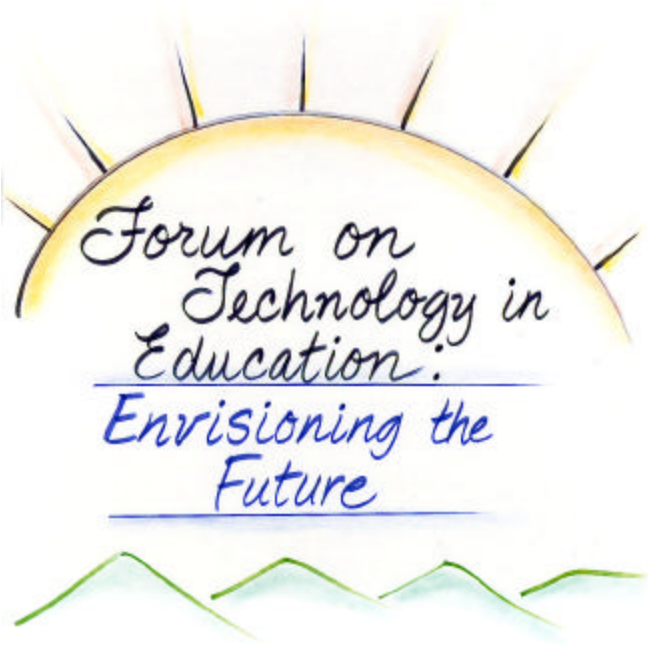
FORUM ON TECHNOLOGY IN EDUCATION: ENVISIONING THE FUTURE

PROCEEDINGS

DECEMBER 1-2, 1999
GEORGETOWN UNIVERSITY CONFERENCE CENTER
WASHINGTON, DC



A WORKING MEETING SPONSORED BY THE OFFICE OF EDUCATIONAL TECHNOLOGY
U.S. DEPARTMENT OF EDUCATION

FORUM ON TECHNOLOGY IN EDUCATION: ENVISIONING THE FUTURE

PROCEEDINGS

PREPARED FOR:
OFFICE OF EDUCATIONAL TECHNOLOGY
U.S. DEPARTMENT OF EDUCATION

PREPARED BY:
DOUGLAS LEVIN & CECILY DARDEN
AMERICAN INSTITUTES FOR RESEARCH
1000 THOMAS JEFFERSON STREET, N.W., SUITE 400
WASHINGTON, D.C. 20007

THIS REPORT IS A SUMMARY OF THE *FORUM ON TECHNOLOGY IN EDUCATION: ENVISIONING THE FUTURE*. IT DESCRIBES POINTS RAISED BY FORUM PRESENTERS AND PARTICIPANTS, AND SHOULD NOT BE CONSTRUED TO REPRESENT THE VIEWS OF THE U.S. DEPARTMENT OF EDUCATION. THE OPINIONS PRESENTED ARE INTENDED TO STIMULATE FURTHER THINKING AND CONTINUED DISCUSSION ABOUT THE FUTURE OF TECHNOLOGY IN EDUCATION.

TABLE OF CONTENTS

FORUM ON TECHNOLOGY IN EDUCATION: ENVISIONING THE FUTURE

INTRODUCTION

In recent years, interest in increasing the use of technology in education has catapulted to national prominence. This interest has been spurred by the widespread recognition of the transformations technology is having on the American economy, as well as by the potential for technology to transform the teaching and learning experience. Coupled with dramatic increases in the availability and use of technology in elementary and secondary schools, there is a growing sense that there now exists a critical mass of opportunities to make tremendous strides in improving the nation's schools.

In recognition of these opportunities, the U.S. Department of Education's Office of Educational Technology (OET)—charged with providing leadership and direction to the U.S. Department of Education's educational technology initiatives and with developing policy—has undertaken a strategic year-long review and revision of the national educational technology plan, *Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge*. The first steps in this strategic process included the commissioning of several white papers in the fall of 1999 on the future of technology in education, including:

- *Technology in K-12 Education: Envisioning a New Future* by David Thornburg, which calls for deep systemic changes in elementary and secondary education as a consequence of two central ideas: (1) that how we use technology in education is more important than if we use it at all, and (2) that unless our thinking about education is transformed along with increases in the use of technology in our classrooms, our technology investments will fail to live up to their potential;

- *Extracurriculars as the Curriculum: A Vision of Education for the 21st Century* by Roger Schank and Kemi Jona, which calls for the fundamental reshaping of the American educational system including establishing new roles for teachers, new roles for schools, and the centralization of curriculum and instructional development;

- *Rewiring the History and Social Studies Classroom: Needs, Frameworks, Dangers, and Proposals* by Randy Bass and Roy Rosenzweig, which helps identify the opportunities to use technology to make the social studies classroom a site of active learning and critical thinking through inquiry-based learning, bridging reading and writing through on-line interaction, and making student work public in new media formats;

- *Forum on Technology in K-12 Education: Envisioning a New Future—Science* by Steven Rakow, which explores the realities and possibilities of instructional technology applications in science education—from the "Global Classroom" to the "Technologically Enhanced Classroom";

- *Technology Meets Math Education: Envisioning a Practical Future* by Andee Rubin, which describes many of the ways that technology can help create communities of learners in which students actively engage in the process of mathematical sense-making;

- *The Future of Technology in K-12 Arts Education* by Joan Assey, which speaks to the essential nature of using technology in arts education and the linkage between learning and technology; and,

- *Toward a Vision of the Future Role of Technology in Literacy Education* by Linda Labbo, which suggests how technological innovations are likely to play a role in literacy education, explores the concept of digital literacy, and describes likely new tools for teachers.

