, cell phones)
Digital Natives are Programming differently (open systems, mods, search, Flash)
Digital Natives are Socializing differently (learning social behavior, influence)
Digital Natives are Evolving differently (peripheral, emergent behaviors)
Digital Natives are Growing Up differently (exploring, transgressing)

Educational researcher Ian Jukes (2005) in an article entitled, *Understanding Digital Kids (DKs): Teaching and Learning in the New Digital Landscape*, notes, *"Today's Instant Messenger Generation has grown up in a new digital landscape. For most of them, there's never been a time in their lives when computers, cell phones, video games, the Internet and all the other digital wonders that increasingly define their world haven't surrounded them.*

These Digital Natives process and interact with information, and communicate in fundamentally different ways than any previous generation before them. Meanwhile, many of us, the Digital Immigrants, struggle as we try to deal with the rapid change and powerful new technologies native to a fundamentally different world than the one we grew up in."

Summarizing the Real Digital Divide

1. "[Digital] *Native learners prefer receiving info quickly from multiple multimedia sources while many teachers prefer slow and controlled release of info from limited sources.*
2. *Native learners prefer parallel processing and multi-tasking while many teachers prefer singular processing and single/limited-tasking.*
3. *Native learners prefer processing pictures, sounds and video before text while many teachers prefer to provide text before pictures, sounds and video.*
4. *Native learners prefer random access to hyperlinked multimedia information while many teachers prefer to provide information linearly, logically and sequentially.*
5. *Native learners prefer to interact/network simultaneously with many others.*
6. *Many teachers prefer students to work independently rather than network and interact.*

7. *Native learners prefer to learn 'just-in-time' while many teachers prefer to teach 'just-in-case' (it's on the exam).*
8. *Native learners prefer instant gratification and instant rewards while many teachers prefer deferred gratification and deferred rewards.*
9. *Native learners prefer learning that is relevant, instantly useful and fun while many teachers prefer to teach to the curriculum guide and standardized tests."*

So How Do We Bridge this Digital Divide?

"Teachers must learn to communicate in the native language and style of their students. This doesn't mean changing the focus on what is important or what is going to be measured, but it does mean that we have to change our instructional styles.

- *This requires more making learning fun and more relevant to them and their world.*
- *This means going faster so they can receive information quickly.*
- *This means less step-by-step instruction and more random access, hyperlinked, just-in-time learning experiences.*
- *This means less text and more pictures, sounds and video wherever possible.*
- *This means providing more opportunities for multitasking, networking and interactivity.*
- *This means applying what we now know from the brain and mind research about learning.*

[In addition to the standard curriculum there is] *what we call 21st century content. This includes critical thinking, problem solving and the structured teaching of process skills, combined with personal life skills, interpersonal life skills, team skills, communications skills, information fluency skills, technology fluency skills, visual fluency skills, biotechnology and bioethics skills. We can't do it all – we have to get rid of some of what is not as important as it was when we went to school to make room for teaching our digital native learners the skills they need for their future lives.*

If we want to unfold the full intellectual and creative genius of all of our children–if we are going to march through the 21st century and maintain our tradition of success–if we want our children to have the relevant 21st century skills–we must create a bridge between their world and ours."

Globalization of Information, Business and Communications

In 1990, the National Center for Education and the Economy authored the publication entitled, *America's Choice: High Skills or Low Wages* which emphasized America's choice to prepare students for working in high performance workplaces of the future or to end up retaining low wage jobs in the workplaces of the past.

In 1987, Arnold Packer and William B. Johnstone co-authored the Hudson Institute ground breaking report entitled *Workforce 2000: Work and Workers in the 21st Century* and later Arnold Packer held the Executive Director position of the U.S. Department of Labor Secretary Commission on Achieving Necessary Skills (SCANS). The following three books under Dr. Packer's leadership have altered the national policy and research regarding education and workforce development. These books all emphasized the need for preparing all students in the nation's schools for the emerging high performance workplaces in the 21st century. The abilities identified by the SCANS reports were the basis for many industry skill standards and school curricula in many states.

- Packer, Arnold and Johnstone, William B. (1987). *Workforce 2000: Work and Workers in the 21st Century*. Washington, D.C. and New York, NY: Hudson Institute Dane Publishing Company.
- U. S. Department of Labor, Secretary's Commission on Achieving Necessary Skills (1991). *What Work Requires of Schools: A SCANS Report for America 2000*. Washington, D.C.: U.S. Department of Labor.
- U.S. Department of Labor, Secretary's Commission on Achieving Necessary Skills (1992). *Learning a Living: A Blueprint for High Performance. A SCANS Report for America 2000*. Washington, D.C.: U.S. Department of Labor.

The first SCANS report (1991) detailed the following three primary conclusions:

1. All American high school students must develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life.
2. The qualities of high performance that today characterizes our most competitive companies must become the standard for the vast majority of our companies, large and small, local and global.
3. The nation's schools must be transformed into high-performance organizations in their own right.

SCANS Workplace Know-How

The know-how identified by SCANS (1991) is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. Table 6 details the know-how, with phrases relevant to this report coded in red bold italics.

Table 6: SCANS Workplace Know-How

COMPETENCIES--effective workers can productively use:

- ***Resources****--allocating time, money, materials, space, and staff;*
- ***Interpersonal Skills****--working on teams, teaching others, serving customers, leading, negotiating, and working well with people from culturally diverse backgrounds;*
- ***Information****--acquiring and evaluating data, organizing and maintaining files, interpreting and communicating, and using computers to process information;*
- ***Systems****--understanding social, organizational, and technological systems, monitoring and correcting performance, and designing or improving systems;*
- ***Technology****--selecting equipment and tools, applying technology to specific tasks, and maintaining and troubleshooting technologies.*

THE FOUNDATION--competence requires:

- ***Basic Skills****--reading, writing, arithmetic and mathematics, speaking, and listening;*
- ***Thinking Skills****--thinking creatively, making decisions, solving problems, seeing things in the mind's eye, knowing how to learn, and reasoning;*
- ***Personal Qualities****--individual responsibility, self-esteem, sociability, self-management, and integrity.*

Table 7 details the second SCANS report (1992) which made additional recommendations to the 1991 model.

Table 7: SCANS 1992 Report

1. *The qualities of high performance that today characterize our most competitive companies must become the standard for the vast majority of our employers, public and private, large and small, local and global.*
2. *The nation's schools must be transformed into high-performance organizations.*
3. *All Americans should be entitled to multiple opportunities to learn the SCANS know-how well enough to earn a decent living.*

And to make those principles a reality we [the SCANS commission] recommend:

1. *The nation's school systems should make the SCANS foundation skills and workplace competencies explicit objectives of instruction at all levels.*
2. *Assessment systems should provide students and workers with a resume documenting attainment of the SCANS know-how.*
3. *All employers, public and private, should incorporate the SCANS know-how into all their human resource development efforts.*
4. *The Federal Government should continue to bridge the gap between school and the high-performance workplace, by advancing the SCANS agenda.*
5. *Every employer in America should create its own strategic vision around the principles of the high-performance workplace.*

Recommendations for Improving Education K-12

- *Teaching should be offered 'in context,' that is, students should learn content while solving realistic problems.*
- *'Learning in order to know' should not be separated from 'learning in order to do.'*
- *Improving the match between what work requires and what students are taught requires changing how instruction is delivered and how students learn.*
- *High performance requires a new system of school administrators and assessment.*
- *The entire community must be involved.*

Recommendations for Reinventing Schools

- *Workplace know-how (the SCANS foundation and workplace competencies) should be taught along the entire continuum of education, from kindergarten through college.*
- *Every student should complete middle school (about age 14) with an introduction to workplace know-how.*
- *Every student by about age 16 should attain initial mastery of the SCANS know-how.*
- *Every student should complete high school sufficiently proficient in the SCANS know-how to earn a decent living.*
- *All federally funded programs for youth and adults, including vocational education programs, should teach the SCANS know-how.*

Recommendations for Fostering Work-Based Learning

- *Federal, state, and local agencies should incorporate SCANS workplace competencies into their own employee programs.*
- *Private-sector work-based training programs should incorporate training in the SCANS workplace competencies.*
- *Coalitions of businesses, associations, government employers, and labor organizations should teach the SCANS competencies to the current workforce, including employees of small businesses.*

Recommendations for Reorganizing the Workplace

- *The vast majority of employers should adopt the standards of quality and high performance that now characterize our most competitive companies.*
- *Firms should develop internal training programs to bring employees to the proficiency in the SCANS competencies needed for high-performance work organizations.*

Recommendations for Restructuring Assessment

- *A national education-based assessment system should be implemented that will permit educational institutions to certify the levels of the SCANS competencies that their students have achieved.*
- *Public and private employers should define requirements for higher-level competencies.*
- *Employment-based assessments should permit diagnoses of individual learning needs.*

In a keynote panel at the 2006 Florida Educational Technology Conference, Chris Dede noted that *"the next decade will shape the future of the U.S. economy for generations to come because the nation is at the beginning of a global knowledge-based economy."* He compared the situation to the Industrial Revolution, illustrating his point by saying, *"the first nations to join the Industrial Revolution gained at an enormous advantage."* He then elaborated on his own comment in a later interview stating, *"In the same way, many people think that as we move into a global knowledge-based economy…the countries that get in first figure out how to do high-quality education centered around information and communication technologies and figure how to prepare students to be effective citizens and workers.* [They] *are going to gain an almost insurmountable advantage."*

Dede indicates that the countries that will succeed in the global economy will link business, education, workforce development, and national policy. And in a 2005 report entitled, *Transforming Learning to the 21st Century: An Economic Imperative*, Dede, Korte, Nelson, Valdez and Ward (2005) note that "to succeed in life and keep our country strong and prosperous, all of today's students must graduate able to deal with ambiguity and capable of higher order analysis and complex communication."

Further, when discussing neo-millennial learning styles, their 2005 *Economic Imperative* report notes the following about digital age students:

- *Fluency* [is needed] *in multiple media, valuing each for the types of communication, activities, experiences, and expression it empowers;*

- *Learning* [is] *based on collectively seeking, sieving, and synthesizing experiences rather than individually locating and absorbing information from some single best source;*
- *Active learning* [is] *based on experience (real or simulated) that includes frequent opportunities for reflection;*
- *Expressions* [are] *through nonlinear, associational webs of representation rather than linear 'stories' (e.g., authoring a simulation and a Web page to express understanding rather than a paper;*
- *Co-design of learning* [are] *experiences personalized to individual needs and preferences.*

These authors also note the following partnership characteristics that recognize education as an investment rather than as an expense:

- *Recognize that information and communication technologies are drivers, engines, catalysts, and enablers—vital to accelerate scalability;*
- *Evolve next-generation curriculum standards that create capacity for expert thinking, complex communications, and analytical reasoning; and*
- *Develop new sets of metrics to inform progress at the classroom, school, community, and regional levels.*

Digitalization and Internationalization of Business

In his (1999) book, *Business @ the Speed of Thought*, Bill Gates notes the increasing digitalization and internationalization of business.

"If the 1980s were about quality and the 1990s were about reengineering, then the 2000s will be about velocity. About how quickly the nature of business will change. About how quickly business itself will be transacted. About how information access will alter the lifestyle of consumers and their expectations of business. Quality improvements and business process improvements will occur far faster."

