SOAPBOX DIGEST

A Publication of the Institute for the Advancement of Emerging Technologies in Education at AEL

The Online Assessment of K-12 Technology Literacy

An e-mail-based Soapbox discussion hosted by IAETE

As our society grapples with rapid technological change, assessing technology literacy has emerged as a K-12 education issue. The No Child Left Behind Act specifies as a goal that every child will be technologically literate by the end of the eighth grade, business pleads for a workforce that can use information and communications technology (ICT), and the education community itself recognizes the importance of establishing a foundation for lifelong learning.

The Institute for the Advancement of Emerging Technologies in Education (IAETE), housed at Edvantia's Appalachia Educational Laboratory, addressed the need to assess technology literacy in an e-mail-based panel held during one week in September 2005. (Further exploration of this topic can be found in companion articles in IAETE's online publication, *InSight,* at www.edvantia.org/insight/).

The conversation began with the importance of defining technology literacy, identifying a range of definitions rather than precise limits. There was, however, consensus that ICT literacy—which can be viewed as one component of technological literacy—implies both basic computer skills and the cognitive abilities associated with using those tools for learning and communication. The panelists then turned to the emerging possibilities for assessing via simulation, the new design processes needed for any computer-based assessment, and the lack of research to assist assessment developers in this new territory. Mary Axelson moderated the discussion among the following panel members:

- **Martin Ripley** heads the eStrategy Unit of the United Kingdom's Quality and Curriculum Authority (QCA). In that capacity, he has led groundbreaking work on assessing technology skills and higher order thinking via simulations. His work differs from other such work because it looks at large patterns of activity rather than solely at a final answer. See www.qca.org.uk and www.ks3ictpilot.com.
- **Greg Pearson,** program officer with the National Academy of Engineering in Washington, DC, serves as the responsible staff officer for Assessing Technological Literacy in the United States, a study funded by the National Science Foundation (NSF), and the State Educators' Symposium on Technological Literacy project, which is funded by the U.S. Department of Education. He is the lead author of *Technically Speaking: Why All Americans Need to Know More About Technology* (National Academy Press, 2002) and a related report on assessment to be published in 2005. See www.nae.edu/techlit.
- **Margaret Honey** is vice president of the Education Development Center (EDC) and director of EDC's Center for Children and Technology (www.edc.org/CCT). In the latter capacity, she is also the coauthor of *Assessment of 21st Century Skills: The Current Land*scape, a report of assessments published by the Partnership for 21st Century Skills (www.21stcenturyskills.org).
- **Kate Kemker,** director of instructional technology for the Florida Department of Education, has worked with a state team that created a simulation-based assessment of technology skills for teachers, known as the Inventory of Teacher Technology Skills. She now works on a similar inventory for eighth-grade students to be used in the spring of 2006. See www.flstar.org.

Defining Technology

Technically Speaking, writes Pearson, "spends many pages defining and defending an expansive notion of technology and technological literacy." Elsewhere, he summarizes technology literacy "as a process of modifying the natural world to satisfy human needs and wants, and of course the products that result from that process." For the National Academies, technology can be a computer, or it can be a shovel, a pencil, paper, or the process of identifying chromosomes on a strand of DNA. Writes Pearson, “As this panel illustrates in microcosm, when the word *technology* is mentioned in the context of U.S. education, it is associated almost exclusively with computers and IT (information technology) or ICT literacy.This is not wrong . . . but it is a rather narrow view of things.” From his work on assessment, Pearson notes that an emerging priority is a familiarity with the “technological design process, which has many parallels with science inquiry.”

Pearson also points out that, beyond this panel, the National Academies’ perspective has supporters.

> In the interest of complete honesty, the Academies are far from the firstto describe and promote this larger view of technology.Philosophers of technology such as Langdon Winner, historians of technology like Thomas Hughes, and technology critics like Neil Postman have all taken this larger view.So has the STS (science, technology, and society) movement in U.S. postsecondary education, and the International Technology Education Association, which represents technology education teachers in this country.