In December 1999, a two day meeting—*The Forum on Technology in Education: Envisioning the Future*—was convened to provide an opportunity to explore the implications of these white papers and to engage in interactive exercises designed to explore the most promising future roles of technology in education. Participants included a dynamic group of educators and students, technology futurists, content area experts, business and government representatives, and others (including the white paper authors). Aided by a carefully constructed agenda and a GroupWare application running on laptop computers[1], an experienced graphics facilitator supported the interactions of participants and pushed them to make new connections—all to the end of identifying emerging priorities that could lead to new national goals for the use of technology in education.

This paper serves as a synthesis of the main ideas arising from the Forum. It incorporates reproductions of notes taken during the meeting, as well as summaries of participant comments submitted via GroupWare. Appended to the summary are the Forum agenda and the list of participants. The white papers commissioned for the initiative are available at OET's website: http://www.ed.gov/Technology. The paper concludes with a brief description of the next steps to be undertaken by OET in their process of reviewing and revising the national educational technology plan.

[1]The GoupWare application allowed participants to quickly and anonymously contribute their thoughts, feelings, and opinions at specific times during the meeting, as well as to read the comments of other participants.

A FUTURE DIFFERENT FROM OUR PAST: IMPLICATIONS FOR EDUCATION OF EMERGING TECHNOLOGIES AND TRENDS

The Forum opened with a consideration of the pace and breadth of technological change in recent years, emerging technological trends over the next ten years, the intersection of those trends, and potential implications for education. Indeed, what was most striking to participants was the increasing pressure on schools to adapt to a society in the midst of dramatic change. As one participant noted:

> *"The pace and breadth of technological change is hard to reconcile with the very traditional organizational structure of schools. Combined with the increasing infrastructure to support the involvement of folks outside the school staff in education, this suggests increasing pressure to involve multiple sources of information, coaching, and expertise in K-12 education. Not to do so would risk making education increasingly irrelevant in the lives of students, particularly at the middle and secondary school levels."*

Opening remarks by Marshall "Mike" Smith, Acting Deputy Secretary of Education, all but challenged education policymakers and practitioners to join the technological revolution: "As a mentality, as an orientation, as a big idea, technology has swept the nation in almost every sector, and I say that with the exception of education." Among the many technological trends with the potential to affect education in the coming years, he emphasized three:

> "The fundamental issue is whether to push for the existing educational system to assimilate technology or whether to pose the problem as needing to accommodate to the demand for inquiry, collaboration and public accountability and offer technology as a possible means to do this."
> – Forum Participant

(1) universal accessibility to computing devices and the Internet, which will be made possible through small, portable, and inexpensive devices currently under development;

(2) dramatically faster access to information, through increases in bandwidth and computing power; and,

(3) increased private sector involvement in delivering technology, information, and applications to education.

The implications of these three trends, he asserted, are enormous and will result in nothing less than the unleashing of space, time, and competition in education.

Through visual maps of predicted technology trends and their intersections over the next ten years, Mary O'Hara Devereaux of the Institute for the Future asked participants to consider the likelihood of changes to society that some would consider being straight out of science fiction novels. While she would be the first to admit that the future of technology could take many paths, she and her colleagues at the Institute for the Future have defined four primary pathways of technological advances: information and communication technologies, biotechnology, material sciences, and energy science. Some of her examples included: dramatically increased life spans and quality of life through biotechnology advances, ubiquitous sensors linked to networks that would allow technology to adapt to the needs of its users—even before those needs were made known, and the ability to move "off the grid," allowing us to access information and services from anywhere at anytime. While her presentation spurred participants to consider future scenarios of which they had never even conceived and their implications for education, she also cautioned participants that social, economic, political, and demographic trends will influence technological trends in unpredictable ways: "Never mistake a clear view for a short distance—you can see a path, but the path is fraught with difficulties and not as fast as people may think."