"The successful companies of the next decade will be the ones that use digital tools to reinvent the way they work. These companies will make decisions quickly, act efficiently and directly touch their customers in positive ways. [Bold emphasis added by report authors.] *I hope you'll come away excited by the possibilities of positive change in the next ten years. Going digital will put you on the leading edge of a shock wave of change that will shatter the old way of doing business. A digital nervous system will let you do business at the speed of thought-the key to success in the twenty-first century."*

In responding to a series of questions regarding the book *Business @ the Speed of Thought* (http://www.microsoft.com/billgates/speedofthought/looking/q&a.asp), Gates responds to the following questions.

What's the Meaning of Business @ the Speed of Thought?

"Well, up until now, the speed of business has been limited by moving information around, but with digital tools moving that information at the speed of light, the only constraint is how well you use

your knowledge workers, your thinkers, to react to what's going on, to plan new products, to make sure you're using all of your resources in the right way. So 'business at the speed of thought' says that business will be done in a new way and it's about empowering those knowledge workers and reaching out with digital tools to make sure that all the best thinking gets applied."

How can technology reshape government and schools?

"Well, the basic idea of a Digital Nervous System where you have everything online and easily accessible, applies to enterprises of all types. Think about government. Their business is to help process information and to make a lot of that information available to the public. So the efficiency and improvement that can be gained by a Digital Nervous System inside government is, if anything, greater than inside your typical business. Likewise, think about education. Students are, in a sense, the ultimate knowledge workers. Their whole job is to try out problems, see how they solve those problems and have access to a broader set of information than you need inside a typical business. So letting those students have this tool, letting them bring back the things they've seen and share that with other students, that kind of activity can make education more effective than ever before. It was kind of amazing, as I wrote the book; how the principles that applied to large *companies, those principles applied equally well to these different kinds of enterprises and smaller enterprises. In fact, the smaller you get, the more you need to partner with other people using these digital tools so that you can be competitive with the large companies that will be doing the same thing."* [Bold emphasis added by report authors.]

In 1991 Anthony P. Carnevale authored the report, *American and the New Economy*. This report was published by the American Society for Training and Development and the U.S. Department of Labor Employment and Training Administration. This report notes, *"In the new economy organizations and nations compete not only on their ability to improve productivity but on their ability to deliver quality, variety, customization, convenience and timeliness as well."*

"The shift from the old to the new economy results from the globalization of wealth and competition from the introduction of new flexible technologies that allow the simultaneous pursuit of the full range of new competitive standards on a global scale."

"Central to the new economy is flexible and information-based technologies. In fact, today's most important technology is our friend, the computer. In its various disguises, this information based technology raises our potential for higher productivity and quality."

In discussing the globalization of industry and trade, Carnevale adds, *"the impact of globalization of economic competition has been profound and in some ways unexpected. At its simplest level, globalization has increased the intensity and nature of competition…*

Globalization has been a mixed blessing for Americans. In a robust global market, the possibilities for economic expansion are impressive. The potential demand for goods and services in the world economy is vastly greater than current production level…At the same time, globalization has helped change competitive standards in ways that do not play exclusively to our strengths. Productivity and the price reductions that it brings are necessary, but not sufficient for successful competition in global markets. Our scale advantages are eroding as Europe and Asia become more cohesive market spheres. In addition, the European and Japanese [and we could now add

China and India, report authors] *have more experience than we do with the flexible production systems necessary to succeed in the highly fragmented global marketplace."*

"In the final analysis, however, we have no choice but to embrace the complex competitive standards of the global marketplace and to devise a new set of rules and procedures to stabilize world trade…Moreover, if we are allowed access to foreign markets, we cannot deny others access to ours."

For the new economy Carnevale (1991) specifies that the new basic skills will include the academic basics of reading, writing at work, and computation but then adds learning to learn, communication both speaking and listening, adaptability with problem solving and creative thinking skills, and developmental skills with self-esteem, goal setting, motivation, and personal and career development.

Emerging Digital Communications Technologies

Digital computer and communication technologies are merging rapidly. Relevant technologies include wireless and wired high speed Internet connections, broadband transmission and direct satellite links, internet phone services (e.g., Vonage and Skype), teleconference services and other telecommunication technologies, miniaturization of the computer and its components, flash and thumb drive technology, cellular phones with voice, graphics, Internet, video, and digital audio, audio and video iPod technologies, personal digital assistants (PDAs), peer to peer networking, digital and Web cameras, laptop and notebook computing, pocket PCs, and integrated communication technologies (e.g., Treo and Blackberry). These emerging digital technologies all have significant impact on digital communication technologies and application tools and the software that is available worldwide; and will thus significantly impact the education of K-12 and college students as well as all workers. This convergence is exemplified by the rapid international deployment of the digital camera, wireless laptop, cellular phone, and iPod.

Another example of the rapid entrance and merge of technologies was the Keynote session for the 2006 Consumer Electronics Show where Bill Gates demonstrated elements of a scenario leading to the confluence and integration of digital and communications technology for the digital decade. We have detailed an excerpt of his keynote in Appendix B, entitled The Digital Decade.

Formation of the International Digital Communications Standards Advisory

Certiport recognized the confluence and integration of the digital computer and communication technologies and the need to move to Internet and Communication Technology literacy as measured by the Internet and Computing Core Certification (IC^3) and digital communications validated learning and assessment for K-12 and college schools. Certiport formed the International Digital Communications Standards Advisory, meeting for the first time on January 26, 2006 in San Mateo, CA.

The vision statement for the group is to assist

Students who are…

Provided the opportunity to explore, investigate, analyze, evaluate, design and create using state-of-the-art techniques to solve real world problems in order for them to perform in the global community.

Teachers who...

Combine and integrate technological tools with new instructional models that continue to acknowledge the individual learning styles of students and ensure those students opportunities to become life-long learners.

The mission statement for the International Digital Communications Standards Advisory is

To research, develop, and promote an international standard for digital communications and provide information and tools aimed at defining digital communication and how it can be integrated within academic settings.

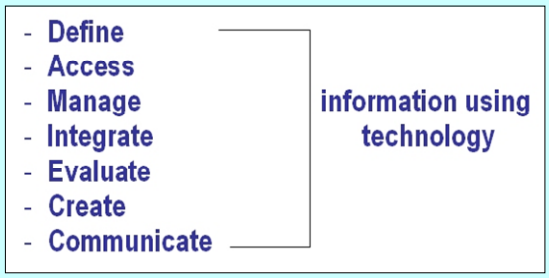
The International Digital Communications Standards Advisory is:

- Independent and international;
- Provides leadership and vision for the integration of digital communication within academic settings;
- Establishes universal digital communication standards and objectives;
- Shares best practices within academia and industry; and
- Establishes new and better practices where they might be employed.

The Digital Communications (DC) Domain is defined as the skills and performance capabilities needed to address the following seven proficiencies with information using technology.

DC Domain ➔ Cognitive Skills

The Digital Communication Domain will be the foundation for defining cognitive skills needed to:



The goals of the International Digital Communications Standards Advisory are to:

- Establish an internationally-accepted domain for digital communication;
- Foster the integration of digital communication within academic curricula;
- Validate the domain so it can become the cornerstone for hiring, promoting, and assessing digital communication competency;
- Increase the integration of digital communication within academic curricula;
- Develop educational guidelines, standards and policy for integrating digital communications within academic curricula;
- Develop a sponsorship program;

- Develop digital communication messaging;
- Promote education and industry collaboration; and
- Review best practices and leverage other certification organizations.

As of the publication date of this white paper, the International Digital Communications Standards Advisory has meet in one onsite meeting (January 26, 2006), one virtual meeting (March 31, 2006), and numerous virtual working group meetings (comprised of various sub-sets of the Advisory).

Need for Digital Communications Standards in Education

The International Digital Communications Standards Advisory believes the Digital Communications Standards being developed must truly be international in scope; which includes all phases of the domain and standards development process (i.e., international in input, review, and approval). This will help to assure the cognitive skills and performance capabilities developed through implementation of these standards are relevant, useful, and fair to students and teachers in different international contexts. Therefore, the Advisory's Digital Communications Standards will be published as dynamic electronic documents that can be updated and enhanced as additional educators and students work toward meeting these standards.

Target Educational Levels for the Digital Communications Standards

The Advisory's Digital Communications Standards will be developed initially for the grade groups of 6-8, 9-12 and college levels (13-17). It is expected that the Digital Communication Standards for students in grades 3-5 would be difficult to develop and substantiate.

SECTION 2: A PROPOSED DOMAIN MODEL FOR DIGITAL COMMUNICATIONS STANDARDS

What is a Domain Model?

C. Victor Bunderson (2006) formally defined domain theory in an educational measurement context in relationship to the aspects of construct validity as defined by Samuel Messick. The following sections are quoted from Vic Bunderson's recent paper.

Domain Theory Introduced

"It was in elaborating on the content aspect of construct validity (content relevance and representativeness) that Messick (1995) introduced the notion of domain theory as a central element in construct validity."

"The boundaries and structure of the construct domain can be addressed by means of job analysis, task analysis, curriculum analysis, and especially domain theory, in other words, scientific inquiry into the nature of the domain processes and the ways in which they combine to produce effects or outcomes. A major goal of domain theory is to understand the construct-relevant sources of task difficulty, which then serves as a guide to the rational development and scoring of performance tasks and other assessment formats. At whatever stage of its development, then, domain theory is a primary basis for specifying the boundaries and structure of the construct to be assessed." (p. 745.) [Bold emphasis added by report authors.]

Domain and Domain Theory Defined

"Domain: A cognitive developmental definition is used in defining those domains where the attributes being measured are cognitive. It is attributable to McShane (1991), who wrote the term 'domain' … denotes a collection of tasks that share a common representation system and a common set of procedures for operating on these representations to perform tasks. Thus, for example, number is a domain of cognition, so is language…On this account, chess is a domain; music also… domains may overlap, either by having similar representations…or similar procedures. We now give a definition of domain theory in the realm of human learning or growth, where growth can mean maturation with lesser or greater degrees of learning."

"Definition: Domain theory (or learning theory of progressive attainments) is a descriptive theory of the contents, substantive processes, dimensional structure, and boundaries of a domain of human learning or growth that gives an account of construct-relevant sources of task difficulty, and conjointly, an account of the substantive processes operative in persons at different levels of learning or growth along the scale(s) that span the domain. A domain theory is associated with one or more measurement instruments, technological devices that can come in contact with learners at different levels of progress, and in so doing, can associate states of the learner with levels of attainment defined for each dimension in the domain."

"We have taken Messick's (1995) notion of domain theory as giving 'an account of construct-relevant sources of task difficulty' and have added to it thinking processes, multiple dimensions, and the instrumentation required to accomplish the measurement of level of attainment. First, we added the needed account of the processes people use to accomplish the tasks. In this way, we have tried to look to the processes of thinking and learning, typically invisible, that provide hope for a causal explanation of why some tasks are more difficult than others, and why some people can master more difficult tasks. By drawing attention to the dimensional structure, we have included in the definition the possibility that valid interpretations and actions in some domains will require reference to more than one dimension of learning or growth. Developing a domain theoretic account of only one unidimensional scale might give an incomplete picture, leading to non-optimal interpretations and actions that should be conditional on progress on another dimension, and on the correlations between dimensions."