No matter the definition, people working in a K-12 environment make ICT their priority. Writes Honey,

> In contrast to Greg, I’m choosing to highlight a set of fairly specific skills and competencies that students need. I don’t by any means disagree with Greg—I like the breadth of his argument and ideas. I’m motivated to write more specifically only because I see too much of what is NOT being taught in schools. In too many schools we are stuck with a very 1980s notion of technology competency—a kind of basic facts approach to technology—that’s not serving our kids well.

Kemker, too, sees a pressing need to establish a foundation of computer skills. In Florida, for example, the state hopes to put its high-stakes test online, and an inventory of student computer skills could help ensure that the computer-based format does not hinder student performance. However, she’s also wary of the momentum stopping there:

> The discussion from my perspective is, do you measure all of these skills at once with a performance-based solution within scenario-based settings? Or do you begin with basic computer skills, then communication, basically in a hierarchal method? The situation that we face in K-12 education is that if we begin with one area then precedence has been established in which those skills tend to have greater value than the other skills.

Technology Literacy or Technological Literacy?

Panelists were happy with either term. This document, however, will use *technological literacy* to reference the National Academies’ inclusive view of technology and *technology literacy* for the subset related to information and communications technologies. Kemker lobbied for “digital literacy” for the latter.

Defining Literacy as Higher Order Thinking

Though there was not wide agreement on the scope of the word *technology,* all panelists did share an understanding of *literacy* as something significantly beyond basic skills. Ripley has a particular interest in the higher order thinking that high-tech tools make possible. Observing that schools now focus more on developing student computer skills to support learning across curricula rather than studying about computers, Ripley asks,

> So, can we usefully ponder what subject will replace IT, and why?My view is that the subject must change its outlook from training students predominantly in the skills and capabilities that arise from the existence of personal computers. Instead we should look for the subject IT to concern itself increasingly with the growing range of technologies (mobile devices, blogs, video). It should concern itself with the uses to which technology is put (work, leisure, recreation, purchase). And it should concern itself with the facilities (or capabilities) that those technologies provide to students and adults (voice, visual communication, decision making, choice, responsibility).

After quoting a job description for an engineer at Boeing (and safely assuming education prepares people for jobs), Ripley summarizes, “In other words, we must expect technology to help our students to be ‘flexible’ and to be ‘curious.’”

Pearson’s reports identify “three interdependent *dimensions*” of technological literacy: knowledge, capability, and ways of thinking and acting. Pearson notes that the capability dimension relates to abilities that may be easier to assess. According to Pearson, the committee noted that a “technologically literate person would

- have hands-on skills, such as using a computer for word processing and surfing the Internet and be able to operate a variety of home and office appliances,

- be able to identify and fix simple mechanical or technological problems at home or work, and
- be able to apply basic mathematical concepts related to probability, scale, and estimation to make informed judgments about technological risks and benefits."

Honey observes that students today have almost universal access to unfiltered and unsubstantiated information. No longer do they receive their information solely from teachers or librarians, or through textbooks or print-based reference materials. She continues,

> To navigate through this wealth (or glut) of data, draw conclusions, and communicate with others proficiently, teachers and students require whole new sets of skills surrounding accessing, interpreting, analyzing and evaluating complex sets of images, words, numbers and sounds in meaningful ways.

She identified some of these skills as communicating effectively, analyzing and interpreting data, understanding models and simulations (computational literacy), managing and prioritizing tasks, engaging in problem solving, and ensuring security and safety. Her work with the Partnership for 21st Century Skills identifies ICT learning skills as related to thinking and problem-solving skills, information and communication skills, and interpersonal and self-direction skills. Honey and the Partnership emphasize that these skills are a priority and can be addressed through core subjects as well as in areas they refer to as 21st Century Content: global awareness; financial, economic, and business literacy; and civic literacy. ICT learning skills are interwoven with technology because their pursuit is so often assisted by high-tech tools.

The Promise of Simulation-Based Assessment

An assessment environment that simulates common software applications is an ideal and obvious way to investigate a student's abilities with computer applications. Assessments that utilize only one brand or model of software would be severely limited, as there is no standard for any common software applications, such as word processors, spreadsheets, or databases. A simulation also allows greater leverage for the capturing and reporting of multiple points of data, functions that would be complex or expensive to retrofit to existing software. After developing such projects, Kemker and Ripley are eager to apply the environment to other school subjects. Kemker sees a fit with music. Ripley wants students to explore performances of Shakespeare. Both also see potential for science. More broadly speaking, however, simulations may hold promise for assessing complex cognition.