> "As we move from an age of information to an age of creativity, are our schools prepared to meet this challenge? Education, as a system, has been resistant to change and, often, limited in its creative vision. We barely understand information—how well do we understand creativity?"
> – Forum Participant

In the context of thinking about broad technological changes in society and their implications for education, David Thornburg challenged participants to examine many of the assumptions about the current organization and structure of education that, in his view, simply no longer serve a useful function:

"As we complete the twentieth century and prepare for the twenty-first, it is important to realize that our world is far different from the one which existed a hundred years ago. In the 19th century, a largely agrarian workforce existed alongside an emergent industrial economy powered by muscle, water, and steam. Since the turn of this century, we have had the flight of airplanes, commercial radio broadcasts, television, the invention of modern computer technologies, the emergence of new sciences (e.g., bioinformatics, chaos, and complexity) and a continued rapid increase in the development of new information in a myriad of fields and endeavors."

For instance, he takes to task the fact that education is currently a system based on a fixed number of class periods and school days during which students are expected to master a predetermined body of knowledge and acquire certain skills. This time dependent system, he asserts, is in essence a filtering system—one that separates those who learn quickly from those who do not. Rather than address the needs of each learner, we label some children as "slow learners," and relegate them to the "scrap heap of society." The folly of this approach, he points out, is that at the same time as we allow schools to act as filtering systems for our children, we are moving to recognize the vital importance of adults to engage in lifelong learning—a flexible approach to acquiring skills and knowledge on demand, at the time and place of one's choosing. In essence, he argued that no matter what role technology would play in the school of the future that "we must prepare learners for their future, not for our past."

> "The rethinking of the curriculum—what is worth learning and better ways to learn it and measure its learning—is central. Better learning goals, methods, and measures are central and the delivery medium (real or virtual) is secondary."
> – Forum Participant

Roger Schank, reinforcing and extrapolating the comments of David Thornburg, called for the controversial and wholesale abandonment of what, in his view, is an antiquated educational system. The new system he envisions will be enabled by the universal availability of on-line courses that will remove from teachers and schools the responsibilities for teaching academic subjects and allow students to determine their own success by completing tasks individually at their own pace:

"Instead of teaching academic subjects, teachers and schools will focus on combating the increasing social isolation that our society will face. Schools will become activity centers where students work in groups on real-world projects, go on trips, and participate in the community. While students may also use schools as locations to engage in on-line course work, this course work will be just as available at home."

He asserts that one key implication of his view is that curriculum and instructional development must be centralized. Only through centralization will we be able to realize the tremendous efficiencies of developing top-quality courses once, rather than having every teacher in the country repeatedly doing lesson plans for the same courses: "The fiction of local control of education will become evident and a panel of experts instead of local groups of well-meaning, but uninformed, parents will develop the curriculum."

"What does local choice mean in a ubiquitous pool of alternative learning opportunities when each parent and each teacher can 'kick the tires' of each potential learning resource at a micro-level (day by day; hour by hour)? What is the national role? Perhaps to assure high quality options, to assure options for 'special students,' to assure options aimed toward major national needs?"
– Forum Participant

ADVANCING MASTERY OF CONTENT THROUGH TECHNOLOGY

A major focus of the *Forum on Technology in Education: Envisioning the Future* was to explore the intersection of technology and content. Indeed, at the same time that technology is creating pressures on the organization and structure of schooling to change, it also is enabling the acquisition of student knowledge and skills in new and more powerful ways. In addition, participants recognized that technology is re-defining the content areas. Consequently, considerations of white papers commissioned about the future of technology in each of the major content areas (social studies, science, mathematics, arts, and reading/language arts) occupied a great deal of participant attention.

> "There is an under-emphasis in our discussions of the need for 'integrative knowledge' to be one of the key forces driving an educational reform process. The integration of content, pedagogy, and technology (in the broadest sense of new learning environments)…both within traditional and in new fields, and across subjects and fields, is a critical place for reform or revolution."
> – Forum Participant

In their own ways, each of the content experts who authored a white paper offered their own reasons for believing that the use of technology is beneficial in advancing teaching and learning in their discipline. Importantly, though, there was a striking convergence of ideas about what all teachers desire in their classrooms regardless of content area or level:

- Teachers want their students more engaged in learning;
- They want their students to construct new and better relationships to knowledge, not just represent it on tests; and,
- They want their students to acquire deeper and more lasting understanding of essential concepts.

Below, examples of some of the powerful opportunities afforded by technology are summarized for each of the major content areas explored during the Forum.

SOCIAL STUDIES

Randy Bass and Roy Rosenzweig highlighted in three broad categories some of the most successful educational uses of technology in social studies:

- **Inquiry-based learning** utilizing digitized and multimedia primary sources available on CD-ROMs and the World Wide Web, involving different senses and forms of expression and addressing different learning styles. Probably the most important influence of the availability of digital materials and computer networks has been on the development of inquiry-based exercises rooted in the retrieval and analysis of primary and cultural documents. These range from simple Web exercises in which students must find a photo that tells something about "work" in the late nineteenth century to elaborate assignments

in which students carefully consider how different photographers, artists, and writers historically have treated the subject of poverty.