"In addition to amplifying the thinking process side of the task difficulty—person proficiency conjoint pair, we have added a clear acknowledgement that measurement instruments are needed; theory is not enough, and that these instruments are technologies. This invokes the process of construction, or design and development of these technological devices. The definition also requires that the instruments can interact with any person and in so doing can associate states of the learner with defined levels of progressive attainment interpretable in the constructs of the domain theory. This requirement places a burden of clear and invariant interpretation on the measures, which is treated in the next section. When these forms of invariance are achieved in a measurement system and its visual displays, testable predictions can be made about the relationships between tasks, processes, and locations along the scale(s). Evidence for different aspects of validity can be obtained and used in a validity argument."

It is not enough to theorize only about tasks (items) as columns in a data matrix or about the people as rows in a data matrix. Measurement can emerge only through the interaction of both, so therefore any domain theory that gives the resulting scale any explanatory power must also give an

account of both tasks and people. The construct-relevant sources of task difficulty are contributed by both the items and the people. The tasks or items must be anchored at benchmark levels of task difficulty to give them empirical substance and interpretive utility.

In summary, a domain model or testable domain theory should identify the number of distinct or unique dimensions that are hypothesized to account jointly for the construct-relevant sources of task difficulty and of the person's ability. It is through the interaction of both tasks and person that educational measurement is possible for both tasks and people. The domain model or theory should specify the construct-relevant sources that are contributed by both the items/tasks and the persons.

Why Digital Communications Needs a Domain Model?

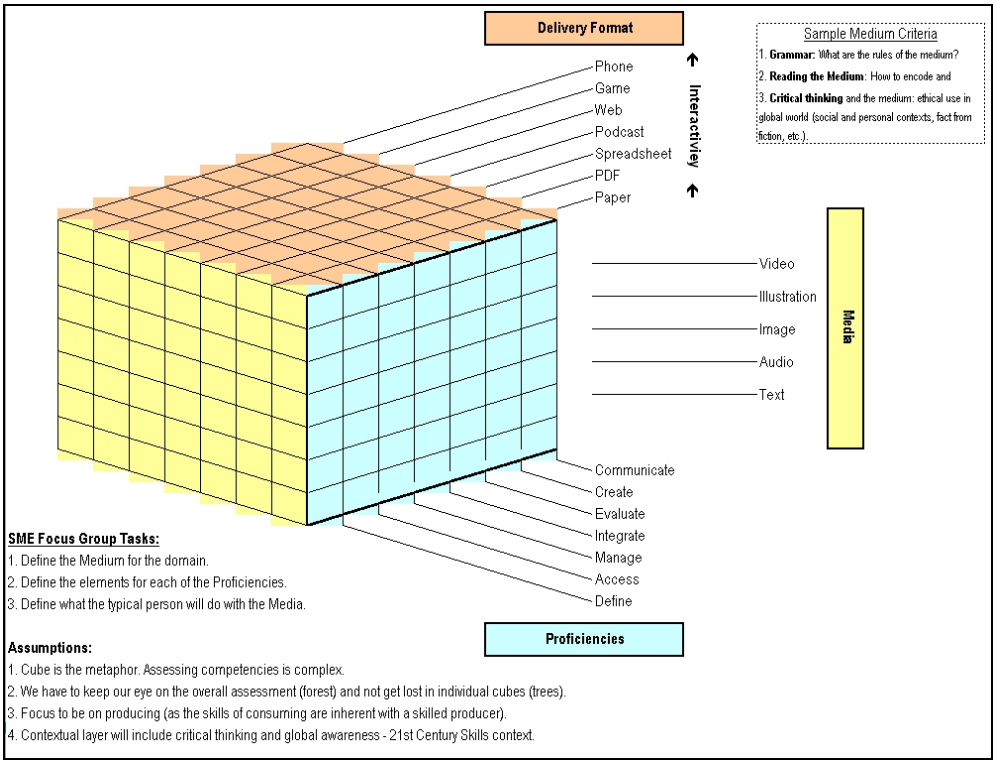
As an emerging and unique professional field, there are crucial educational and research needs to move from Information and Communications Technology literacy to the learning and assessment of digital communications, creating digital communication messages, and sending and receipt of such messages tailored to the relevant audiences. Effective digital communications will not occur unless these messages are designed, the appropriate media to create the messages are employed, and the appropriate dissemination or delivery format(s) are used. As a result of the complexity of the targeted digital communications proficiencies, the variety of media that are available and can be integrated with the messages, and the various dissemination or delivery format for the messages, a domain theory should be specified, investigated, reviewed and critiqued.

Digital Communications in 3D: The Model

Standards provide educators with a guide to the knowledge and skills necessary for students. However, yet another side-effect of the rapid transformation to our globalized society and new economy is the emphasis on skills—mainly those needed to function in the 21st century. Dede et al. (2005) summarize these into three broad areas: expert thinking, complex communications, and analytical reasoning. Current curriculum standards do not adequately access these skill areas, and therefore next-generation curriculum standards need to be developed (Dede et al, 2005). The Digital Communications Standards and Domain are being designed to access this challenge.

Like the Guilford *Structure of the Intellectual* or *SOI model* (see Guilford SOI Model section below), the International Digital Communication Standards Advisory envisions three major interrelated dimensions (see Figure 1) that characterize the domain theory and model for digital communications.

Figure 1: The Digital Communications Model



The first dimension includes the proficiencies that characterize the learners and examinees. These proficiencies indicate the cognitive and performance capabilities that learners and examinees are able to demonstrate with digital communications content. The second dimension addresses the content, format and integration of the media elements the learners will be seeing and responding to. The third dimension addresses the delivery format that will be used to send and receive digital communication messages. The delivery formats vary on a scale from low to high levels of interactivity.

Benefits and Cautionary Notes Regarding the Model

The domain model presented above is represented as a cube. However, this form of representation should be viewed as a metaphor for investigation, review and critique. Since digital communications itself is a complex process, the learning and assessment of the proficiencies is also complex and multifaceted. A series of focus groups will be conducted with subject matter experts in digital communications that work regularly with teachers and students in the middle and secondary schools to provide learning environments practical application situations for students to learn digital communications proficiencies. The cubic model will also be reviewed and critiqued by the International Digital Communications Standards Advisory. In the multiple focus groups and standards advisory group reviews, the cubic representation will be addressed as a metaphor where we need to keep our eye on the overall teaching and assessment (as the forest) and not get lost in the individual cubes and their interactions with their near neighbor cubes (the trees).

The focus will be on having learners manipulate various digital communication messages elements and demonstrate their performance proficiency with these communication messages and elements.

The intent of the initial domain work is to focus on student as consumer or user of digital communication messages and elements.

The digital communications messages and elements will be provided to students in a realistic contextual framework that allows for assessment of problem solving, critical thinking and global awareness. Thus, the communication messages and elements will be presented in a 21st century context and application format.

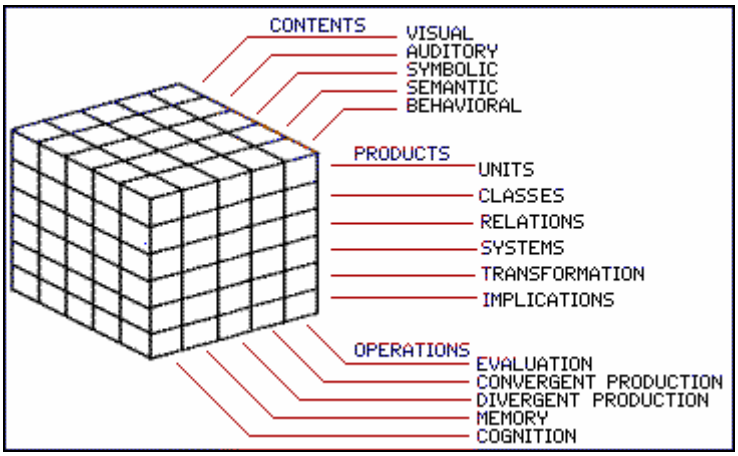
With the cubic representation it is possible that certain slices of the cube or even individual small cubes may not truly exist in the fully researched and vetted digital communications model. It is highly unlikely that there are 7 proficiencies x 7 delivery formats x 5-7 media types = 245 to 343 individual cubes or atomic digital communication elements in the model.

The International Digital Communications Standards Advisory, Certiport and Adobe also expects that elements within and among the three dimensions will likely be correlated rather than independent dimensions and cells within each dimension.

Guilford Structure of Intellect (SOI) Model

The Guilford Structure of the Intellectual (SOI) model (Guilford, 1967; Guilford and Hoepfner, 1971) was originally proposed as an investigative research and development model for the study of human intelligence. As shown below in Figure 2, the Guilford SOI model depicts 5 types of cognitive operations (cognition, memory, divergent production, convergent production, evaluation) 6 different types of products (units, classes, relations, systems, transformations, and implications) and 5 types of content (visual, auditory, symbolic, semantic, and behavioral).

Figure 2: The Guilford SOI Model



Since each of these dimensions was originally proposed as independent, there were theoretically 150 different components that contribute to intelligence. Subsequent research on this model of intelligence showed that there were multiple group factors and higher order factors that were identified and that there were grouped into one third order factor (general intelligence), 8 second order factors (clusters of intelligence abilities such as visual perception) and 66 unique cognitive or intelligence abilities or first order factors (Carroll, 1993). In his latest publications, Guilford also noted that correlated factors were likely present rather than only independent uncorrelated factors.

SECTION 3: RECOMMENDED PRINCIPLES FOR STUDENT ASSESSMENT

Blending of Knowledge and Performance Skills

Assessment is an integral part to the educational process and therefore, using the proper method of assessment is just as important as the proper method of instruction. There are two significant reasons for developing and utilizing the proper assessment method: one, appropriate assessments provide rich data about a student, which enhances a teacher's ability to help them develop essential skills (Dede, Korte, Nelson, Valdez, & Ward, 2005); and two, instructional decisions by the teacher are often influenced by the current educational assessments, especially the many that have strong incentives tied to them. For these reasons it is critical that the right tests and assessments are used (Levy & Murnane, 2005). Many of these incentive- (and penalty) laden tests are mandated by the states, and are centered on their respective content standards. These standards frameworks outline the knowledge deemed essential for each student to study and understand, grounded in the basic skills of reading, writing, and mathematics. However, these types of assessments are not designed to capture a student's mastery over the skills needed for the 21st century (outlined previously). The strategic instruction and assessment (i.e., validated learning) of these skills and tasks must go hand-in-hand.

The recent societal, economic, and technological changes that have occurred implicate that instruction and assessment must change as well. Pellogrino, Chudowsky, and Glaser (2001) explain that *"assessments must tap a broader range of competencies than in the past. They must capture the more complex skills and deeper content knowledge reflected in new expectations for learning. They must accurately measure higher levels of achievement while also providing meaningful information about students who still perform below expectations."*

New models for assessment are needed that measure a student's aptitude with 21st century skills. One current method that examines a blend of both knowledge and performance skills is performance-based assessment. These types of assessments appear in classrooms at varying degrees, and have increasingly received increased support for their use. The U.S. Department of Education's Office of Research explains that "because they require students to actively demonstrate what they know, performance assessments may be a more valid indicator of students' knowledge and abilities" (1993). Certainly, selecting an answer from a provided list can not capture a student's acquisition of a skill--especially those being outlined as 21st century skills. The Office of Research's report perhaps summarizes it best by saying, "there is a big difference between answering a multiple choice question on how to make an oral presentation and actually making an oral presentation" (1993). Take the phrase 'oral presentation' and replace it with any of the tasks that a 21st century citizen needs to be proficient at in our globalized-technological society and the point becomes very clear.