Ripley's assessments take place in the virtual world of Pepford, where work assignments arrive via e-mail and a "walled garden" provides a virtual world of Web sites and applications. Writes Ripley,

> The use of simulations is a key development. A simulator provides the context within which authentic assessment tasks can be designed and delivered to students. It alsofacilitates the development of assessment tasks that invite students to combine a range of capabilities and skills. The combination of these two aspects enables us to assess higher order IT capabilities, such as choice or communication.
>
> The test records and scores the actions that the student takes while completing the test. For example, a higher order capability for a 14-year-old student in England includes designing a system for someone else to use. That capability in turn includes an assessment of the end-user's requirements. This we assess dynamically in the virtual world of Pepford by collecting evidence of the student researching into those requirements, by sending and receiving emails to ask about requirements, by the student refining the system to meet requirements and so on. To achieve this we have worked with an extensive range of teachers to document the processes that students go through when producing eloquent or satisfactory responses to the task set. We use this [data from teachers] to create a matrix of plausible routes that a student will take when en route to complete a satisfactory (or better) response.

Simulation, of course, is not the only possible method to assess technology literacy. As Pearson points out, "I first will disagree slightly with Mary's contention that assessment of higher-order thinking requires 'new' assessments. Assessments that get at the more complex aspects of student thinking already exist—in instruments that creatively use extended and open-ended response items, and in some portfolio techniques." He points to an assessment of design capability by the International Baccalaureate as an example.And Pearson observes that while portfolio assessments are often viewed as limited in terms of providing valid and reliable data in a high-stakes arena, they could face fewer problems "if the rubrics for evaluating them are carefully thought through and teachers/evaluators are trained on the rubrics' use." Honey's report, *The Assessment of 21*st *Century Skills: The Current Landscape* (www.21stcenturyskills.org/assess21), also identifies an array of assessments for the 21st Century Skills other than ICT literacy.

Working with a New Design Process

Should one wish to pursue simulation or other computer-based applications, such as virtual environments or multiplayer, role-playing applications, both Ripley and Kemker forewarn that the entire design process changes. Writes Ripley,

> In every e-test development project I have worked on it is possible to get all of the senior staff (designers, technologists, psychometricians, trainers, teachers) together regularly. These core teams number around 15-20 individuals and can be ledeffectively as a single team.There is no parallel in my experience with paper-based tests, which are often developed in a linear process, with different teams (involving large numbers of people) responsible for the various stages of development, administration and marking.

Kemker, too, describes such teams. Echoing advice given at an IAETE symposium[1] on formative, online assessment, she focuses on the importance of the project manager.

> The development of online assessments requires a very diverse team of individuals. It is imperative that each member of the team be an expert in specific fields, such as measurement, technology, and curriculum. Last year, as we developed the online assessment tool for teacher technology skills, the team consisted of these individuals in addition to teachers.
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> However, the key ingredient was to have a leader that focused on the scope of the project, or basically the project manager. This individual understood every aspect of the process, so that the focus remained the development of a performance based tool . . .
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> It is critical to have the team leader be a measurement expert so that the team does not stray from the original scope of the project. In addition the team needs to be forward thinking so that the tool developed will have longevity.

In Kemker's experience, bringing technologists and assessment experts together sparked a great deal of creativity and discussions of new possibilities for assessment. Ripley, however, lamented the lack of creativity from technologists in his experience. "The concepts, the ideas, the vision have come predominantlyfrom the assessment experts and teachers.The quest for technology solutions to the many complex measurement problems and barriers has come from the assessment experts."

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[1]Axelson, M. (2005). Online standards-based formative assessment conference proceedings. Charleston, WV: Edvantia.