- **Bridging reading and writing through on-line interaction**, extending the time and space for dialogue and learning, and joining literacy with disciplinary and interdisciplinary inquiry. One very significant dimension of "making thinking visible," is the bridging of reading and writing through on-line writing and electronic dialogue. The emergence of electronic mail, electronic discussion lists, and Web bulletin boards can support and enhance such pedagogies by creating new spaces for group conversations. To take one simple example, *Postcard Geography* is a project, organized through the Internet, in which hundreds of classes (particularly elementary school classes) learn geography by exchanging postcards (real and virtual, purchased and computer generated) with each other.

> "The best courses will be developed with "experts" on content and teaching...AND with students...take a look at the latest round of THINKQUEST modules that were developed by TEAMS of students who found each other on-line and come from more than one country."
> – Forum Participant

- **Making student work public in new media formats**, which encourages the exchange of knowledge-representations and creates opportunities for review by broader professional and public audiences. New technology—particularly the emergence of the Web as a "public" space that is accessible to all—has greatly leveraged the advantages of public presentations of student work. For example, at an elementary school in Virginia, fifth graders studying world cultures build a different "wing" of a virtual museum each year, researching and annotating cultural artifacts, and then mounting them on-line.

SCIENCE

Steven Rakow asserted that the true potential impact of instructional technologies on K-12 education would be to enhance the classroom of today by applying technology to create what he termed "The Global Classroom" and "The Technologically Enhanced Classroom."

- **The Global Classroom** opens the walls of the classroom to provide students access to a plethora of information and opportunities. For instance, to address the fact that with the rapid advances in science, textbooks were out of date as soon as they left the presses, the *sci*LINKS project was started. S*ci*LINKs symbols are now found in science textbooks in certain topic areas. By keying in a code number, students, teachers, or parents can access

a relevant, up-to-date, age appropriate website that has been reviewed by a panel of science educators. Another web site, The Virtual Field Trip Site, is dedicated to providing teachers with access to information and pictures from areas and events that they might not be able to physically visit or see, such as deserts, hurricanes, oceans, salt marshes, tornadoes, and volcanoes.

- **The Technologically Enhanced Classroom** extends human capabilities by providing teachers with the time and opportunity to enrich their instruction. New technologies, such as CD-ROMs and robotics, have provided incredible resources for teachers. Other technologies employed by science classes are microcomputer-based laboratories that provide a wide range of probes, including pressure, EKG, alpha waves, heart monitors, conductivity, sound, and motion detectors, to name just a few. These probes, along with the supporting software, allow students to collect, display, and analyze vast quantities of data over time periods ranging from seconds to days.

MATHEMATICS

In mathematics, Andee Rubin described five types of opportunities afforded by technology (including computers, calculators, the Internet, and associated input and output devices):

- **Dynamic connections**. For many students, the lack of visual representation in mathematics makes it difficult to make connections between a mathematical expression and the situation to which it refers. Computers—which can draw graphs and other mathematical objects and allow students to "play" with them—can help students relate mathematical expressions to images in the "real" world. One way these connections can be made is with digital cameras; no longer are the pictures we take static objects, but as digital objects they take on a new life that enables them to be closely linked with mathematical representations. For instance, CamMotion provides tools to analyze motion as it is captured on a video camera and to create the corresponding graphs of changes in position or speed over time. Since the video and the graphs are linked, when the student points with the mouse to a point on the graph, the corresponding frame of the video is displayed.

- **Sophisticated tools**. Exploratory data analysis software (and other visualization techniques) allow students to see patterns in data they would never glimpse if they had to do the calculations or even draw the graphs themselves—emphasizing the meaning of mathematical objects and the beauty of the patterns they exhibit. One such tool is Fathom, a sophisticated tool that provides students with many ways to look at—and therefore understand—complex databases.

- **Resource-rich mathematical communities**. Creative uses of the Internet allow for the creation of virtual communities in content areas. The best known of these is the Math Forum site, which includes a large list of (screened for quality) resources for K through college math teaching, including interactive activities; recommendations of software; examples of classroom activities and links to related discussion groups; a

"[These are the]…critical criteria teachers have for any classroom technology: Will it help kids learn? Is it reliable? Is it flexible? Do I have to fix it if it is broken? How much do I have to invest in learning it?"
– Forum Participant

conversation space for teachers; an extensive math library; an Ask Dr. Math feature, in which an expert answers students' questions; Problems of the Week at a variety of levels of difficulty; discussion groups on topics, such as discrete math and a multi-lingual discussion on the history of mathematics; and, a showcase that highlights recently added material. This site has served as an important portal for mathematics educators and as a kind of social center for the mathematics education community.

- **Construction and design tools**. The increasing power and versatility of computers makes possible uses that are dramatically different than previously available—uses rooted in "constructionism." Its roots are in the LOGO community; LOGO is a powerful yet accessible programming language in which it is particularly easy to create pictures, animations, and simple robot command sequences. Programming in LOGO incorporates math explicitly at times, but also introduces students to more general mathematical concepts such as iteration and recursion. For instance, in one recent project, students designed and programmed computer games that would teach other students about fractions.