It is likely that additional approaches for measuring the combination of knowledge, skills, and abilities will emerge as the importance of 21st century skills becomes stronger and more evident. An example of this at the macro-level is the Programme for International Student Assessment (PISA). Developed by an international collaboration led by the Organization for Economic Co-operation and Development (OECD), the PISA is an international standardized test that is administered to 15-year-olds in over 58 countries. Its aim is to directly assess life competencies

that apply across different areas of the school curriculum and to determine the student's ability to be a reflective, communicative problem-solver (analyze a situation, manage multiple conditions simultaneously, determine underlying relationships in a problem, solve it systematically, check their work, and communicate results). First administered in 2000, the third cycle of this assessment will occur this year. The second administration of the PISA occurred in 2003. The results from which place U.S. students in the bottom third of all participating nations. Results such as these solidify the urgent need for a new model of teaching and assessment for 21st century skills.

The International Digital Communications Standards Advisory recommends the need for blending of knowledge (e.g., multiple choice, matching, drag and drop, point and click, order objects) and performance skills (construct a science diagram, write a brief short response, write an essay to a designated prompt, perform multiple tasks in either a real or a simulated environment) in tests for digital communications. The assessment designers should use selected response items where possible to measure knowledge of vocabulary, concepts, and processes. A blend of constructed response items and performance tasks should be used to effectively measure student's capabilities to use complex multiple step procedures in digital communications. It is not an either/or situation but an *and* logic that should be followed as there is a clear need for blending both knowledge and performance skills in assessing digital communications.

The following section briefly introduces some of the characteristics of performance testing and constructed response testing.

Mulkey (2001) defined performance-based testing as "a methodology for evaluating individuals by having them actually complete a real or simulated task relevant to a particular job. Performance-based testing differs from multiple choice testing in that a performance test allows the test-taker to create a solution to solve a problem…Performance-based tests are designed to emulate what a candidate does on the job." (Mulkey, 2001, p. 60.)

There is increasing interest in designing and developing performance assessments as supplements to conventional selected response tests (Bennett and Ward, 1993). For example, Bennett, Ward, Rock and LaHart (1990) provide a scheme for categorizing item types that includes the following six levels ranging from selection to construction:

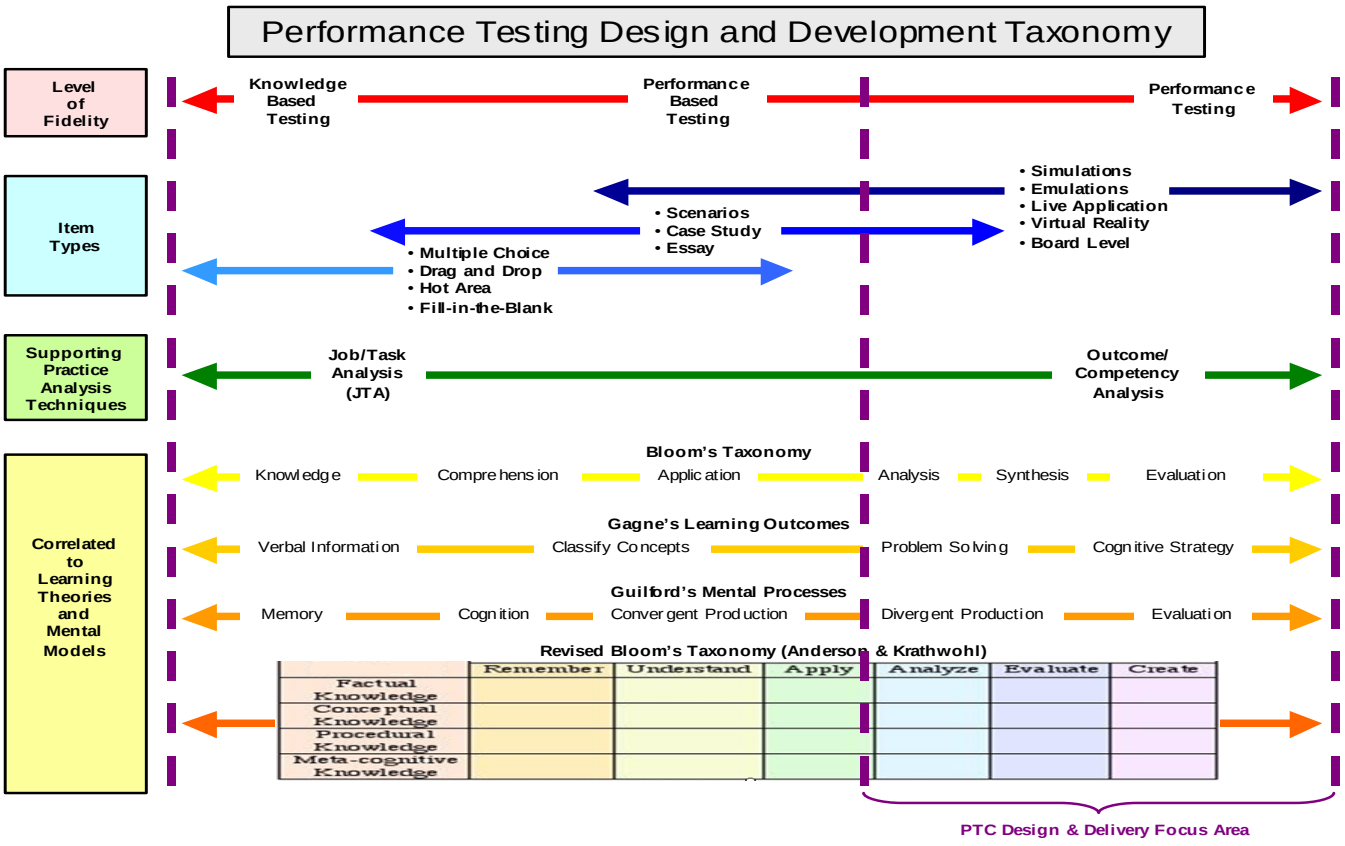
- 0 Multiple choice
- 1 Selection/identification
- 2 Reordering/arrangement
- 3 Substitution/correction
- 4 Completion
- 5 Construction
- 6 Presentation

These performance assessments require examinee actions demonstrating what the person 'knows and can do'. The performance exercises and tasks represent those required in realistic contexts and job tasks. Examples of performance tasks include installing and maintaining a software program, troubleshooting typical system problems, and predicting outcomes based on identified symptoms. Performance tasks provide information on learning and thinking processes (analysis, synthesis, problem solving and troubleshooting), types of performance errors and overall performance quality and competence.

Conventional test development procedures represent the job task analysis with verbal task lists, test objectives and selected response knowledge tests. Unfortunately, these knowledge-based tests do not adequately measure the expert's performance competencies and skills. Real expertise is found not only in the words, but also in the fingers, in the actions, and in the gut. Effective performance tasks should be modeled to provide high fidelity rather than merely visual realism to the applied setting, job tasks and meaningful work-like materials.

Figure 3 shows a taxonomy model presented by the Performance Testing Council that shows the progression from knowledge based testing to performance testing and from selected response item formats to constructed and performance-based item and task formats.

Figure 3: Performance Testing Council Taxonomy Model



Creating Assessment Items and Tasks for Measuring Knowledge and Performance Skills in Digital Communications

Following are the primary principles that are recommended for measuring knowledge and performance skills in digital communications.

1. Employ a blended approach to assessment where the most straightforward and direct method of assessment is used for measuring the knowledge, skill or ability that is represented in the test specifications document.
2. Provide sufficient number of performance exercises and performance scenarios at each assessment level that require the examinee to demonstrate proficiency in the integration and use of digital communications using a variety of media elements and providing for distribution with a variety of delivery formats.
3. Provide a standard set of application software that can be used for the performance-based elements of the assessment. The standard application software should include an Internet browser, word processor, presentation package, integrated video and audio player, Web page design package, and photograph and graphics package.
4. Assess student skills of information gathering, problem solving, decision making, critical thinking and communication.
5. Provide both overall scores and diagnostic profiles of individual and school level capabilities.
6. Provide a menu of acceptable assessment instruments that can be used to assess digital communication skills
7. Use technology appropriately to administer, score and report on the digital communication assessments.
8. Move from assessment of discrete knowledge and skills to measuring integrated use of digital communication skills in concert.
9. Provide real-world contexts for the presentation and assessment of digital communication skills.
10. Use dichotomous scoring wherever possible to measure attainment of the competencies. Use weighting of the scores only when such score weights improve the classification of students into proficiency standards or where the weighting of scores increases the correlation of the individual item and task scores to the overall test score.
11. Use graded response models and rubric scoring where the graded response model is determined by the subject matter experts and test designers to be preferable to the dichotomous scores. When the graded response model is used, use the smallest number of possible score points.

Recommended Assessment Models for Assuring Validity of Digital Communications Knowledge and Performance Skills

Two alternative models are recommended for assessing the validity of digital communications knowledge and performance skills. These two models are Evidence-Centered Design (ECD) proposed by Robert Mislevy and his colleagues and Validity-Centered Design (VCD) proposed by C. Victor Bunderson and his colleagues.

These validation models are briefly introduced below. Additional references are provided for more in-depth investigation of each of these validation models.

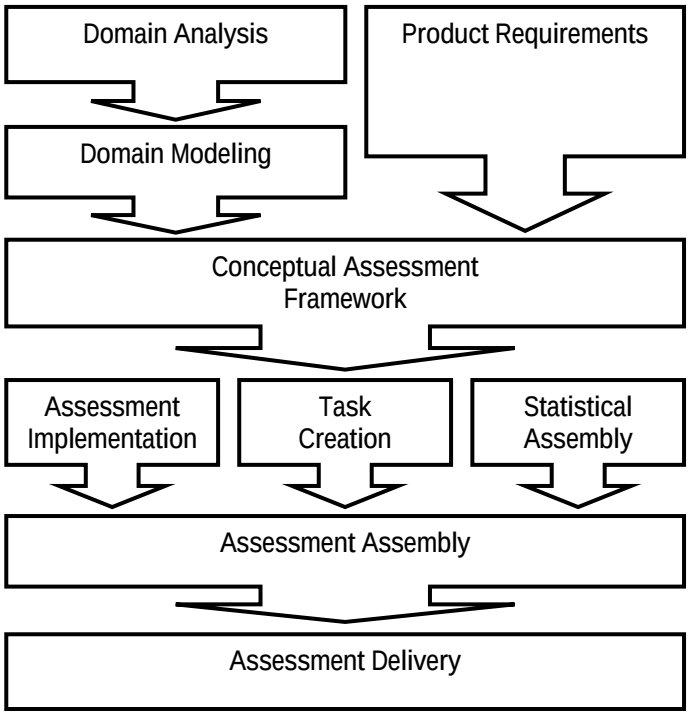
Evidence-Centered Design

Evidence-centered design is an approach to testing and assessment design that attempts to formalize the various types of inferences that can be derived from test scores and the types of evidence that can be marshaled in support or negation of these inferences. Evidence-centered design also attempts to build a comprehensive assessment framework and identify testing processes that support this approach. Evidence-centered design is a program with research and applications initiated at Educational Testing Service (ETS) in 1997 and continuing now at the University of Maryland, Stanford University, and other universities. The psychometric scientists using evidence-centered design include Robert J. Mislevy, Linda Steinberg, and Russell G. Almond (Almond, Steinberg, & Mislevy, 2002; Mislevy, Steinberg, & Almond, 1999; Mislevy, Steinberg, & Almond, 2003a, 2003b).