Ripley also cautions that change must go beyond the design group. The types of tests his work group designs pose problems beyond the "one correct answer" paradigm that dominates assessments for accountability purposes. He writes,

> Assessments which use simulations are a radical development. Delivering high-stakes assessments to all schools onscreen is a departure from current practice. This type of test development project involves systemic, nationwideinnovation and change. The nature and extent of innovation inthis type of redesignchallengespsychometric expertise and wisdom; it requires teachers to adapt their teaching, andit requirespupils to reconsiderideas of whattests involve; it requires a national school hardware infrastructure that is as robust as someinternational banking systems; it requiresnetwork managers and technical staff in schools who can support the system. So, this is what I mean by'systemic innovation.'
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> Another way of describing such systemic innovation is to say that it requires a clear acknowledgement, including from national political and educational sponsors, that in the beginning there are no guarantees of success and there is absolutely no track record of successful delivery. From the beginning, there needs to be flexibility within the proposed approach toreconsider, review and learn lessons. A willingness to admit mistakes and start afresh when needed. And there needs to be enough time in theearly development phases and initial roll-out, to prove the conceptual approach and to build the track record.
>
> We started our project to develop an ICT test for 13-year-olds in 2001. We aim to have it rolled-out toall of our secondary schools (high schools) by 2008. I do not believe that we could achieve our aims in less than seven years!

Establishing a Research Base

Ripley's comment above, "The nature and extent of innovation in this type of redesign challenges psychometric expertise and wisdom," is a reference to the lack of research on the validity or reliability of assessment via simulation. Pointing out the increasing presence of simulation for instruction, Pearson observes that "the use of simulation in educational assessment probably requires quite a bit more study before it can be used with confidence. The assessment literature is mostly silent on simulation and essential psychometric issues such as reliability, validity, and precision." Ripley suggests the need for research on all computer-based testing:

> Greg has elsewhere madea good point about the general lack of psychometric research and empirically based evidence to support the most adventurous forms of e-test development. I see that defi-

ciency in almost all aspects of e-test development. .. . In England I like to remind colleagues that paper-based testing has been in use for 140 years. The science and business of paper-based testing is well refined andwell evidenced. A person experienced in managing, researching or administering one set of paper-based tests is likely to be able to move in a straightforward way to a similar role in relation to other paper-based tests. In contrast, there is littlestability yet in e-testing. The business processes are immature. Even when the e-test consists of closed-response or multi-choiceitems, the on-screen delivery involves making design decisions on the basis of emergent thinking, not on industry best practice standards (which do not yet exist).

Ripley advises that research focus on "sources of difficulty" (the full range of demands carried by a test, but not part of the targeted assessment domain), the validity and reliability of measurement methods used in simulation-based assessments, and the possibilities of expanding it to domains beyond ICT.

Pearson offered one illustration of the numerous research questions that need to be considered for simulation-based assessment: "Can each action taken by an individual in a simulation or game be treated as a test item and its correctness be judged by an on-demand, real-time assessment of the circumstances in which that action is taken, or do prior actions that led to the context in which the action is taken need to be considered?" In other words, how much of a student's activities do we analyze?

Additionally, the domain needs to be understood. Beyond a definition of technology, Pearson points out, we need to know more about "how people actually learn technological concepts." He explains,

Assessment designers would benefit from having more information about such issues as expert/novice differences in knowledge acquisition, concept formation, misconceptions, and knowledge transfer, just to name some of the most obvious areas. A better understanding of these very fundamentalaspects of learning will greatly improve the quality of assessment for technological literacy, as well as the potential to harness simulation effectively.

Panelists also identified issues beyond the functionality of the test format. For Pearson, technological literacy includes the ability to weigh the risks and benefits of new technologies, and he applies that to simulation-based assessment:

I would like to ask my colleagues whether they feel students and teachers should, in addition to simply using ICT as a learning tool, also be challenged to think about and discuss ICT in a somewhat more critical way. For example, what are some of the unintended consequences of our use of computers in education?What trade-offs are we making, intentionally or not, by placing ICT in such a prominent position in U.S. education?

In response, Ripley shifts the critical eye from technological priorities to assessments. He writes,

The difficulty and challenge in focusing our technology ambitions on assessment is that assessment is such a blunt instrument. National assessments are filled with unintended consequences. They atrophy and become predictable within a matter of a couple of years, with the result that creativity and innovation are lost. And the processes of preparing students for high stakes national assessments are rarely witnesses of exemplary pedagogy.

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