- **Tools for exploring complexity**. For mathematicians, one of the most important developments in technology has been the increased number of tools for dealing with complexity. From Mathematica, a general algebraic tool, to specific modeling systems (e.g., Agent Sheets) to specifically designed languages for exploring large-scale parallel models (e.g., Star LOGO), areas of mathematics that had previously been off-limits for almost everyone are now accessible to students as well as mathematicians. One type of investigation made possible by such tools is simulation.

ARTS

Arts education means using the aesthetic symbols of music, theatre, visual arts, and dance to give our humanity form and meaning: music uses notes, theatre uses storytelling, the visual arts use images, and dance uses body movements. Students are thus able to create, perform, and respond to the arts. According to Joan Assey, technology as a tool in arts education can assist students and teachers as they incorporate overwhelming amounts of information related to these symbol systems. Each area of arts education can be augmented by technology:

> "I think the main beauty of technology in the arts is that it allows those who do not have virtuosity to actually compose music, choreograph dances, create a digital orchestra, design graphics/visual arts through the assistance of synthesized sound/images/ notation. It allows those who do not or cannot read music (like myself) to experiment and create musical scores, discover and share my own voice through digital storytelling. That's powerful."
> – Forum Participant

- **Music:** Electronic keyboards are being used as classroom instruments and computers are being used for creating and composing music in many classrooms today.

- **Theatre:** Video technology and various software applications are available to assist the theatre experience by offering both teachers and students choices to improve the delivery of the curriculum. Video technology can capture students' participation in theatre.

Software can help with set design, costuming, computerized lighting and sound control boards.

- **Visual Arts:** Digital technology has become a vehicle of creative expression as well as a source for arts. Electronic drawing, computer animation, video digitizing, and multimedia activities are parts of many art classes that have integrated technology.

- **Dance:** Technology can be used in dance to document and analyze the dynamics of movement. For example, computer-aided choreography gives dance educators the ability to work out ideas of space and movement on screen without bringing the dancers together. Computer software created as a movement notation system allows teachers and students to create and edit dance notation scores very quickly.

READING/LANGUAGE ARTS

In anticipation of changing social literacy expectations, Linda Labbo described, not so much the ways in which technology is enhancing, but changing, the teaching of reading and language arts. These expectations include:

- **Forthcoming Definition of Digital Literacy.** The penetration of digital reading and writing into all aspects of daily literacy activity has increased and will ultimately have a profound effect on what is considered mainstream reading and writing in the very near future. For example, when many Americans want to write a quick note to a colleague, they compose and immediately send it via e-mail on a computer screen. The note will be sent in the same amount of time to a computer in an office across the hallway as it will take to send it to a computer in an office across the ocean. When someone decides to find out the latest international news, he accesses an on-line news service and downloads video clips, audio commentary, or printed news columns on his computer screen. When someone decides to write a report, she is more likely to draft, revise, and edit it on a computer screen with a word processor than with a pen and paper. In these instances, the computer is more than a typewriter or publishing instrument, it is a tool for composing that allows the author to encounter and manipulate ideas on the computer screen.

- **Formulating Relevant Learning Theories.** It is possible that digital literacy is so complex that it will require multiple theoretical underpinnings. Imbedded in appropriate learning theories are social learning strategies that will be crucial to children's literacy development because social collaborations, such as group learning among Internet project participants, help prepare them for future workplace organizational/decision-making frameworks.

- **Supportive Digital Environments.** In recognition of this context, children in the near future who have difficulties comprehending text will have supportive digital environments on screen that allow them not only to read text, but have access to video clips of conceptual constructs (e.g., an orbiting planet), definitions of specialized vocabulary (trajectory), links to other textual references (an interactive encyclopedia of the solar system), additional background knowledge (a narration about why it is important to learn about planetary orbits), pronunciations of unknown words, or a mini-

lesson that may be tailored to help a child learn how to sound out an unknown word (a voice prompt “If you know that J-a-n-e-t is Janet, then pl-a-n-e-t would be … planet.”).

TOWARD ESTABLISHING A VISION FOR THE FUTURE OF EDUCATION AND TECHNOLOGY

In considering the information presented during the Forum, participants had an opportunity to identify trends and forces, assumptions, concerns, and opportunities pertinent to establishing a vision for the powerful use of technology in education. In so doing, many participants expressed that while we may have a good sense of what is possible at the classroom level in a vacuum, much work still remains in identifying strategies to encourage sustained institutional change at the national, state, and local levels.

A Need for Radical Reform or Incremental Change?

One of the notable conversations during the Forum directly addressed the apparent value conflicts over the purposes of technology in schools, its uses, and impacts—debating whether technology should assist with a radical re-organization of the structure of schooling or with more modest, incremental reforms. Participants thought it necessary to make explicit these value conflicts before a meaningful vision for the future of technology in education could be established.