Evidence-centered design involves a principle-centered validity framework concerned with all phases of educational assessment process. It is "a principled framework for designing, producing, and delivering educational assessments," particularly assessments that include complex student models and interactive exercises and simulations (Mislevy, Steinberg, & Almond, 1999, p. 1). Evidence-centered design is derived from advances in cognitive and instructional sciences, technology, and evidentiary reasoning. It includes an assessment design focused on appropriate inferences, observations to ground these inferences, situations that will evoke the observations, and chains of reasoning to connect them, and a conceptual design framework with coherent assessment elements. Evidence-centered design provides an overall conceptual framework for assessment design, an object model for creating the specifications for particular assessment products and software tools for creating and managing the design objects.

Figure 4 on the following page presents a schematic design for evidence-centered design. This section provides brief descriptions of key theoretical elements summarized from a recent article by Mislevy, Steinberg, and Almond (2003a). This article also includes a more elaborate schematic design.

Figure 4: Design and Implementation Schematic



Evidence-centered design addresses three stages of the assessment design process.

1. Domain analysis identifies substantive elements and relations in the target domain.
2. Domain modeling develops illustrative paradigm situations within the domain. Three types of paradigms are investigated. Proficiency paradigms model claims regarding examinees and their proficiency levels. Evidence paradigms model observable actions that examinees can say and do. Task paradigms model representative task situations where evidence of task performance can be collected. The modeling process defines relationships among the proficiency levels, what examinees say and do, and typical task situations.
3. A conceptual assessment framework is created. The assessment framework includes student models, task models, and evidence models. The evidence models have both an evaluative or judgment component and a measurement or comparison component. The conceptual assessment framework includes an assembly model for creating appropriate assessments and a presentation model for delivering and scoring these assessments. (pp. 7–8.)

Evidence-centered design uses probability-based reasoning with Bayesian inference networks from observed task and test performance to unobserved ability or proficiencies of the individual. Bayes' theorem is used for updating a prior distribution given new information to form a new posterior probability distribution. This allows for accumulation of evidence over many observations, synthesis of information from multiple lines of evidence, and use of different data sets for different students or groups of students. Other evidence linking methods can be used to define relationships between task characteristics, performances, and proficiencies.

In identifying sources of information for domain analysis, evidence-centered design investigates seven key information types:

1. Valued work products,
2. Task features,
3. Representational forms,
4. Performance outcomes,
5. Valued knowledge,
6. Knowledge structures and relations, and
7. Knowledge-task relations. (Mislevy, Steinberg, & Almond, 2003a, pp. 18–19.)

At the present time, evidence-centered design has been applied in professional fields as diverse as language learning and information-technology training and has proved useful for design, development, delivery, and analysis of knowledge and performance-based tasks. The use of evidential arguments and evidence and task variables allows scoring of actual performance assessment tasks and job work tasks as elements of an assessment system. Evidence-centered design uses Extensible Markup Language (XML) data structures and records to show static and dynamic performance properties and variable states, as well as structural relationships, statistical distributions, and statistical updating procedures. The author expects to see more and varied applications of evidence-centered design.

Validity-Centered Design

Validity-centered design and its associated theories, methods, and realizations are centered in the work of C. Victor Bunderson and his professional colleagues and graduate students, including the principal author. Doctoral dissertations and papers building the elements for validity-centered design, domain theory, and learning-progress measurement include Bunderson (2000, 2003); Bunderson, Martinez, and Wiley (2000); Martinez, Bunderson, and Wiley (2000); Wiley (2000), Pelton (2002), Strong-Krause (2000, 2002), and Xin (2002).

Components of Validity-Centered Design

Validity-centered design is focused on designing and implementing the ideas of Samuel Messick on validity in operational and online educational and assessment environments. Messick (1988, 1989a, 1989b, 1998) has been perhaps the most influential validity theorist of the last 15 years. He developed the unified validity framework that showed that construct validity is the central, unifying concept among a variety of different views or perspectives on validity. Construct validity deals with the invisible traits or constructs that intelligent observers have formulated and constructed in words, diagrams, and so forth; how these invisible constructs are made visible through responses to items and performance situations; and how these responses are turned into scores. Construct validity is the link between invisible theoretical ideas about important human qualities (sometimes called latent traits) and the scores on some instrument or measurement procedure designed to produce numbers reflecting differences in the unobservable human qualities. These numbers represent more or less of the latent trait or construct in question.

Validity-centered design is a set of methods and tools used at each of several stages of a design process to develop a learning progress system, to implement it in an online environment, and to keep improving it. The learning progress system is revised over a series of implementation improvement cycles. The learning progress system is used by teachers and students and improved based on qualitative and quantitative results. Data are collected during each cycle of implementation and during the design process itself. Over time, data and documentation provide an increasingly strong validity argument for the quality of the learning progress system. The idea is

that validity cannot be proved once and for all, but that evidence and argument threads can be assembled to show how well a given learning progress system, when used in certain ways, meets the multifaceted ideal of the unified validity model. Validity is much more complex and unified than usually understood. Validity-centered design identifies nine different but interrelated aspects of validity. These incorporate the six aspects of construct validity identified by Messick (1989a, 1989b):

1. Content
2. Substantive process
3. Structure
4. Generalizability
5. External
6. Consequential

Validity-centered design restructures these six aspects and then adds three new aspects: overall appeal, usability, and value and positive consequences. A comprehensive validity argument can be organized around these nine integrated aspects of validity. Table 8 shows the nine validity aspects structured into three primary classifications each with three elements.

Table 8: Validity-Centered Design Elements for Assessment Systems

I. Design for Usability, Appeal and Positive Expectations (User Centered Design)
- A. Overall Appeal
- B. Usability
- C. Value and positive consequences (perceived)

II. Design for Inherent Construct Validity
- A. Content
- B. Substantive Thinking Processes
- C. Structural (number of dimensions)

III. Design for Criterion-Related Validity
- A. Generalizability
- B. External Validity (convergent/discriminant)
- C. Consequential (positive and negative)

Validity-centered design aspires to do more than guide and design an assessment system. A learning progress system also includes a measurement system. This system may be used for ongoing, cyclical evaluation of not only the students, but also the measurement system itself, the instructional materials delivered on the same computers as the measurement system, the adaptive research system that includes adaptation to individual differences, and the strategic implementation of learning and content management systems. The student-progress measures are a part of this comprehensive measurement system but are not all of it.

To accomplish this, validity-centered design leads to an interpretive framework with domain-spanning unidimensional scales that can be used for monitoring and measuring learning progress along the various domain dimensions.

SECTION 4: DEVELOPING EXEMPLARY STUDENT ASSESSMENT TASKS AND ITEMS

The Steps of Test Development

The International Digital Communications Standards Advisory, Certiport and Adobe will use a modified twelve step process outlined by Downing and Haladyna (2005, 2006) for the development of assessment tasks and items for measuring digital communications. The report authors have added a thirteenth test development step regarding test adaptation and localization for individuals with differing primary and secondary language capabilities. Each of the steps are outlined and briefly explained below.

1. Test Planning

Building an effective test can be compared in many ways to building a new house. The first step begins with a test plan or blueprint. The test planning document answers many questions about the test. What is the test purpose? Who is the intended test audience? What are the intended score interpretations that you would like to make about an individual or group of persons after they have completed the test? What are the issues regarding the schedule for test development, administration and scoring? Who will be responsible for the various tasks in the test development process? What are the resources available both human and financial for the test development, administration, scoring and reporting? Who will manage the test development process? How will you provide statistical and psychometric assistance during the test development, analysis, and validation process? What documentation is needed during each of the test development step?.

As with the building of a house, a solid test plan will prove immensely valuable when other individuals ask questions or seek information regarding the test under development.

2. Content/Task Definition and Analysis

The second step is the development of a solid content/task definition and analysis. For achievement tests where there is a domain of content which must be addressed, the content analysis process is used. With achievement tests the intent is to understand whether the required content has been mastered (criterion-referenced tests) or to order individuals with respect to the relative score on the exam for a group of individuals or some normative population (norm-referenced tests). The proposed digital communications exams will be created as criterion referenced tests.

For professional certification and licensure tests where there is a professional body of information that must be addressed and the individuals score is compared to a professional standard, then the job analysis or practice analysis is used. Subject matter experts, focus groups and survey ratings are used to determine which tasks are the most crucial in relationship to task difficulty, frequency of use, criticality, and importance for inclusion on the test.

Once the content or task elements are defined, these content topics or performance tasks are further defined to identify the knowledge, skills, and abilities that are needed to perform well on the required content or tasks. Content topics are typically organized into objectives and strands that subsume or cross several objectives. The content topics, objectives, and strands are carefully defined and consensus agreement is reached that the topics, objectives and strands are

comprehensive and complete. A taxonomy for classifying the objectives is used to identify the level of cognitive demand that is required for each topic, objective, and strand. Taxonomies such as the revised Bloom's taxonomy, the Merrill taxonomy, or others are used. The primary use of the taxonomy is for communication and ensuring that the test items will be written to the appropriate levels of difficulty. One variation that is typically used is the Knowledge, Skill or Ability (KSA) taxonomy. Each topic, objective, or strand is identified as either a knowledge (cognitive), skill (performance), or ability (prerequisite capability).

The content and job analysis skills provide content-related evidence and construct-related evidence (unobservable constructs underlying the test scores) in support of the validation of the scores from the test. The content or job analysis should investigate the expected number of dimensions that underlie the test scores. Procedural evidence in support of score validation comes from documentation evidence at each step of the test development process. The subject matter expert ratings of items and task difficulty also provide content-related and construct-related in support of the validity of the test scores.

3. Test Specification

The test specification as step three can be compared to the blueprint for building of a house. The house blueprint identifies the number of floors of the home, and the number and type rooms, room dimensions and room organization. The test specification is typically a two dimensional matrix that identifies the objectives or tasks as specified by rows in the matrix and the number, type, and classification of items as columns in the matrix. The test development personnel and item writers can examine the test specification to understand the characteristics of the test items that are envisioned. Sample test items of each type and level of difficulty are recommended to give explicit exemplars of the types of items that are to be considered within each column or classification level. The test specification should be detailed enough to provide the information for test development and item writers, however, it should not be so specific to provide no leeway for creativity and writing more than one item to address each objective. The test specification should also specify general characteristics of the item difficulty and discrimination indices that are acceptable for the test. Acceptable item formats should also be identified in the test specification.

The test specification is the blueprint document that guides the test development process. The test specification can be followed to ensure adequate sampling of the content domain as specified and represented by the test specification. The test specification is also valuable procedural evidence of validity since it is the blueprint design from which the test was developed. The test specification document should be developed by subject matter expert committees, in accord with the professional test development standards, and in support of the intended test purpose and intended test score interpretations.