> "I was relieved at the end of the session yesterday that some of us recognized explicitly that there were deep value conflicts over the purposes of technology in schools, their uses, and their impact. It is precisely these conflicts over values that have to be made explicit before we can come to any agreement over national goals for schools."
> – Forum Participant

On the one hand, some participants asserted that the organization and structure of schooling is fundamentally flawed, essentially agreeing with the propositions advanced by David Thornburg and Roger Schank. Arguing that the future of education should not simply be an extrapolation of the past, they pointed to examples of how poorly the educational system is aligned with the requirements of being a citizen and worker in today's technologically rich society. Not only are new generations growing up with fundamentally different

perceptions of what is normal, technology provides new opportunities for learning far beyond what was thought possible even a few short years ago.

Many of the opportunities these participants saw address current critiques of the education system. For instance:

- **Curriculum and course development**. A rethinking of the core curriculum is long overdue. This rethinking must address the underlying assumption that knowledge (as in educational content) remains static while everything else, including new discovery knowledge changes around it. In so doing, we should examine what is worth learning, what better ways exist to learn it, and how to measure progress in learning. In addition, the best courses should be developed with "experts" on content and teaching *and* with students.

> "The technology in our schools should be equal to the newest technologies in our markets. When we choose to develop new technologies, our students and teachers should have access so that we continue to go forward and improve. Our technology trends will come to a halt without the education of the next generation."
> – Forum Participant

- **Availability of learning tools**. We have been constrained by the power of our learning tools. New tools—enabled by innovations in software and learning environment design—give us a chance to create rich and diverse learning resources, such as graphic and simulation tools, that are fully accessible to all. These tools offer us the first real possibility of reaching students who heretofore have been failed by our schools.

- **Quality control**. Technology enables us to imagine ways of assessing the quality of an educational experience on a national, or even international, scale—allowing a parent to know how well their child's educational program compares to the best available.

> "The organization of school will be difficult to change. Ultimately, we need to think about new ways of assessing and documenting competence, much of which may be supported by technology in order to free up educational organizations and structures to try new methods to meet the goals of education. This will be a technology-based, more far ranging version of the current exchange of flexibility for accountability seen in charter schools."
> – Forum Participant

On the other hand, other participants saw much that works with the current education system, rejecting characterizations of an antiquated, irrelevant institution. These participants tended to be wary of the promises made about the ability of technology to solve social and political problems and were quick to assert that meaningful change could come only from within the system. While they certainly recognized many of the ways in which technology could enhance the ability of schools and teachers to serve students, they were decidedly pragmatic about the speed and scope of any dramatic changes. For instance, some asserted that there already exists some consensus regarding what the future of technology in education holds: preservice

education focused on content; professional development centered on teachers; development of tools and filtering mechanisms aimed at allowing teachers to make better use of the resources of the digital world; research and assessment that brings teachers into the process; and, a reconsideration of standards and assessment in ways that don't stifle innovation.

FOSTERING CHANGE

Importantly, some participants saw the choice of options for the future presented by the "radical reformers" and the "incrementalists" as a false dichotomy, emphasizing the danger in misleading stakeholders of all levels. Recognizing the importance of the social context of technology use, these participants advocated the establishment of a hybrid approach—one that encourages incremental improvements at the same time as it supports innovation—as the true opportunity.

> "I think there is something fundamental missing in what we've heard so far—and that is an acknowledgement that there are things that work well, there are students who learn a lot and teachers who teach well in analog environments. That is not a luddite comment. Just a notion that we're not starting from a pile of ashes."
> – Forum Participant

That being said, each of the participants also came away with a heightened awareness of some of the organizational and structural constraints facing those seeking to improve education. Interestingly, participants asserted that one of the most basic and conspicuous of these constraints is our own collective imagination about what the future of education could hold: the public images of education and the ways in which local school boards and policymakers envision the organizational structure of education of all levels are stifling innovation and creating barriers to change.

In this regard, participants provided some examples of current barriers to change in terms of how schools are currently organized and structured. For instance, one participant noted that we are constrained by the fact that we have to teach collectively and indoors. Another pointed to the obsession with the "course" as a semester or quarter entity, which has continuously shrunk from a "course of study" to a year long course to a 10-15 week marking period. Other barriers to change discussed by Forum participants included:

- A fear of change coupled with what some participants termed "techno-resistance" (i.e., an unwaranted fear of automation);

- A narrow definition of school and a lack of consideration of the purpose of education;

- Inequitable access to and use of technology along a variety of lines, including economic, racial/ethnic, and gender (i.e., the "digital divide");

- The need to demonstrate the "value-added" of technology use in schools, while that use is still in a formative stage;

> "As we move from an age of information to an age of creativity, are our schools prepared to meet this challenge? Education as a system must increase its creative vision and embrace change."
> – Forum Participant

- The imposition of accountability systems that stifle innovation, stress breadth of content coverage, and do not pick up the kinds of skills and habits of mind needed now and in the future;

- Teachers who feel ill-prepared to use technology in conjunction with systematic lack of support for teacher professionalism, including the lack of supported (paid for) time in the teacher's day for (teacher) learning, planning, and collaboration;

- The lack of a critical mass of technology in schools to really make a difference;

- The initial and ongoing expense of acquiring, maintaining, and upgrading technology; and,

- The lack of availability of high-quality software and other resources on the Internet connected to state and local content standards, coupled with a fragmented market that does not reward necessary research and development.

In the end, though, despite the barriers to change discussed by participants, there was broad agreement that technology should and must play a central role in the future of education. And, in this era of economic prosperity, participants agreed that now is the time to make a strong commitment to the future by challenging the nation to take bold action in hastening the coming of the future of education.

EMERGING PRIORITIES

"People tend to overestimate the impact of new technologies in the short run, and underestimate their long-term impacts."

– Mary O'Hara Deveraux

The Forum concluded with the identification of emerging priorities that the U.S. Department of Education—in collaboration with other Federal agencies, state and local governments, the private sector, and others—should address through goal setting or other national leadership activities. In so doing, participants emphasized the need to:

- Eliminate the digital divide by ensuring that all students and teachers have access to computers and the Internet, be technologically literate, and know how to effectively use the technology.

- Support traditional school improvements with technologies in mainstream public schools while also providing incentives for experimentation and radical systems change.

- Foster innovation at the national level to help set a context that supports breaking down old, irrelevant, and unproductive ways of managing and supporting education in the nation's school districts.

- Improve the linkage between local policies and practices and state and national policies and priorities—emphasizing dissemination of all aspects of local technology-based initiatives from adoption to implementation to outcome assessment.

"The fact that we still can identify a 19th classroom as a school may be a good example of form dictating function. Have we, as educators, been limited in our vision of the possibility by the form of the current reality?"
– Forum Participant

The specific priorities identified by participants included:

1. **All students and teachers will have ubiquitous access to state-of-the-art information technology in their schools, classrooms, communities, and homes.** Participants were unanimous in their agreement of the importance of providing universal access to technology for teaching and learning. Much of the promise of the use of technology in education, including the notion of fostering learning anytime anywhere, hinges on ubiquitous access to learning tools for students *and* teachers and on how they are used. In addressing this issue, participants stressed the importance of paying attention to individual learner characteristics and needs, as well as the social context of using technology.

2. **All teachers will effectively use technology.** Participants were universal in their support for devising ways to encourage teacher use of technology aligned with instructional

goals—whether delivered through preservice education or inservice professional development or both. Noting the continual changes and advances in technology, participants pointed out that the need for training is ongoing and must not only be about how to use technology, but also about how to support student learning.

3. **All students will be technologically literate and responsible cybercitizens.** Today's world is marked by increasingly rapid social, political, and technological change—

change that is becoming increasingly more difficult to predict. In this context, participants emphasized the need for educators to re-examine the skills and knowledge assumed to be important in preparing students to become good and productive citizens. In addition to being academically, socially, and emotionally prepared, students will need to be technologically savvy—understanding how to locate information, determine its relevance, determine its accuracy, and integrate it with other sources.

4. **Research, development and evaluation will shape the next generation of technology applications for teaching and learning.** As the use of technology in education becomes more commonplace, it becomes critical to understand what we are learning about what works and what does not. Too often individual schools and districts are left without good information that could guide them in making appropriate investments in technology—investments that could result in tremendous changes to the educational experience for both teachers and students. As one participant noted: "There are many examples of successful application of technology in schools. What are some of the major conditions that exemplify successful implementation?" Other research topics suggested by participants included: how technology can address learning problems, the use of technology to facilitate second language learning, the relationship between the features of technology and cognition, technology and performance assessment, equity of access to and use of technology, identification of successful pre-service teacher training models, identification of effective policymaking systems, and promising organizational change strategies.

5. **Education will drive the e-learning economy.** The Internet is fast becoming an engine of innovation in education. As it is revolutionizing business through e-commerce, the Internet is on a course to redefine education. E-learning, or the delivery of education and related services over the Internet, is being touted as the next most innovative application of the Internet, and private investment in education organizations is rapidly expanding.

Participants felt that fostering innovation in education—from the provision of digital learning, digital content, assessment services, tutoring, distance learning, data warehousing, and other forms of instructional technology—was important to encourage. Other areas ripe for innovation included ways of: establishing collaboration among schools, libraries, museums, higher education, and industry; evaluating the quality of educational materials and content; and, archiving public domain historical, cultural, and scientific resources.

CONCLUSION

The Forum on Technology in Education: Envisioning the Future marks the beginning of OET's efforts to review and revise the national educational technology plan. A variety of outreach activities will be conducted over the coming months to solicit additional input from stakeholders on the future use of technology in education. Primary among them will be the solicitation of input into the emerging priorities identified during the Forum via a website constructed for that purpose. In addition, further work will be done to refine and elaborate upon the priorities raised at the Forum. A revision of the plan is expected by fall 2000. Additional information about the development of the revised national educational technology plan—including how you can contribute—can be found at the OET website: http://www.ed.gov/Technology.