4. Item Development

The fourth step involves use of content specialists or subject matter experts to write items or tasks for the test. The test specification can be used to decide which item format(s) are helpful in measuring the content or performance tasks within the target content domain. Before writing items, the item development team should consider issues such as the test purpose, the types of behaviors or evidence that the examinee can exhibit, the types of validity considerations, logistics, costs and practicality. The item writers should follow approved guidelines or style guides as they

write the test items. These guidelines and style guides should be based on evidence based principles rather than folklore. Content and subject matter experts should be selected for writing the items and tasks. To provide for continuity in training of item writers an item writing guide or manual should be developed. The item writers should be effectively trained with appropriate cycles of practice, feedback and review. The item writers should be given assignments for writing and the test development manager should monitor each writer's progress in meeting the assignments. Where possible, the items and tasks should be developed in a common item banking or test development system. This will help to ensure appropriate item and task security and management.

During writing, issues of language, reading level and item complexity should be addressed. Each item or task should be reviewed by one or more peers with rigorous content review cycles.

Issues such as sensitivity or bias in favor of or against any particular subgroup should be considered during the item writing process. Documentation of the correct answer and verification of the keyed answer is crucial during item writing. During item writing appropriate accommodations should be specified for special needs examinees. Throughout the item writing process, the item writers should follow the professional item writing standards and guidelines and should document their ongoing progress.

After the items have been written, the items should have a content, grammar, and technical edit to ensure that the item is as clear, concise and straight forward as possible. Additionally, a review of the content should insure it is free from cultural bias, particularly for assessments intended for global programs. Development field testing or think-aloud testing is very helpful to uncover any potential ambiguities in the test items or tasks. Formal field testing or pilot testing should be conducted wherever possible. The sample for the field test or pilot test should be as similar to the final examinee population as is feasible. Item analysis should be conducted to identify the item difficulty, item correlation to the total test, and high and low group discrimination indices. When feasible, item response theory indicators of item difficulty, discrimination, and guessability should be computed and reported.

For selected response items, the item key should be double checked for accuracy. If the item analysis statistics suggest that a keyed answer may not been seen as correct by the examinee population as a whole, then the test development staff can consider a variety of decisions related to the non-consistent item. Possible decisions may be to revise the item, change the key, eliminate the item, or keep as is. For performance-based items, scoring should also be double checked to insure that all possible correct methods of completion to achieve the end state are supported. All of these decisions regarding the content and scoring of the items should be carefully cross checked by content matter specialists and subject matter experts. If the item or task passes all of the edits and statistical criteria, then the item or task is banked and is then available for use on the test forms.

5. Test Design and Assembly

The fifth step involves test design and assembly. In this step the acceptable test items and tasks from the item bank are allocated to alternative test forms for administration to examinees in accord with the test specification and test purpose. The test development specialist should follow both content criteria and statistical criteria in the design and assembly of the test forms. The considerations for test design and assembly should be in accord with the test purpose, type of

exam, and desired inferences from the test scores. Alternative test designs can be considered for a single test form, multiple test forms, or dynamic form assembly. Considerations for use and value of computer-based and technology delivered tests or computerized adaptive testing are required at this point. The *Guidelines for Computer Based and Internet Testing* from the International Test Commission and the *Guidelines for Computer-Based Testing* from the Association of Test Publishers should be reviewed for relevance and application.

6. Test Production

Step six is the test production. In this step the test design and assembly is finalized into production line masters or golden production versions of computer-based or technology delivered tests. This step is very important and detailed checks and quality control procedures should be followed. Regardless of all of the procedures that have been followed in the development of the test, if there are production problems in the final production stage, these error are present for each candidate that receives a specific test form. Validity evidence is supported by following high quality test production procedures. There is a need to spend sufficient time and resources in planning, scheduling, and quality control checks to ensure that the test is accurate, complete, and of the highest quality. Attention to details and documentation are important especially in the test production step.

7. Test Administration

Although there are many variations in test administration procedures, there are three general classes of test administration procedures. 1) There are linear test forms that are administered in paper and pencil format, 2) there are linear tests that are administered in computer-based or online-based format, and 3) there are dynamic or computerized adaptive tests. The linear test in paper and pencil format typically has a test booklet and a corresponding scanning answer sheet. The linear test in paper and pencil format is typically administered at fixed times in designated testing windows. The linear test form in computer based or online format presents the items and collects the examinee responses in a sequential, item-by-item fashion. The linear form in computer-based or online format is typically given on multiple test dates or testing windows. Depending on the number of examinees and testing dates, the computer-based test typically has multiple test forms that are generated or equated to have comparable score equivalency. In the dynamic or computerized adaptive test, the first item or task is selected based on item analysis or calibration statistics. The item is presented to the examinee and a new estimate is made of the proficiency or ability level of the examinee. A new item is selected from the available items based on the revised proficiency or ability level. The dynamic or adaptive test can be administered with each item or task being selected and administered adaptively or a group or cluster of items, called a testlet being the unit that is selected and administered.

The standardized test administration procedures provide a very important source of evidence in support of the validation of the test scores. Non-standard test administration procedures can seriously disrupt the evidence process. The test administration process is the point where there are the greatest threats to the security of items, tasks, tests, and scores. The test administration process must be rigorously followed by experienced test administration or test proctor staff.

A written and detailed guide should be developed to ensure standardized test administration.

8. Test Scoring

Step eight is the scoring of the test according to the designated score key or scoring rubric. The test can be scored dichotomously with a score of “1” for all correct answers and a score of “0” for all incorrect answers or the test can be scored polytomously with a range of scores possible for a correct score or a range of possible incorrect actions. There is a need to verify that the test is being scored correctly. Scoring problems can result from test administration staff mistakes, poor quality control checks, poor policy and procedures guidelines, poorly trained staff for oversight personnel, and lack of independent evaluation and verification. In the scoring process there are many technical issues that are involved in determining how to account for non-responses, missing data, guessing or intentionally missing the items, invalid test answer sheets or test score records, and test cheating from collusion or item or task theft.

9. Performance Standard Setting

The ninth step in test developed is performance standard setting. This step requires a plan since there are several alternative procedures that are available for setting a defensible performance standard(s) or cut score(s) for the test. Either relative or absolute standards can be set for the exam. Relative standards are based on percentile values on the exam. Absolute standards are based on measured differences between the examinee score and the performance standard(s) or cut score(s). The rationale for the selection of the performance standard setting process should be thoroughly documented. Performance standard setting typically involves use of subject matter experts to 1) make judgments of the relative difficulty of each item or task for the minimally qualified individual (modified Angoff), 2) the placement of a book mark at the relative difficulty for the minimally qualified individual, or 3) use responses from survey items or independent classification criteria to categorize individuals into above, at or below borderline groups. The standard setting study should be carefully planned, scheduled, conducted and reported. The performance standard study will specify a range of acceptable test scores that can be considered by the policy making group. The final decision on the performance standard(s) or cut score(s) is based on both policy issues and statistical information. The test development specialist or psychometrician reports the results of the standard setting study to the appropriate decision making agency or policy setting group. The decision making agency or policy setting group then communicates the performance standard to the relevant stakeholders.

10. Reporting Results

Step ten is preparing score reports for examinees and sponsoring agencies. The test score is the primary communication device for all users and should be complete, accurate, and comprehensive. The score report should explain clearly all scores and interpretations. The score report should also indicate how to avoid common misinterpretations of test scores. The professional standards should be followed in the score reporting process. The score reports should include all of the important scores and subscores. The score report should specify appropriate uses and interpretations of the test scores. Subscores from the exam should only be reported if there are sufficient test items or tasks to have a reliable score. Measures of the imprecision of the scores, standard errors of the mean, standard errors of measurement should be reported in addition to the test scores. Graphical or histogram reports are also very helpful for communicating a group of test scores.

11. Item Banking

The eleventh step in test development is to consider the benefit of item banking. An item bank should provide four major capabilities: 1) a camera ready or graphic What You See Is What You Get (WYSIWYG) display for the item or task, 2) statistical characteristics for the item or tasks that are included and can be searched and retrieved, 3) taxonomy, objective and topic classifications for the item or task content, and 4) an easy to use item ordering and management system. Flexibility of the definition of the classification titles is very helpful.

12. Technical Reports/Validation

Step twelve is to prepare technical reports and validation and reliability studies. The technical reports should include all of the technical information that is available on the test. This information should include test plan, test specifications, test item writing procedures, test review procedures, item analysis statistics, test form design and analysis, test administration procedures, test scoring procedures, test reporting procedures, and studies of the technical validity, reliability and fairness of test scores. The technical reports should include recommendations for improvement of the testing process at each stage. The technical reports and validation studies should be conducted in conformance to the professional standards. Documentation of the content-related evidence, construct-related evidence, and predictive validity evidence should be thoroughly documented. The technical manuals and validation studies provide evidence for public information and legal defensibility of the test, its scores, and resultant interpretations.

The test validation process is ongoing with new evidence of score uses and interpretations being added to the ongoing evidential argument for the validation of test scores. The evidential argument includes both procedural evidential links and statistical or empirical evidential links. The technical reports should be detailed with sufficient evidence for a knowledgeable test specialist or test users to determine how well the technical evidence supports the validity, reliability, usefulness, and fairness for the test scores uses and score interpretations.

13. Test Adaptation and Localization

As noted above, the report authors have added a thirteenth test development step to the twelve steps specified by Downing and Haladyna (2005, 2006). This final step details test adaptation and localization for individuals with differing primary and secondary language capabilities. For exams that will be delivered to international audiences, item writers must be especially vigilant in insuring that items will appeal to a wide audience. Additionally, the items must not be biased, offend or give unfair advantage to any gender, ethnic, or cultural group.

Test adaptation and localization is the process of adapting exam items and tasks into various cultures and translating the items and tasks into a variety of native languages. Localization affects editorial and style decisions. Item writers must facilitate accurate translation of the items, and therefore, must write in clear and concise English. If a translator has to guess the intended meaning of a word or phrase, the risk of translation mistakes increases significantly.

Similarly, item writers must use the same term to refer to the same thing throughout an exam, so that the translator does not need to wonder or question whether the same thing is actually intended in different places or whether a single translation can be used throughout.

Whenever possible, item writers should not use over-modified nouns. It may be difficult for localizers to understand which qualifier applies to which object if several adjectives are used. Articles should not be dropped, as it may be difficult for localizers to understand a sentence with too many elements missing. All implied pronouns should be included. Even if it is implied already, the pronoun should be used before the verb. Verbs and auxiliaries should always be used. Contractions such as "he's" (for he is or he has) should be avoided.

The exams should measure the examinees' knowledge, skills and abilities in the domain, rather than their comprehension of an unfamiliar cultural reference or scenario.

The International Test Commission has prepared a set of professional guidelines on adapting and localizing tests for use in an international context with speakers of different languages.

ITC Guidelines on Adapting Tests

The ITC website notes that *the "ICT Guidelines were developed by a 13-person committee representing a number of international organizations. The objective was to produce a detailed set of guidelines for adapting psychological and educational tests for use in various different linguistic and cultural contexts."* (Van de Vijver & Hambleton, 1996; Hambleton, R. K. and Patsula, L.,1999; Hambleton, R, K, Merenda, P.F. and Spielberger, C. D., 2005.)

"This is an area of major importance as tests become used in more and more countries, and as tests developed in one country get translated or adapted for use in another. Adaptation needs to consider the whole cultural context within which a test is to be used. Indeed, the adaptation guidelines apply wherever tests are moved from one cultural setting to another - regardless of whether there is a need for translation."

Hambleton (1994) describes the project in detail and outlines the 22 guidelines that have emerged from it. These guidelines fall into four main categories: those concerned with the cultural context, those concerned with the technicalities of instrument development and adaptation, those concerned with test administration, and those concerned with documentation and interpretation. All but the second of these also have direct implications for test use and for test users.