APPENDIX A
FORUM AGENDA

FORUM ON TECHNOLOGY IN EDUCATION: ENVISIONING THE FUTURE

AGENDA

DECEMBER 1 AND 2, 1999

GEORGETOWN UNIVERSITY CONFERENCE CENTER
WASHINGTON, DC

A WORKING MEETING sponsored by the U.S. Department of Education, Office of Educational Technology

DAY ONE

8:00-8:30	**Continental Breakfast**
8:30-8:35	**Welcome** *Linda Roberts, Office of Educational Technology, U.S. Department of Education*
8:35-8:50	**Opening Remarks** *Marshall Smith, Acting Deputy Secretary, U.S. Department of Education*
8:50-9:00	**Orientation**
9:00-10:00	**Emerging Technologies: A Map of the Horizon (Presentation by Mary O'Hara Devereaux)**
10:00 -11:00	**Technology in K-12 Education: Envisioning a New Future (Presentation by David Thornburg)**
11:00-11:15	**Break**
11:15-12:15	**Extracurriculars as the Curriculum: A Vision of Education for the 21st Century (Presentation by Roger Schank)**
12:15-1:15	**Lunch**
1:15-3:15	**Technology & Content White Paper Presentations (Part I)** **Roy Rosenzweig and Randy Bass (Social Studies/History)** **Steven Rakow (Science)** **Andee Rubin (Mathematics)**
3:15-3:30	**Break**

FORUM ON TECHNOLOGY IN EDUCATION: ENVISIONING THE FUTURE

AGENDA (CONTINUED)

3:30-5:30	**Synthesis of emerging trends, assumptions, and opportunities for leadership**
5:30	**Wrap-up and orientation to tomorrow's work**
	Dinner on own

DAY TWO

8:30-9:00	**Continental Breakfast**
9:00-9:10	**Orientation to Day 2**
9:10-10:30	**Technology & Content White Paper Presentations (Part II)**
	Joan Assey (Arts)
	Linda Labbo (Reading/Language Arts)
10:30-10:45	**Break**
10:45-12:30	**Envisioning the future: Exploring desired future states of education and technology**
12:30-1:30	**Lunch with U.S. Congressman John B. Larson (D—Connecticut)**
1:30-3:00	**Synthesis of emerging trends, assumptions, leadership opportunities: Toward draft national goals for technology in education**
3:00-3:15	**Break**
3:15-4:30	**Prioritization and refinement of draft goals and strategies**
4:30	**Wrap-up and Next Steps**

APPENDIX B
PARTICIPANTS

FORUM ON TECHNOLOGY IN EDUCATION: ENVISIONING THE FUTURE

PARTICIPANTS

TONY AMATO
Hartford Public Schools
Hartford, CT

JOAN ASSEY
Office of the Governor
South Carolina

RANDALL BASS
Georgetown University

JIM BLACKABY
Mystic Seaport
The Museum of America and the Sea

LARRY CUBAN
Stanford University

MARY O'HARA DEVEREAUX
Institute for the Future

DONALD ELY
Syracuse University

RAYMOND FARLEY
Hunterdon Central Regional High School
Flemington, NJ

WELLESLEY "ROB" FOSHAY
TRO Learning, Inc.

CHARLES "CHUCK" HOUSE
Intel Dialogic Division

THOMAS KALIL
National Economic Council

HENRY KELLY
Executive Office of the President

JIM KOHLENBERGER
Office of the Vice President

LINDA LABBO
The University of Georgia

U.S. CONGRESSMAN JOHN LARSON

ALAN LESGOLD
University of Pittsburgh

BARBARA MEANS
SRI International

KATRINA MILLER
National Technology Student Association

STEVEN RAKOW
University of Houston-Clear Lake

DIANE REED
Technology Teacher in Residence
U.S. Department of Education

LINDA ROBERTS
U.S. Department of Education

ROY ROSENZWEIG
George Mason University

ANDEE RUBIN
TERC

NORA SABELLI
National Science Foundation

ROGER SCHANK
Northwestern University

FORUM ON TECHNOLOGY IN EDUCATION: ENVISIONING THE FUTURE

PARTICIPANTS (CONTINUED)

KATHLEEN SCHROCK
Dennis-Yarmouth Regional School District
South Yarmouth, MA

MARSHALL "MIKE" SMITH
U.S. Department of Education

DAVID THORNBURG
The Thornburg Center

TONYA VANDERGRIFF
Powell High School
Knoxville, TN

FORUM STAFF

CECILY DARDEN
American Institutes for Research

TODD ERICKSON
CoVision, Inc.

KAYLA KIRSCH
The Grove Consultants International

DOUGLAS LEVIN
American Institutes for Research

DAVID SIBBET
The Grove Consultants International

CAROLE WACEY
U.S. Department of Education