ITC Test Adaptation Guidelines

Following are the *ITC Test Adaptation and Localization Guidelines* (April 21, 2000 Version). The 5th Conference of the International Test Commission is being convened in Brussels, Belgium, July 6-8, 2006.The title of this conference is *Psychological and Educational Test Adaptation Across Languages and Cultures: Building Bridges Among People.* This conference will provide information, guidance and support for updating the ITC Guidelines on Adapting Tests.

Context

1. *Effects of cultural differences which are not relevant or important to the main purposes of the study should be minimized to the extent possible.*
2. *The amount of overlap in the constructs in the populations of interest should be assessed.*

Test Development and Adaptation

1. *Test developers/publishers should insure that the adaptation process takes full account of linguistic and cultural differences among the populations for whom adapted versions of the instrument are intended.*
2. *Test developers/publishers should provide evidence that the language use in the directions, rubrics, and items themselves as well as in the handbook are appropriate for all cultural and language populations for whom the instrument is intended.*
3. *Test developers/publishers should provide evidence that the choice of testing techniques, item formats, test conventions, and procedures are familiar to all intended populations.*
4. *Test developers/publishers should provide evidence that item content and stimulus materials are familiar to all intended populations.*
5. *Test developers/publishers should implement systematic judgmental evidence, both linguistic and psychological, to improve the accuracy of the adaptation process and compile evidence on the equivalence of all language versions.*
6. *Test developers/publishers should ensure that the data collection design permits the use of appropriate statistical techniques to establish item equivalence between the different language versions of the instrument.*
7. *Test developers/publishers should apply appropriate statistical techniques to (1) establish the equivalence of the different versions of the instrument, and (2) identify problematic components or aspects of the instrument which may be inadequate to one or more of the intended populations.*
8. *Test developers/publishers should provide information on the evaluation of validity in all target populations for whom the adapted versions are intended.*
9. *Test developers/publishers should provide statistical evidence of the equivalence of questions for all intended populations.*
10. *Non-equivalent questions between versions intended for different populations should not be used in preparing a common scale or in comparing these populations. However, they may be useful in enhancing content validity of scores reported for each population separately.*

Administration

1. *Test developers and administrators should try to anticipate the types of problems that can be expected, and take appropriate actions to remedy these problems through the preparation of appropriate materials and instructions.*
2. *Test administrators should be sensitive to a number of factors related to the stimulus materials, administration procedures, and response modes that can moderate the validity of the inferences drawn from the scores.*
3. *Those aspects of the environment that influence the administration of an instrument should be made as similar as possible across populations for whom the instrument is intended.*
4. *Test administration instructions should be in the source and target languages to minimize the influence of unwanted sources of variation across populations.*
5. *The test manual should specify all aspects of the instrument and its administration that require scrutiny in the application of the test in a new cultural context.*

6. *The administrator should be unobtrusive and the administrator-examinee interaction should be minimized. Explicit rules that are described in the manual for the test should be followed.*

Documentation/Score Interpretations

1. *When a test is adapted for use in another population, documentation of the changes should be provided, along with evidence of the equivalence.*
2. *Score differences among samples of populations administered the test should not be taken at face value. The researcher has the responsibility to substantiate the differences with other empirical evidence.*
3. *Comparisons across populations can only be made at the level of invariance that has been established for the scale on which scores are reported.*
4. *The test developer should provide specific information on the ways in which the socio-cultural and ecological contexts of the populations might affect performance on the test, and should suggest procedures to account for these effects in the interpretation of results.*

Sample Test Items and Tasks for Digital Communications

Appendix A provides sample test items and performance tasks for the digital communications domain.

Employing Assessment Creativity and Innovation

The International Digital Communications Standards Advisory recommends that any assessments developed to measure the Digital Communications Standards use creativity and innovation in the design, presentation, scoring, and reporting. Examples of such creativity and innovation that should be considered could include simulation exercises, use of live software applications, emulations, rich multimedia content, testlet clustering, and common measurement scaling of the selected response items and constructed response and performance items and tasks. The assessments should also include some assessment items and tasks that require integration, realistic problem solving, decision making and synthesis rather than testing for isolated and decontextualized snippets of knowledge, skill or abilities.

Digital communications technology is itself becoming more cohesive and integrated. Such innovation and creativity in the corresponding assessments will likely appeal to the digital native students and more accurately evaluate their true capabilities with the new digital media and delivery formats.

A Bakers Dozen Questions for Test Designers

This section presents a series of questions for test design consideration in determining the most appropriate combination of test and item types consistent with a given test purpose.

- What construct(s) is the test attempting to measure?
- What are the purposes and uses for which the test will be administered?
- What are the most appropriate item types to meet the specified purpose of the exam?
- How many test items of each item type can be developed to meet the planned test budget?
- How many test items of each item type can be administered within the planned test administration budget?
- How will the test be scored including both automated and/or human judged elements?

- How will security be provided for test items, test item banks, test forms, scores and test reports?
- What is the required type and accuracy for decisions and interpretations that will be made from test scores?
- What are the stakes associated with scores from the exam?
- How much time can be allocated for the assessment?
- How close can the assessment come to meeting the purpose of the exam with less complex item and test types?
- What kinds of validity considerations are relevant for the target exam?
- What are the advantages and disadvantages of the chosen assessment method(s) for maintaining validity evidence to support the testing program?

Construct Validity for Digital Communications Assessments

Samuel Messick is a pioneering scientist in validity theory for educational and psychological testing. In his (1989b) seminal work on validity, he summarizes the key elements of validity investigations of assessment.

"Validity is an integrated evaluative judgment of the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of inferences and actions based on test scores or other modes of assessment. As will be delineated shortly, the term test score is used generically here in its broadest sense to mean any observed consistency, not just on tests as ordinarily conceived but on any means of observing or documenting consistent behavior or attributes. Broadly speaking, then, validity is an inductive summary of both the existing evidence for and the potential consequences of score interpretation and use . . ." (Messick, 1989b, p. 13.)

Messick (1989b) notes that the threats to validity can be grouped into two general classes. Construct under representation results from a test that is too narrow to faithfully represent the key facets of the construct. Construct-irrelevant variance is found when the test exhibits reliable variance that is not relevant to the tested construct(s). Messick (1994) also notes that these two classes of threats to validity are also the primary evaluation issues required for justifying the validity of performance assessments.

Messick (1989a) clarifies that construct validity is the basic integrative foundation of all of the facets of validity (see Table 9 below). *"Construct validity appears in every cell, which is fitting because construct validity is the integrating force that unifies validity issues into a unitary concept."* (p. 10.)

Table 9: Elements Needed for a Solid Validity Argument

	Test Interpretation	Test Use
Evidential Basis	Construct Validity	Construct Validity + Relevance/Utility
Consequential Basis	Construct Validity Value Implications	Construct Validity Relevance/Utility Value Implications Social Consequences

"Constructing Construct Validity" (Messick 1998)

In a paper specifically addressing validation of performance assessments, Messick (1994) emphasizes that performance tests should adhere to the same *"general validity standards as any other test or assessment: content, substantive, structural, external, generalizability, and consequential aspects of construct validity. Performance assessments must be evaluated by the same validity criteria, both evidential and consequential, as are other assessments."*

Messick (1994) suggests that performance assessments should be construct-driven rather than task-driven. This means that the validity investigation should focus on the relevant constructs measured by the test rather than on the specific task or item set included in the assessment.

With the construct-centered approach, the investigators can examine evidence for construct-relevant variance and construct-irrelevant variance in aspects of task performance. The task-centered approach focuses on the specific tasks provided in the assessment rather than the generalizations to a larger domain of potential tasks that might have been administered. A construct-centered scoring approach leads to score criteria and rubrics across multiple tasks rather than the specific criteria and rubric for the sampled items and tasks.

SECTION 5: VALUE IMPLICATIONS, SOCIAL CONSEQUENCES AND RELEVANCE/USE ISSUES RELATED TO DEVELOPING INTERNATIONAL DIGITAL COMMUNICATION STANDARDS AND ASSESSMENTS

Table 10 replicates Table 9 but with a different emphasis placed on Messick's position that appropriate test score validation is also influenced by value implications, social consequences, and relevance/utility issues (Messick, 1989a, 1989b, 1994, 1995, 1998). Meaningful interpretations and uses of test uses must also attend to the value, social and relevance implications of the assessments.

Table 10: Elements Needed for a Solid Validity Argument with Emphasis

	Test Interpretation	Test Use
Evidential Basis	Construct Validity	Construct Validity + Relevance/Utility
Consequential Basis	Construct Validity Value Implications	Construct Validity Relevance/Utility Value Implications Social Consequences

"Constructing Construct Validity" (Messick 1998)

Messick 1989b notes, *"The evidential basis of test use is also construct validity, but as buttressed by evidence for the relevance of the test use to the specific applied purpose and for the utility of the test in the applied setting. The consequential basis of test interpretation is the appraisal of the value implications of the construct label; of the theory…Finally, the consequential basis of test use is the appraisal of both potential and actual social consequences of the applied setting."* (p. 20.)

"Indeed, it is difficult to isolate questions of value implications of score interpretations from questions or the validity of those interpretations…Values are important to take into account in score interpretation not only because they can bias score based inferences and actions, but they could also indirectly influence in more subtle and insidious ways the meanings and implications attributed to test scores, with consequences not only for individuals but for institutions and society." (pp. 58-59.)

"In particular, critical value implications frequently emerge when the test is placed in the specific social context of a local applied setting… The consequential basis of test use addresses the functional worth of test scores by adding an appraisal of the social consequences of testing to our

concerns with meaning, relevance, utility, and value implications as integral aspects of score validity." (p. 88.)

"In general, the best protection against adverse social consequences as threats to score interpretation and use is to minimize in the measurement process any potential sources of test invalidity, especially construct underrepresentation and construct-irrelevant variance. Thus, the watchword for educational and psychological measurement is to maximize the empirically grounded interpretability of the scores and minimize construct irrelevancy." (p. 89.)

In summary, the assessments that are to developed to measure Digital Communications proficiencies should include alternative media representations and alternative delivery formats as well as attend to the value implications, relevance and utility, and social consequences of the assessment models.

SECTION 6: CONCLUSIONS AND RECOMMENDATIONS

International Digital Communications Standards must be addressed in the context of the skills needed for the 21st century. These emerging standards must pierce the digital literacy boundaries to address communication skills with the new digital interactive communications tools and technologies. The purpose of the assessments must remain focused on the capability of the students to select and create appropriate communication messages needed to meet specific audience purposes and needs including any additional capabilities offered by new generation tools and technologies that further the communication process. The digital communications assessments must use a blended approach to measurement of knowledge, where skills and processes can be addressed with simplified assessment procedures and item types. However there may be a need for simulations, emulations and performance oriented case studies and scenarios that require integrated search, selection, application, and appropriate use of the available digital information resources. The focus of the Digital Communications Standards is to ensure that students in classrooms around the world are capable of communicating well, seek information from appropriate sources, solve real world problems, and make correct decisions in an international context.

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APPENDIX A: SAMPLE TEST ITEMS AND PERFORMANCE TASKS FOR THE DIGITAL COMMUNICATIONS DOMAIN.

Digital Communications Outcome-based Item Sample

Examinees will be made aware that this item type does not provide specific task instructions, but that sufficient information is provided to enable them to understand the outcome they are expected to achieve. Examinees will be informed that they may choose from the available elements and tools they believe are best suited to achieve the specified outcome. Examinee will be informed that partial scoring is possible for each of the completed steps that contribute to the outcome.

This item type will be preceded by a set of selected response items designed to assess examinees' knowledge, cognitive skills and understanding of fundamental concepts necessary to perform the tasks for the item. (For example, what is a Web page, how is a Web search conducted, what is the utility of the applications, what affects file sizes, what is the meaning of multi media, etc.).

The sample item incorporates the examinee's demonstration of the proficiencies indicated as the objectives listed below are met:

Proficiencies

- Communicate--Communicate in a persuasive and engaging manner, applying information technologies for content, audience and purpose
- Create--Support communication with appropriate images, sounds and music
- Manage--Use a range of ICT efficiently to combine, refine and present information by extracting, combining and modifying relevant information for specific purposes
- Access--Search a variety of sources for information relevant to a task
- Define--Demonstrate an understanding that digital technology follows a logical order of operations

Objectives

- Select appropriate Rich Media to communicate a specific message
- Use appropriate applications to modify Rich Media file properties
- Add content to a Web page
- Use appropriate search methods to search the Web for information
- Demonstrate understanding of elementary (Web) page layout principles
- Performance Scenario

Available Resources

The information provided to the examinee includes a list of resources available to complete the tasks. In this sample, the resource files include a folder containing an .htm Web page and several associated images. A media folder is also available on the desktop which contains the following digital media resources:

Images	• Dolphin Map.jpg • Spinner Dolphin2.jpg • Dolphin Lagoon.jpg
Video Clips	• Aquatic Life.avi • va-dolphin-swim.wmv

The Scenario and Examinee Instructions

The examinee is given the following scenario and explanation of the required outcome:

You are completing a Web page to announce a new dolphin exhibit at the Great Blue Ocean aquarium.

As the aquarium marketing manager you have been tasked with effectively communicating and persuading Web site visitors of all ages to visit the newly opened exhibit by:

- *reviewing existing project information;*
- *locating, selecting and using appropriate information elements;*
- *and using appropriate software tools.*

The Media folder, which is located on the desktop in the folder named Great Blue Ocean, provides project resources for the exhibit.

- *You must select the most appropriate combination of information elements to inform and invite attendance for the new exhibit.*
- *You must use only those application tools that are located in the Software List to complete the tasks.*

The outcome you must achieve is as follows:

- *The Web page must include a media file from the resource list to support the existing message in the Web page.*
- *The size of the media file must not exceed 150 KB and it must fit within the current dimensions of the Web page. (You may modify media files to meet the design requirements.)*

The Web page must also include the aquarium's address. (You may search the Web to locate relevant information.)

Scoring

The tasks are dichotomously scored. As detailed in Table 11, points are scored progressively for each task; based on the scoring criteria and rationale.

Table 11: Task Scoring Criteria, Rationale and Points

Task	Scoring criteria & rationale	Points (9 possible points)
Inserting media element into the Web page.	Any one of the media files from the resource list page has been inserted into the Web page.	Inserting a media file = 1 point
	A media file with any relevance to the purpose has been inserted into the Web page. (The photographs depict dolphins but do not contain any elements to support the dolphin swim program referenced in the Web page.)	Selecting media with some topic relevance = 1 point
	The va-dolphin-swim.wmv has been inserted into the Web page. (The file depicts dolphin interaction and tricks which support the dolphin swim program referenced in the Web page.)	Selecting media with the most topic relevance = 1 point
Positioning of the media element within the Web page.	The media file has been inserted into the specified position on the Web page. (The media file has been placed below the last paragraph, as indicated by the text in the Web page.)	Placing media appropriately = 1 point
Modifying the media element to fit within sizing constraints	The media file has been modified so that the file size does not exceed 150 KB. (The file size must be modified to meet sizing constraints. Depending on the media selected by the examinee, several methods of reducing the file size may be used.)	Modifying file to meet sizing specifications = 1 point
Modifying the media element to fit within the existing dimensions of the Web page	The media file dimensions have been modified such that it does not change the Web page dimensions. (File dimensions may be modified before adding the file to the Web page, using an appropriate editing tool, or may be resized from Dreamweaver. The candidate must understand what the dimensions of the Web page and how inserting a media file that is larger than the given area will affect them.)	Modifying dimensions of the media = 1 point
Inserting the aquarium's address into the Web page	An address for the aquarium facility has been inserted into the Web page. (The address must be located through a Web search using relevant keywords and then placed in the Web page through typing or copying and pasting.)	Inserting located information = 1 point
	The address has been inserted into the specified position on the Web page. (The address has replaced the text "location" in the Web page.)	Placing information appropriately = 1 point
Ordering of operations	The examinee must modify the media to meet the file size constraint before inserting it into the Web page. (The order by which the tasks are performed will indicate if the examinee understands of the purpose of each application and the relevance of accessing and assessing the content before implementing it.)	Performing tasks in a logical sequence = 1 point

Technical Specifications:

For the purpose of this item, the computer environment (OS and applications), real or simulated, will be configured with the following programs:

- *Windows Media Player (or another video player)*
- *Apple QuickTime*
- *Dreamweaver*
- *Photoshop Elements*
- *Premiere Elements*
- *An Internet browser (Mozilla or Internet Explorer)*

The Software List should contain an icon that is able to launch each of the software programs.

A folder named Great Blue Ocean exists on the desktop. The browser's home page must be set to http://www.google.com in preparation for the Web search they must perform.

APPENDIX B: The Digital Decade

In Bill Gates Keynote session for the 2006 Consumer Electronics Show he demonstrated elements of a scenario leading to the confluence and integration of digital and communications technology for the digital decade.

"Now, we talk about this as the decade of Digital Lifestyles, the decade of Digital Workstyles. That means that all these tools are becoming mainstream. And it's not just one application that makes it happen. It's not just banking or advertising, or filling out your tax return, or even instant messaging, it's the fact that as you adopt those things they really go together, and it becomes more and more familiar to work in that fashion."

"I thought I would start off and show a scenario that we think will be real by the end of the Digital Decade, so within the next four years or so, this will be something we think will actually be realistic. Let's start off, let's say we're at home in the morning. We've got a screen here that shows some of the information that we care about. It comes up and it's kept up to date. We just touch it. We've got some of the kids' drawings here. We can just grab those, move those around, pick different pictures that we want. We see the time of day here. All very simple to work with."

"Down here we've got a little bit of a map, and because everyone in the family has decided that they're willing to share their location with the rest of the family, we can see here on the map where mom left early and headed off to that soccer game. We see the family schedule there. So, we're able to track everybody and know what's going on. Here we've got a connection up to our video, and so the latest news information has been categorized. It picks the ones that would be of interest to us, and it actually lets us navigate. So, here I can pick a particular show, news item, that's relevant to the work that I do, and I can see there's been a storm here, it's interrupting the supply chain of a lot of different companies, probably including mine. That could be a real challenge. So, I'll click this button here and say, I would like to track that topic. I would like to continue to watch that video clip, and so as I head in to work that video has now been connected up to my cell phone, and I can watch that as I'm getting into the car and heading off to do my work."

"When I arrive there, I've got a nice desktop screen. You can see it's got a lot of area. We think this will be very important. You want to have more information that you can just glance at and work with in a very simple way. The idea of a big screen that uses your full field of vision makes sense to us. Now, of course, instead of using a password, I'll just use my fingerprint here, so I'm authenticated in a more reliable way. I see a lot of different information here, including that news story that I was tracking. I go ahead and set up a little conference call that's going to have a lot of people talking about this problem. And so we can see here our Chief Operating Officer is online, our VP of Operations is only connected up through voice. We're talking through the issue. There is the article there, people are annotating that, seeing how it affects us. I've actually got here on my Tablet PC, that's really logically just part of this screen one PC. I've got a little chart here, and so what I would like to do is go ahead and go in and select that, say, OK, this is a chart that I think is relevant, and I can drag it up here, I can either move it to my desktop, or I can move it into this video conference. So, I'll go ahead and drop it there, and we'll sit and talk about this thing. And say, OK, what's going on with it."

"It was actually created, I can see, by Thomas Anderson, and so I'm interested in bringing him into the conversation we have here. So I go off and select him, and say that I want to do instant messaging in a side conversation. We're talking to him, and I indicate, hey, you really ought to come in and give us some advice. I can simply drag him over into the conversation, and so he's there. He's now part of that, so not only do we have his document, but we have his advice, and we figure out pretty quickly what needs to be done."

"And actually as we get towards the end of the call, I notice that it's been looking at the traffic in my schedule, and it says there's a traffic jam, so I'm going to have to leave a little bit earlier to get to the airport. I've got a flight today, and actually it puts that right here on my telephone as well, along with the map, suggests an alternate route, so I can grab onto this, and take that with me as I leave work."

"Later that day, I find myself in the airport, and all I've got with me on this particular trip is my phone. And yet I'm very interested I figuring out what's the latest, what's going on. And so I can take my phone here, and I just put it down on a table that's here in the airport lounge, and it recognizes it. It's got a little camera here, and a little Bluetooth, nothing very complicated with the magic of software behind it. And it says it wants me to authenticate that this is really me, my phone. So, as soon as I put my fingerprint there, I'm connected up, and I actually get a full-sized desktop. And so now, if I want to read mail, or browse, that's all there. Actually, what I'm going to do is take a business card that somebody handed me while I was on this flight, and just put that down on the table there, and the camera scans that, detects it's there, recognizes it, I'll just flip that over, I've got a little note I made when I was talking with this person about some information they would like to see, and it sees that, gets that text, and then I can take that and say, OK, go ahead and put that into my contacts. So, as I drag it up there, I can see the information being connected up and put down into my phone. So, now I have a reminder of a task, send him that information, and see his picture, his name, his e-mail, it's all been added to my contacts list there."

"Well, that's pretty nice, I'll take that off and go ahead and look at whatever mail has come in. In fact, I see that Thomas when we were working there in the office has got a press release and here, because it's very critical they know I'm agreeing with what they've got here, again, I authenticate that this is me, and I make my digital signature available because of the fingerprint there."

"Now, that that's sent off, here I am, I'm able to do anything I want, I can see up in the right-hand corner through my calendar it knows the flight I'm taking, so it's showing me exactly how much time I have before I have to leave, so I can work here and get the benefit of the full screen, even though this phone normally just has that small screen. When I'm done, I just pick this up, and of course it's smart enough to recognize now that it's logged me off, and somebody else can come in here and use this and that's just simply available to them."

"So, it's a very simple thing to have all these devices working together, and I have that Digital Workstyle, my calendar, the traffic, my contacts, my rich communications done in a very different way."

"The phone is very different, the idea of meetings is very different, the way we collaborate, we're able to share across different companies, it's all very different, and that's because we've taken software and put it at the center, the digital approach applied to all of those activities."

“Well, we see that in so many areas. I think five or six years ago, if you'd said to people that software would be incredible in terms of making photos better, music better, TV better, phone calls very different, they would have been quite skeptical, they would have thought how can software do that.”

“Well, now particularly in music, to some degree in TV, they've seen that it makes a huge difference. It allows them to pick the things that they're interested in, it allows them to see it when they want to, to share with friends what they've seen and what they like.”

“And so this really is the symptom of the great progress we have here in the digital decade.”